



# Gulf of Mexico

## Oil Spill & Ecosystem Science Conference

January 21-23, 2013  
*New Orleans, Louisiana*

## Thank You

We would like to thank the Executive Committee for its time and direction in planning the Conference.

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Gulf of Mexico Research Initiative

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National Aeronautics and Space Administration

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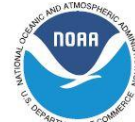
Gulf of Mexico University Research Collaborative

**Denis Wiesenburg**

Gulf of Mexico Research Initiative

We also thank the staff of the Gulf of Mexico Research Initiative Administrative Unit and the Federal Subcommittee on Ocean Science and Technology, who worked so diligently behind the scenes to ensure everything ran smoothly.

And our conference sponsors:



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# Executive Summary

The Gulf of Mexico Oil Spill and Ecosystem Science Conference was held January 21- 23, 2013 in New Orleans, La.

The conference was organized by an Executive Committee composed of representatives of seven federal agencies, the Gulf of Mexico Research Initiative (GoMRI) and Gulf of Mexico University Research Consortium (GoMURC).

The conference announcement and call for scientific session proposals were released in the spring of 2012. Scientific community enthusiasm and need for this conference generated a robust agenda:

- Fifty-three session proposals were received which resulted in the coalescence and/or selection of **19 separate scientific sessions**
- Conference registration produced **1044 registrants** representing 13 countries, 40 states and the District of Columbia, from more than 120 universities internationally, 23 federal agencies, 11 state-level agencies and organizations, and more than 70 businesses and NGOs
- With regard to scientific content, **518 abstracts** were accepted for the Conference; given the number of scientific sessions chosen and participant interest it was impossible to include everyone and not have up to 6 concurrent scientific sessions
- Two and a half days of concurrent sessions with **334 oral presentations** and **184 posters** in three poster sessions
- Student participation was significant with a total of **135 abstracts** submitted by student authors (54 oral and 82 poster)

The opening plenary session consisted of a keynote address by Admiral Thad Allen and five plenary speakers. Adm. Allen gave a highly motivating talk about lessons learned during the Deepwater Horizon event and offered specific suggestions for policy change and moving forward within federal agencies and the interaction across those agencies, state government and the scientific community.

Five plenary speakers were engaged to set the scene for scientific discourse during the conference; topics included reflection on past events as they relate to oil spill chemistry, our state of the knowledge of ecosystem level science, public health and related community science, socio-economics, and policy. The meeting closed with the five plenary speakers providing wrap up suggestions and research gap analysis, along with a combined Q&A and comment session to solicit input from the conference attendees.

Feedback from the plenary speakers and comments by the audience during the closing plenary session formed the basis for discussion about where we have come, recommendations for

# Executive Summary

future research, and suggestions for a future conference. The primary gaps identified included a lack of socioeconomic and public health research. A major need identified was collaboration between all the funding agencies involved in the Gulf of Mexico to leverage their resources and avoid duplication. Some sample bulleted highlights include:

- Research content had good cross-cutting, inter-disciplinary, components of breadth, depth, and diversity
- There was integration of social science and human health research in discussions, though more is needed
- There was a gratifying mix of students and senior researchers – students are our legacy
- Outreach activities show interactions that can inform all stakeholders, needs to continue as we move forward
- Participants engaged in healthy (agree/disagree) dialogue on dispersants
- Encourage more of a balance between risks and rewards of funded research
- Avoid pre-mature synthesis of research but start working now to bring groups together for synthesis discussion
- We should avoid redundancy among science funding agencies and inefficient use of resources
- Hold this meeting again and allow time for interactive workshops with open dialog about gaps
- Lack of higher trophic level work underway (some buried in NRDA)

Conference feedback was also garnered through an online survey of conference participants two weeks after the conference. About 30% of 1044 attendees responded to the post-conference survey and comments were similar to the plenary panel:

- Respondents rated the overall conference positively (4.1/5)
- There was mixed response on the number of concurrent sessions (just right vs. too many)
- Over 80% said their knowledge/skills increased and they intend to use what they learned and will recommend the conference to others
- Over 75% plan to attend next year

This and other feedback will be incorporated into the planning and design of the 2<sup>nd</sup> Annual Gulf of Mexico Oil Spill and Ecosystem Science conference to be held January 2014 in Mobile, Alabama.

# Agenda

Monday, January 21, 2013

## Opening Plenary Session [8:00am – 10:00am]

### Welcome Remarks

Dr. Rita Colwell  
Gulf of Mexico Research Initiative

### Keynote Speaker

Admiral Thad Allen  
United States Coast Guard, Retired  
Booz Allen Hamilton

### Plenary Panel

#### Introduction:

Dr. Robert Detrick  
National Oceanic and Atmospheric Administration

#### Speakers:

Dr. John Farrington  
University of Massachusetts-Dartmouth

Dr. Steven Murawski  
University of South Florida

Dr. Maureen Lichtveld  
Tulane University

Dr. Michael Orbach  
Duke University

Dr. Holly Bamford  
National Oceanic and Atmospheric Administration

# Agenda

Monday, January 21, 2013

## Science Sessions [10:30am – 12:30pm]

**Session 007:** Ecosystems of the open ocean: microbes, mammals and models--Analysis and modeling

**Session 009:** The submesoscale route to transport and mixing.

**Session 012:** Socio-economic impacts of the Deepwater Horizon oil spill.

**Session 016:** Time series studies of the impacts of oil and gas releases in the northern Gulf of Mexico.

**Session 017:** Technological, environmental and policy developments for improved research in the Gulf of Mexico.

**Session 018:** Remote sensing and the Deepwater Horizon oil spill.

## Science Sessions [2:00pm – 4:30pm]

**Session 004:** Dispersants: New developments in science and technology and implications to deep sea oil releases.

**Session 006:** Ecosystems of the open ocean: microbes, mammals and models--Higher trophic level studies.

**Session 008:** Physical oceanography of the northern Gulf of Mexico.

**Session 012:** Socio-economic impacts of the Deepwater Horizon oil spill.

**Session 016:** Time series studies of the impacts of oil and gas releases in the northern Gulf of Mexico.

**Session 018:** Remote sensing and the Deepwater Horizon oil spill.



# Agenda

Monday, January 21, 2013

## Poster Session [5:00pm – 6:30pm]

**Session 004:** Dispersants: New developments in science and technology and implications to deep sea oil releases.

**Session 006:** Ecosystems of the open ocean: microbes, mammals and models--Higher trophic level studies.

**Session 007:** Ecosystems of the open ocean: microbes, mammals and models--Analysis and modeling.

**Session 008:** Physical oceanography of the northern Gulf of Mexico.

**Session 009:** The submesoscale route to transport and mixing.

**Session 012:** Socio-economic impacts of the Deepwater Horizon oil spill.

**Session 016:** Time series studies of the impacts of oil and gas releases in the northern Gulf of Mexico.

**Session 017:** Technological, environmental and policy developments for improved research in the Gulf of Mexico.

**Session 018:** Remote sensing and the Deepwater Horizon oil spill.

# Agenda

Tuesday, January 22, 2013

## Science Sessions

[8:30am – 10:30am], [11:00am – 12:30pm], [2:00pm – 4:00pm]

**Session 001:** Chemical methods for comprehensive oil spill analysis.

**Session 002:** Coastal inshore impacts of oil: From mousse to food webs.

**Session 004:** Dispersants: New developments in science and technology and implications to deep sea oil releases.

**Session 010:** Advances in modeling the Gulf of Mexico.

**Session 011:** Public health impacts of the Deepwater Horizon oil spill.

**Session 015:** Biodegradation pathways and environmental impacts of hydrocarbon discharge.

## Poster Session [4:30pm – 6:00pm]

**Session 001:** Chemical methods for comprehensive oil spill analysis.

**Session 002:** Coastal inshore impacts of oil: From mousse to food webs.

**Session 011:** Public health impacts of the Deepwater Horizon oil spill.

# Agenda

Wednesday, January 23, 2013

## Poster Session [8:30am – 10:30am]

**Session 003:** Data management and informatics: Supporting Gulf of Mexico research

**Session 005:** Ecosystems of the open ocean: microbes, mammals and models--Lower trophic level studies

**Session 010:** Advances in modeling the Gulf of Mexico

**Session 013:** Hydrocarbon distributions, cycling and impacts in blue water benthic and pelagic environments

**Session 014:** Oil droplets and particles

**Session 015:** Biodegradation pathways and environmental impacts of hydrocarbon discharge

**Session 019:** Models and observations working together to understand the Deepwater Horizon oil spill.

## Science Sessions [10:30am – 12:30pm]

Session 002. Coastal inshore impacts of oil: From mousse to food webs

Session 005. Ecosystems of the open ocean: microbes, mammals and models--Lower trophic level studies

Session 010. Advances in modeling the Gulf of Mexico

Session 013. Hydrocarbon distributions, cycling and impacts in blue water benthic and pelagic environments

Session 014. Oil droplets and particles

Session 019. Models and observations working together to understand the Deepwater Horizon oil spill.

## Science Sessions [2:00pm – 4:30pm]

**Session 003:** Data management and informatics: Supporting Gulf of Mexico research

**Session 005:** Ecosystems of the open ocean: microbes, mammals and models--Lower trophic level studies

**Session 013:** Hydrocarbon distributions, cycling and impacts in blue water benthic and pelagic environments

**Session 014:** Oil droplets and particles

**Session 015:** Biodegradation pathways and environmental impacts of hydrocarbon discharge

**Session 019:** Models and observations working together to understand the Deepwater Horizon oil spill.

# Agenda

Wednesday, January 23, 2013

**Closing Plenary Session** [5:00pm – 6:10pm]

## Closing Plenary Panel

### Introduction:

Dr. Jerry Miller

Office of Science and Technology Policy  
Subcommittee on Ocean Science and Technology

### Facilitator:

Ms. Heidi Stiller

National Oceanic and Atmospheric Administration

### Speakers:

Dr. John Farrington

University of Massachusetts-Dartmouth

Dr. Steven Murawski

University of South Florida

Dr. Maureen Lichtveld

Tulane University

Dr. Rex Caffey

Louisiana State University

Dr. Holly Bamford

National Oceanic and Atmospheric Administration

## Presentation of Student Awards

Dr. Robert Gagosian

Consortium for Ocean Leadership

## Closing Remarks

Dr. Rita Colwell

Gulf of Mexico Research Initiative

# Keynote Speaker



## Admiral Thad Allen

United States Coast Guard, Retired

Admiral Thad Allen (United States Coast Guard, Retired) is a Senior Vice President at Booz Allen Hamilton, and provides thought leadership and client engagement for the Departments of Justice and Homeland Security and also contributes to other initiatives in energy, defense and international markets. He retired from the United States Coast Guard after serving as the 23rd Commandant in June 2010. Prior senior leadership assignments included Chief of Staff of the Coast Guard, Atlantic Area Commander, Commander of the Seventh Coast Guard District (Southeast US and Caribbean Region), and Coast Guard Director of Resources.

In 2005, Allen was selected by President George W. Bush to lead the response to Hurricanes Katrina and Rita as the Principal Federal Official. In 2010, he was selected by President Obama to lead the response to the Deepwater Horizon oil spill as the National Incident Commander.

In 39 years of service in the Coast Guard, Allen served in wide variety of operational assignments including commands at sea and ashore. He is a 1971 graduate of the Coast Guard Academy (BS in Management) and earned Masters Degrees at The George Washington University (Public Administration) and MIT Sloan School of Management (Management Science).

Allen is a Fellow in the National Academy of Public Administration and a member of the Council on Foreign Relations. He serves as a Director with the Coast Guard Foundation and the Partnership for Public Service. From 2010 to 2011, he served as a Senior Fellow at the RAND Corporation.

A native of Tucson, Arizona, Allen now resides in Vienna, VA with his wife Pam. They have three grown children, Amanda, Meghan, and Lucas.

# Plenary Speakers



John W. Farrington, Ph.D.

University of Massachusetts Dartmouth

## The Deep Water Horizon Oil Spill: Fates and Effects Research Progress. Why Was The Spill Plume and Fate and Effects A “Surprise”?

(Dedicated to the 11 people who lost their lives.) Research and experience with oil spills of the 1950s to 2000s provided U.S. government and state agencies with knowledge about how to respond to the DWH spill despite the enormity of the spill and deep water setting. Given rapid response funding from various sources, the scientific research community responded with agility and brought cutting edge scientific methods and discoveries to the study of the spill. Advanced remote sensing methodology, instruments and modeling capabilities of Ocean Observing Systems, new sampling devices, autonomous and tethered underwater vehicles, human occupied submersible vehicles, new analytical chemistry methodologies, and advances in molecular biology for assessing microbial community responses to the spilled oil and gas have provided a rich new knowledge of fates and effects of spilled oil and dispersants in deep water and shallower areas. Even given that hind-sight is usually 20/20, it is important to state that the DWH spill and its underwater plume were anticipated in rough form by experiences with the 1979 Ixtoc I oil well blowout in the Bay of Campeche, Gulf of Mexico, by experiments and modeling, and by an explicit discussion in the 2003 U. S. National Research Council Review Oil in the Sea III. The interface between scientific recommendations and government responses needs strengthening to avoid future surprises.” Furthermore, academic institutions, their governing bodies and researchers need to review lessons to be learned from their interactions with the media during the spill and its aftermath.

### About Dr. Farrington

John W. Farrington is Provost and Vice Chancellor for Academic and Student Affairs (Interim) at the University of Massachusetts Dartmouth and Scientist Emeritus at Woods Hole Oceanographic Institution. He served as Associate Director for Education and Dean of Woods Hole Oceanographic Institution from 1990- 2002, and as Vice President for Academic Programs and Dean 2002-2005.

His scholarly interests include marine organic geochemistry, biogeochemistry of organic pollutants (including oil spills and chronic petroleum releases to the marine environment), biochemistry of marine organisms, environmental quality issues, science education, and science-policy and science-religion interactions. Dr. Farrington has been a member of advisory committees for several international, national, state and local agencies and organizations. He has testified several times before the U.S. Congress on matters pertaining to oceanic and coastal environmental quality issues. He testified before the National Commission on the Deepwater Horizon Oil Spill and Offshore Drilling.

His honors include the Massachusetts Marine Educators Association Award of Distinction in 1997 and the University of Rhode Island Alumni Association Award for Excellence in Research in 1998. “For leadership in promoting science and its use in sound decision-making,” he was awarded the U.S. Geological Survey Ambassador for Science Award in April 2001. “For distinguished service to the environment and community,” he was awarded the David B. Stone Award from the New England Aquarium in September 2001. In October 2003, he was awarded the Bostwick H. Ketchum Award from Woods Hole Oceanographic Institution “in recognition of achievements in science, education, and policy concerning the input and fate of organic contaminant chemicals in the marine environment.” In November 2003, he received a life appointment as a National Associate of the U.S. National Academies, “in recognition of extraordinary service to the National Academies in its role as advisor to the nation in matters of science, engineering, and health.” In 2009, he received the Doctor Honoris Causa from the University of Concepcion, Concepcion, Chile in 2009, the Samuel P. Stone Award for Alumni Achievement in Sciences of the College of Arts and Sciences University of Massachusetts Dartmouth and was elected a Fellow of the AAAS. Dr. Farrington received the Chancellor’s Medal from University of Massachusetts Dartmouth in 2011.

## About Dr. Murawski

Steven A. Murawski is Professor and the St. Petersburg Partnership—Peter Betzer Endowed Chair of Biological Oceanography at the University of South Florida, College of Marine Science in St. Petersburg, Florida. Dr. Murawski is a fishery biologist with 37 years of professional experience.

Prior to the University of South Florida, he worked at NOAA for 35 years, where he retired as the Director of Scientific Programs and Chief Science Advisor for the National Marine Fisheries Service, directing the activities of 4,000 employees located in 22 laboratories. Since coming to the Gulf of Mexico region he has been actively involved in assessing the environmental impacts of the Deepwater Horizon oil spill, and its implications for fisheries in the Gulf of Mexico.

Murawski serves as Principal Investigator for the Center for Integrated Modeling and Analysis of Gulf Ecosystems (C-IMAGE) funded through the Gulf of Mexico Research Initiative. In addition to research on oil spill impacts, he has an active program ongoing to assess the status of fishery stocks in the Gulf of Mexico, with particular emphasis on reef fish stocks. This includes a program to develop new technologies focusing on remote sensing applications. He is involved in research on marine Protected Areas and in climate effects on fisheries.

Dr. Murawski continues to be involved in international fisheries and marine science activities, recently serving a term as vice-president and U.S. delegate to the International Council for the Exploration of the Seas, and external advisor to the United Nations Food and Agriculture's Ecosystem Approaches to Management program in Africa. Additionally, he was recently named by the National Academy of Sciences as a member of the U.S. Committee for the International Institute for Applied Systems Analysis, and as a member of the Gulf of Mexico Fishery Management Council's Ecosystem Scientific and Statistical Committee. His Ph.D. in Wildlife and Fisheries Biology was conferred in 1984 from the University of Massachusetts-Amherst.

# Plenary Speakers

Steven A. Murawski, Ph.D.

University of South Florida



## If I were Poseidon: Right-Sizing a Coastal and Ocean Observing System for the Gulf of Mexico

The Deepwater Horizon (DWH) oil spill and ongoing recovery process has again highlighted the criticality of broad-based, goal-oriented ocean and coastal observing to serve the needs of natural resource management and disaster preparedness. Current ocean observing efforts in the Gulf of Mexico are underfunded, fragmented, relatively un-coordinated and obtuse to most of the scientific community and surely the public. A new, right-sized effort must build upon what is working by enhancing the temporal and spatial coverage of some efforts, and embarking on bold, innovative approaches to meet the requirements that are the most acute. The use of cost-effective technologies, proven useful in the DWH response, can help to provide proper baselines for important biological, chemical and physical oceanographic metrics, in a cost-effective manner.

If I were the king of the seas, I would employ the following principles in designing the Gulf of Mexico observing system of the future: (1) understanding DWH (and any other significant, ephemeral event) in the larger Gulf context, (2) monitoring the recovery of the Gulf for broad-based and project-specific outcomes employing an hierarchical, science-based approach, (3) preparing for the next environmental catastrophe, (4) building physical and human capacity to assess resource status and evaluate societal choices and conflicts when making

resource management decisions, and (5) demonstrating greater transparency in the operations of those sectors using and those responsible for managing Gulf resources. Specific gaps and priorities require consensus among federal, state, industry and academic partners, but include more comprehensive environmental baselines, improved assessments of the status of fisheries and other biological resources, and improved monitoring of ocean conditions, including hydrocarbon budgets and fates.



# Plenary Speakers



Maureen Y. Lichtveld, M.D.

Tulane University

## Recipe for a Healthy Gulf Coast: Linking Community and Ecosystem Health

The health of the Gulf Coast ecosystem and that of its communities is inextricably linked. Communities living in this disaster prone area also suffer historic burdens of health disparities and lack access to the basic pillars of public health. Sustainable solutions to persistent threats posed to the ecosystem and human health must be system-driven, interdependently benefiting both environment and people. Research—whether to strengthen the science base or to address critical data gaps—will only be effective if designed in a transdisciplinary fashion and implemented by a collaborative of scientists and communities.

In the aftermath of the Gulf of Mexico oil spill, the Institute of Medicine (IOM) identified five human health research priorities: psychosocial and behavioral effects, emphasizing vulnerability and resilience; exposure to oil, dispersants and by-products of controlled burns; short-and long-term seafood safety; communication and engagement methods in disaster research; and designing a rapid response research framework.

The current paucity of human health research compared to that targeting the ecosystem not only limits our ability to effectively implement a research portfolio responsive to IOM's priorities, but also our opportunity to comprehensively examine factors interdependently influencing human- and ecosystem health.

Beyond seeking answers to complex questions within the purview of traditional research, Gulf Coast communities also make the case for capacity building in public health as envisioned by the Gulf Region Health Outreach Program. This conference provides an unprecedented opportunity to set the stage for developing a sustainable Gulf Coast roadmap for both research and capacity building.

### About Dr. Lichtveld

Maureen Lichtveld has more than 30 years expertise in environmental public health and currently is Professor and Chair of the Department of Global Environmental Health Sciences at Tulane University School of Public Health and Tropical Medicine. Her research interests include environmental health policy, community-based participatory health disparities research, disaster preparedness, and health systems.

Dr. Lichtveld is currently the Principal Investigator of the NIH-funded Gulf Coast Research Consortium on Women's Health (GROWH), a community- academic research collaborative addressing reproductive health issues in vulnerable communities post the oil spill.

She served as a member of the Planning Committee for the 2010 National Academies Institute of Medicine workshops on the Gulf of Mexico oil spill, which resulted in two reports on the effects of the oil spill on human health and plans for a long-term follow up study.

Dr. Lichtveld serves on numerous national and global editorial boards of peer reviewed journals and chaired several professional boards, including the Environmental and Occupational Health Council of the Association of Schools of Public Health (2012), the Science Board of the American Public Health Association (2010), the human health workgroup of the National Science and Technology Council's Joint Subcommittee on Ocean Science and Technology Principal Investigator's conference to address the impact of the Gulf of Mexico oil spill (2010), and the Board of the National Public Health Leadership Society (2011). She received an MPH from the Johns Hopkins University, School of Hygiene & Public Health, Environmental Health Sciences and her M.D. from the University of Suriname.



### About Dr. Orbach

Michael K. Orbach is Professor of Marine Affairs and Policy and Director of the Coastal Environmental Management Program in the Nicholas School of the Environment at Duke University. He has worked as Social Anthropologist and Social Science Advisor with the National Oceanic and Atmospheric Administration; Associate Director of the Center for Coastal Marine Studies at the University of California at Santa Cruz; and Professor of Anthropology in the Department of Sociology and Anthropology at East Carolina University. He joined the Duke Marine Laboratory in 1993 and was Director of the Marine Laboratory from 1998 to 2006. Dr. Orbach has performed research and has been involved in coastal and marine policy on all coasts of the U.S. and in Mexico, Central America, the Caribbean, Southeast Asia, Europe, Alaska and the Pacific, and has published widely on social science and policy in coastal and marine environments. He was a formal advisor to both the U.S. Commission on Ocean Policy and the Pew Ocean Commission, has served on the Ocean Studies Board of the National Research Council, and has held numerous other appointments to Boards and Commissions, both public and private.

### About Dr. Caffey

Rex H. Caffey is a Professor of Natural Resource Economics at Louisiana State University. For more than 20 years, he has conducted applied research and extension programming related to the economic and policy challenges of fisheries and coastal wetlands. In 2011, Dr. Caffey was named Director of Marine Extension for the LSU Agricultural Center and the Louisiana Sea Grant College Program. This coastal network of 18 community embedded agents has been the primary extension liaison for marine research in Louisiana for more than 40 years. Caffey is also founding Director of the LSU Center for Natural Resource Economics and Policy (CNREP). Established in 2003, CNREP fosters the interaction of social science researchers to address natural resource management challenges at the state and regional level. In the past decade, CNREP has expanded to 28 cooperators at 8 institutions and obtained more than \$10 million in extramural research funds from 43 public and private entities. Through these activities, CNREP has emerged as a primary source of socioeconomic expertise to state and federal agencies in the northern U.S. Gulf of Mexico.

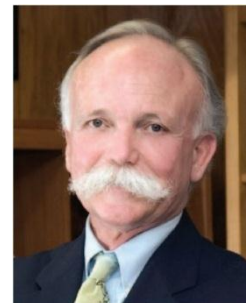
# Plenary Speakers

Michael K. Orbach, Ph.D.

Duke University

Rex H. Caffey, Ph.D.

Louisiana State University



## The Socio-Economics of Gulf of Mexico Oil Spills

As with many other areas of conservation and natural resource policy and management, our documented scientific knowledge of the social and economic aspects of oil spills lags behind that of the biophysical sciences. This is primarily due to the small amounts of funding and social scientific expertise available compared to the biophysical sciences and restrictions due to litigation. However, it is ironically “fortunate” for the Gulf of Mexico that both natural and human-derived events such as hurricanes and oil spills have resulted in data sets sponsored by state and federal agencies developed to assess the impacts of these events or to create baselines for such assessments. Several points need to be made concerning social and economic variables related to oil exploration and development, including spills: 1) the social and economic (S/E) portions of the “ecosystem” – which are defined as including human and institutional systems – are just as amenable to scientific description and analysis as are the biophysical systems, often at lower cost; 2) the S/E systems related to oil spills are not independent of other Gulf S/E systems. For example, labor tends to be mobile between the fishing and oil industries, making the assessment of impacts dependent on the nature of such mobility; 3) the field of non-market valuation related to oil spills, for example the value of ecosystem services from coastal marshlands, is underdeveloped; 4) the assessment of overall S/E impact is difficult to represent in one single “optimal” solution, but is rather dependent on the value choices we make with respect



to various states of the biophysical and human portions of the ecosystem; and 5) a great deal of the available S/E information available is not used or not used effectively.

# Plenary Speakers



**Holly A. Bamford, Ph.D.**

National Oceanic and Atmospheric Administration

## Research and Perspective on DWH Progress and Next Steps

The health of the Gulf of Mexico large marine ecosystem (LME) is of vital importance to the United States for both economic and ecological reasons. The Deepwater Horizon spill created wide-spread economic, environmental, and human health challenges many of which are ongoing. Research conducted since the spill by industry, academia, and the government is helping us better understand the impacts of spills and improve response and recovery efforts. A number of cross-disciplinary studies, such as the impacts of oil on benthos and sediment quality, and impacts of oil and dispersant in coastal ecosystems have filled key gaps in our knowledge and improved our understanding.

Moving forward, there is still a great need for a Gulf-wide integrated ecosystem model with baseline data so when stressors happen, we can understand the impacts and possible solutions. Thus, a real need exists for a mechanism for coordination of the science being done across the Gulf to fill key gaps in our knowledge and improve our understanding of the Gulf LME. One coordinating mechanism to consider is the Gulf of Mexico Coordinated Ecosystem Restoration Research, Monitoring, Observations, Science, and Technology (CERRMOST) Program under the RESTORE Act. This is a science program to achieve an integrative, holistic understanding of the Gulf of Mexico ecosystem and support restoration efforts and the long-term sustainability of the ecosystem. The coordination and integration of government, academic, and industry science programs is vital to ensure priority research is conducted to provide the integrated interdisciplinary understanding of how the ecosystem works today and will respond to tomorrow's coastal and ocean pressures.

### About Dr. Bamford

Holly Bamford is the National Oceanic and Atmospheric Administration's (NOAA) Deputy Assistant Administrator for the National Ocean Service (NOS), managing the financial and business operations while strategically improving the agency's performance to meet its vast ocean science and service missions. In this position, Dr. Bamford's many responsibilities recently included that of NOAA Incident Coordinator during the aftermath of Hurricane Sandy. Under her leadership, NOS executed emergency response efforts including navigation surveys of the New York port area to quickly restore the region's maritime commerce.

Previously, as the first Director of NOAA's Marine Debris Program in 2005, Dr. Bamford brought national recognition to issues related to marine debris and to the program, accomplishments that were recognized with a NOAA Administrator's Award in 2008.

Dr. Bamford has a number of widely referenced publications in the field of environmental chemistry and water quality, including papers in Environmental Science & Technology and Environmental Toxicology & Chemistry.

She has received a number of awards for her exceptional leadership and partnership skills including a NOAA Bronze Medal and two Coastal America Presidential Partnership Awards.

Dr. Bamford has served on a number of science and advisory committees, including Chairperson on the Federal Interagency Marine Debris Coordinating Committee and at the 2007 Ocean Policy Forum in South Korea. She has presented at a number of international meetings and academic institutions and given interviews to national media outlets including CNN, Good Morning America, Rolling Stone Magazine, and the Wall Street Journal.

# Science Sessions

## 001 CHEMICAL METHODS FOR COMPREHENSIVE OIL SPILL ANALYSIS

This session will feature presentations on state-of-the-art analytical techniques for characterizing the chemical constituents of the Macondo wellhead crude oil as well as its photochemical- and bio-degradation, and other processes after the spill. GCxGC provides the most detailed chemical inventory of volatile organics containing up to ~35 carbons. High-field FT-ICR mass spectrometry reveals >62,000 different chemical formulas (C<sub>c</sub>H<sub>h</sub>N<sub>n</sub>S<sub>s</sub>O<sub>o</sub>) from the wellhead oil, and at least twice that number of species in tar balls collected after the spill. HPLC-2 separates species according to the number of aromatic rings (1, 2, 3, 4, >5) and can also speciate sulfur-containing molecules (RSH, RSR, RSSR, thiophenes). Other relevant instrumentation includes: bulk analysis (CHNO, NMR, optical spectroscopy, etc.), time-of-flight mass spectrometry, and various atmospheric pressure ionization methods for mass spectrometry.

### Session Chairs:

Christopher Reddy Woods Hole Oceanographic Institution

Alan Marshall Florida State University

## 002 COASTAL INSHORE IMPACTS OF OIL: FROM MOUSSE TO FOOD WEBS

Environmental stressors such as those arising from hydrocarbon spills can have visible and immediate direct impacts on coastal ecosystems due to physical and toxic effects on organisms or their habitat. Stressors also have indirect effects because, as they begin to degrade, the compounds enter food webs via primary consumers such as suspension-feeding oysters, deposit-feeding bivalves, and grazing snails. These consumers, in turn, are food sources for organisms at higher trophic levels, including humans. The effects of a major environmental stressor can, therefore, cascade through the community as members of lower trophic levels undergo changes in growth, mortality, and reproductive success, and as species turnover occurs and metabolic pathways are altered for days, weeks and even years. This session invites contributions on how coastal salt marsh food webs were affected, or not, by the Deepwater Horizon oil spill in the Gulf of Mexico. This includes data-rich presentation on soil microbes, the dominant aquatic plant (cordgrass, *Spartina alterniflora*), infauna, fish, bivalves, filter-feeders and the symbiotic invertebrate community.

### Session Chairs:

R. Eugene Turner Louisiana State University

Linda Hooper-Bui Louisiana AgCenter

# Science Sessions

## 003 DATA MANAGEMENT AND INFORMATICS: SUPPORTING GULF OF MEXICO RESEARCH

Observational and modeling studies of the atmosphere, oceans, estuaries and ecosystems of the Gulf of Mexico and policy studies are increasing in number due in part to \$500M supporting new research between now and 2020. These will be large heterogeneous data sets and model outputs. The challenge is to assemble, analyze and make intelligent decisions based on these data sets. Data management, the stewardship of data, and informatics, the science of processing, managing, and retrieving information are critical to flow of valid data from sensor to desktop and from observations to knowledge. A number of groups such as the Gulf of Mexico Research Initiative Information and Data Cooperative (GRIIDC), NOAA's National Coastal Data Development Center (NCDDC), and the Gulf of Mexico Coastal Ocean Observing System Regional Association (GCOOS-RA), together with many dedicated individual data managers have developed computer system frameworks and tools that allow researchers and resource managers to locate, retrieve and visualize observations and model output more easily. This session invites all of those people working to integrate comprehensive environmental data sets and model output and other data with application to scientifically-based decision-making especially in the context of oil spill response and restoration and policy to submit abstracts on their work.

### Session Chairs:

Matthew Howard Texas A&M University

Dave Reed Florida Fish and Wildlife Conservation Commission

## 004 DISPERSANTS: NEW DEVELOPMENTS IN SCIENCE AND TECHNOLOGY AND IMPLICATIONS TO DEEP SEA OIL RELEASES

The session will focus on the use of dispersants to mitigate the effects of deep sea oil releases. Topics include (a) understanding dispersant effectiveness in deep sea environments, (b) the fate and transport of dispersed oil and dispersant components with specific relevance to the formation of subsurface plumes, (c) new concepts in the development of improved dispersants, (d) chemical analysis of dispersants, (e) biodegradation of dispersant-oil mixtures, and (f) fate and transport of dispersant and dispersed oil. The session will focus on the fundamental physical and biological sciences related to dispersant development and use.

### Session Chairs:

Vijay John Tulane University

Kalliat Valsraraj Louisiana State University

Jennifer Field Oregon State University

# Science Sessions

## 005. ECOSYSTEMS OF THE OPEN OCEAN: MICROBES, MAMMALS AND MODELS—LOWER TROPHIC LEVEL STUDIES

The health of offshore ecosystems of the Gulf of Mexico, including fisheries, is an ongoing concern following the Deepwater Horizon (DWH) oil spill, but also because of multiple coincident stressors including ongoing habitat loss, nutrient enrichment, effects of harvesting and input of contaminants. Impacts of human activities on species and on the productivity potential of the region are of importance to regulators and the public, as are public perceptions regarding environmental quality. This session will examine information on the abundance, distribution, and contamination levels of various species and trophic levels, and will explore the development of ecosystem models and other decision support tools. Session components will emphasize synthesis of sampling information on the impacts to species and ecosystems as well as the mechanisms of injury from the DWH oil spill and their recovery potential. Now that some baselines have been determined, how should these data be augmented and analyzed to elucidate impacts and prioritize recovery potentials? How can models be used in concert with empirical sampling? In particular the session will emphasize impacts on low trophic levels (bacteria to plankton and benthos), and high trophic levels (fisheries and protected species like sea turtles, birds and mammals, to human use aspects). The modeling component of the session will examine linkages of food web structure, productivity and biodiversity to single- and multiple simultaneous stressors on the Gulf of Mexico offshore ecosystem.

The Lower Trophic Level Studies section will focus on bacteria, algae, benthos, and plankton studies. Algal studies may include both sessile forms and sargassum. Benthic studies will include deep coral and other biogenic communities in addition to continental shelf sessile communities. Plankton studies will include phyto-, zooplankton ecology.

### Session Chairs:

Steven Murawski University of South Florida

Suzanne Fredericq University of Louisiana at Lafayette

Darryl Felder University of Louisiana at Lafayette

Janis Kurtz EPA Gulf Ecology Division

Rebecca Allee NOAA Gulf Coast Services Center

Cameron Ainsworth University of South Florida

# Science Sessions

## 006. ECOSYSTEMS OF THE OPEN OCEAN: MICROBES, MAMMALS AND MODELS—HIGHER TROPHIC LEVEL STUDIES

The health of offshore ecosystems of the Gulf of Mexico, including fisheries, is an ongoing concern following the Deepwater Horizon (DWH) oil spill, but also because of multiple coincident stressors including ongoing habitat loss, nutrient enrichment, effects of harvesting and input of contaminants. Impacts of human activities on species and on the productivity potential of the region are of importance to regulators and the public, as are public perceptions regarding environmental quality. This session will examine information on the abundance, distribution, and contamination levels of various species and trophic levels, and will explore the development of ecosystem models and other decision support tools. Session components will emphasize synthesis of sampling information on the impacts to species and ecosystems as well as the mechanisms of injury from the DWH oil spill and their recovery potential. Now that some baselines have been determined, how should these data be augmented and analyzed to elucidate impacts and prioritize recovery potentials? How can models be used in concert with empirical sampling? In particular the session will emphasize impacts on low trophic levels (bacteria to plankton and benthos), and high trophic levels (fisheries and protected species like sea turtles, birds and mammals, to human use aspects). The modeling component of the session will examine linkages of food web structure, productivity and biodiversity to single- and multiple simultaneous stressors on the Gulf of Mexico offshore ecosystem.

The Higher Trophic Level Studies section will include ichthyoplankton, juvenile and adult fish abundance and distribution, toxicology and fish diseases in relation to the DWH spill, monitoring studies of birds, sea turtle populations and marine mammal abundance monitored with aircraft, ships and passive acoustics.

### Session Chairs:

Steven Murawski University of South Florida

Suzanne Fredericq University of Louisiana at Lafayette

Darryl Felder University of Louisiana at Lafayette

Janis Kurtz EPA Gulf Ecology Division

Rebecca Allee NOAA Gulf Coast Services Center

Cameron Ainsworth University of South Florida



# Science Sessions

## 007. ECOSYSTEMS OF THE OPEN OCEAN: MICROBES, MAMMALS AND MODELS—ANALYSIS AND MODELING

The health of offshore ecosystems of the Gulf of Mexico, including fisheries, is an ongoing concern following the Deepwater Horizon (DWH) oil spill, but also because of multiple coincident stressors including ongoing habitat loss, nutrient enrichment, effects of harvesting and input of contaminants. Impacts of human activities on species and on the productivity potential of the region are of importance to regulators and the public, as are public perceptions regarding environmental quality. This session will examine information on the abundance, distribution, and contamination levels of various species and trophic levels, and will explore the development of ecosystem models and other decision support tools. Session components will emphasize synthesis of sampling information on the impacts to species and ecosystems as well as the mechanisms of injury from the DWH oil spill and their recovery potential. Now that some baselines have been determined, how should these data be augmented and analyzed to elucidate impacts and prioritize recovery potentials? How can models be used in concert with empirical sampling? In particular the session will emphasize impacts on low trophic levels (bacteria to plankton and benthos), and high trophic levels (fisheries and protected species like sea turtles, birds and mammals, to human use aspects). The modeling component of the session will examine linkages of food web structure, productivity and biodiversity to single- and multiple simultaneous stressors on the Gulf of Mexico offshore ecosystem.

The Ecosystem Analysis and Modeling section will explore the various statistical and population-dynamic modeling approaches being used to investigate Deepwater Horizon oil spill impacts and project the recovery of marine populations and more generally the analysis of offshore ecosystems in relation to anthropogenic stressors. Topics will include data integration, ecosystem classification, tool development, model structure/function, and modeling applications (e.g., bioaccumulation, population-level impacts of disease, predator-prey linkages and ecosystem functioning, ecological indicator testing, and ecosystem recovery). Modeling approaches at the species level are aimed at identifying firstorder impacts, while community and ecosystem-based modeling approaches may be used to look for cumulative and synergistic population effects. Model coupling has emerged as one promising tool for integrating physical oceanography with population dynamics and representing population dynamics across multiple spatial and temporal scales. Such attempts often require cross-disciplinary collaboration.

### Session Chairs:

Steven Murawski University of South Florida

Suzanne Fredericq Univ of Louisiana at Lafayette

Darryl Felder Univ of Louisiana at Lafayette

Janis Kurtz EPA Gulf Ecology Division

Rebecca Allee NOAA Gulf Coast Services Center

Cameron Ainsworth University of South Florida

# Science Sessions

## 008. PHYSICAL OCEANOGRAPHY OF THE NORTHERN GULF OF MEXICO

The behavior of the BP Macondo oil spill was governed by physics. Of particular interest is the question of how the Deep Water Horizon oil spill was able to go from water a mile deep to reach the zero depth coast in the Northern Gulf of Mexico. This session calls for papers on past, present and planned observational, theoretical and numerical model results for the physical oceanography of the Northern Gulf of Mexico and its impact on the distribution of chemical and biological properties.

### Session Chairs:

Piers Chapman Texas A&M University

Steven DiMarco Texas A&M University

Allan Clarke Florida State University

## 009. THE SUBMESOSCALE ROUTE TO TRANSPORT AND MIXING

This session aims to bring together biological, chemical, and physical oceanographers to discuss the influence of submesoscale dynamics and coherent structures on the ocean transport, mixing and dispersion. Understanding, sampling and resolving the processes occurring at the submesoscale in the ocean (lateral scales comprised between 100 m and 10 km), is especially important for the multi-scale interactions and energy balance in the ocean, and for biogeochemical transport, dispersion and mitigation of pollutants. Submesoscale and mesoscale processes pose a significant challenge to both observations and modeling, in that the interaction of a wide range of spatial and temporal scales must be captured simultaneously. We welcome presentations related to developments in theory, field observations and numerical modeling studies that shed insight into Lagrangian coherent structures, submesoscale oceanic processes and their impacts on transport, mixing and dispersion.

### Session Chairs:

Tamay Ozgokmen University of Miami

Annalisa Bracco Georgia Institute of Technology

Helga Huntley University of Delaware



# Science Sessions

## 010. ADVANCES IN MODELING THE GULF OF MEXICO

This session will highlight the latest advances made in modeling the Gulf of Mexico from the coastal zone to the deep ocean, including representation of air-sea interaction, extreme events, waves, biochemical and sediments' processes. In particular, we would like to encourage submissions that emphasize cutting-edge computational approaches that would shed light on the complex interaction between multiple spatial and temporal scales occurring in the Gulf of Mexico and uncertainty quantification. This would include direct numerical simulations, large eddy simulations, unstructured mesh models, parameterizations, ensemble methods, mixed-layer dynamics, multi-phase flows, and downscaling.

### Session Chairs:

Eric Chassignet Florida State University

Tamay Ozgokmen University of Miami

Shuyi Chen University of Miami

Mohamed Iskandarani University of Miami

## 011. PUBLIC HEALTH IMPACTS OF THE DEEPWATER HORIZON OIL SPILL

Each environmental or man-made disaster, with its potential health consequences, is unique. However, valuable lessons can be learned from each one that can inform responses and public health approaches for future disasters, thereby reducing both acute and long-term adverse health effects. Along the Gulf Coast, communities face multiple interdependent stressors, including a disaster-prone environment, persistent environmental health threats, and historic disparities in health, socioeconomics, and other factors. Recent natural and technological disasters, such as the Deepwater Horizon oil spill, draw attention to the interconnectedness of ecosystems and human health. This session will address an array of response and research activities related to health impacts during and after the oil spill, including: training of oil spill response workers; evaluation of potential health effects in workers and community members; analysis of oil and dispersant composition, exposure routes and effects; physical and mental health outcomes in affected communities; public health surveillance and assessments at the regional, state, and community levels; and means to assess and enhance community resiliency.

### Session Chairs:

Allen Dearry National Institute of Environmental Health Sciences

Julia Gohlke University of Alabama at Birmingham

# Science Sessions

## 012. SOCIO-ECONOMIC IMPACTS OF THE DEEPWATER HORIZON OIL SPILL

While much of the research being conducted in response to the Deepwater Horizon oil spill is directed to technology, deep-sea environment, and coastal ecosystems, there are many less tangible impacts related to economic gain/hardship and especially to effects on social systems. Many local communities, especially in the north-central Gulf of Mexico coastal region, depend on a combination or alteration of oil and gas employment in the oil patch with natural resource harvesting, i.e., fisheries. Some families depend on only one of these income sources and others a mixture. These economic forces are often supportive and supplemental but often antagonistic. Thus as the fortunes of the oil and gas development and production industry wax and wane in the northern Gulf of Mexico, the economies of many coastal communities follows. Similarly, as the economic viability of fishery resources increases or decreases, communities may switch employment opportunities or suffer the same economic declines as the fishery resources. The fortune of these local and regional economies reflect the multiple stressors that impinge on the coastal ecosystems, such as excess nutrient loading that leads to oxygen depletion or harmful algal blooms, the continuing loss of the coastal landscape and its ecosystem services of fisheries habitat and storm hazard mitigation. Multiple natural disasters such as hurricanes, and the continuing threat of global climate change and human habitat alteration threaten coastal habitats and affects natural ecosystems and the social community structure that they support. A global economy that reflects increased fuel prices, influx of imported goods such as cultured shrimp, increasing national debt, loss of social services through federal and state budget cuts, and loss of education and human health services is an additional threat to social structure that depends on a healthy, functioning ecosystem for basic ecosystem services. Topics in this session will address, in the broadest sense, the social and economic impact of the Deepwater Horizon oil spill as well as chronic stressors that impact human well-being.

### Session Chairs:

David Yoskowitz Harte Research Inst. for Gulf of Mexico Studies, Texas A&M Univ-Corpus Christi

Steven Picou University of South Alabama

# Science Sessions

## 013. HYDROCARBON DISTRIBUTIONS, CYCLING, AND IMPACTS IN BLUE WATER BENTHIC AND PELAGIC ENVIRONMENTS

This session will provide a forum for investigators to present results describing hydrocarbon cycling and impacts on a variety of spatial and temporal scales in offshore environments. The session will include talks on a broad array of topics, including biological and chemical oceanography, multiphase transport processes, food webs, microbiology, geochemistry, stable isotopes, modeling, and animal biology at surface and deep-sea conditions (e.g. low temperature, high pressure). Presentations that highlight changes against the natural baseline that resulted from the Deepwater Horizon blowout are particularly encouraged.

### Session Chairs:

Samantha Joye University of Georgia

Raymond Highsmith University of Mississippi

## 014. OIL DROPLETS AND PARTICLES—PHYSICAL PROCESSES AFFECTING THE BREAKUP AND TRANSPORT OF MICRO OIL DROPLETS AND BIOPHYSICAL INTERACTIONS OF PLANKTON, BACTERIA AT OIL-WATER INTERFACES

Deepwater Horizon has released 4.9 million barrels of crude oil from deep sub-surface sources. It constitutes the largest marine oil spill in history. The “dissipation” and “cleanup” of the spill may involve the transported oil patches and subsurface plums first breakup to droplets by physical processes: surface wave, oceanic turbulence, subsurface shear and stratification; and microbial activities at oil-water interfaces expedite degradation and composition. These processes are complex and involving multiple spatiotemporal scales, which has resulted in conflicting field observations. Consequently, we encounter difficulty in predicting the amount of oil released, breakup into droplets, transport of these droplets, and most of all interactions of them with marine microbial and planktonic communities.

In this session, we bring the expertise from biological, chemical and physical science disciplines, e.g. plankton ecology, marine microbiology, interfacial dynamics, and physical oceanography, to address key questions concerning physical and biological processes of droplets – from breakup, transport to degradation. The session will be divided into two main themes and conclude with a short discussion on future research and collaborations:

(1) Interactions of microbes, planktons and surfactants at the oil-water interface: These interactions include particle migration, micro-organism locomotion near an interface; particle adsorption, aggregation and swimming at the interface; and subsequently their contributions to interfacial instability and emulsification. The effects of particle motility, geometry, hydrodynamics, and interface properties, especially in the presence of large quantity of

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dispersant on interaction will be the foci. Additionally, their impact on interfacial stability, droplet breakup, coalescence, promoting oil degradation and consumption will be assessed. The topic may be organized as: (a) particle mobility and locomotion near an interface; (b) particle adsorption, migration and aggregation at the interface; (c) degradation, consumption, and emulsification; (d) effects of dispersant on microbial activities at interfaces and resulting impact on instability and droplet breakup.

(2) Effects of physical processes on the fate of oil spill, from breakup to transport: This theme may include: (a) Processes involving breakup of large scale oil patches, including subsurface plumes containing gas and oil, as well as oil slicks, by currents, breaking waves, and wind shear. (b) Breakup of oil droplets by canonical micro-scale processes, such as shear, normal strain, and turbulence at the length scales comparable to that of the droplet. (c) Effects of dispersant on physical processes involving in droplet breakup in these settings. (d) Physical processes affecting the transport and settling of droplets including turbulence, shear, gravity, current and stratification as well as the entrainment by bubbles and particles.

## Session Chairs:

Jian Sheng Texas Tech University

Kathleen Stebe University of Pennsylvania

Joseph Katz Johns Hopkins University

## 015. BIODEGRADATION PATHWAYS AND ENVIRONMENTAL IMPACTS OF HYDROCARBON DISCHARGE—OMICS AND BIOGEOCHEMISTRY APPROACHES

Biodegradation mediated by indigenous microbial communities is the ultimate fate of the majority of oil hydrocarbons that enter the marine environment. Much progress has been made to determine the response of specific microbial taxa as well as higher organisms to oil discharge in marine environments impacted by oil spills or natural seeps. However, the majority of studies of biodegradation and the physiological response to hydrocarbons have been conducted in the laboratory, and our ability to understand and predict the in situ response of organisms to environmental stimuli such as the presence of oil hydrocarbons remains in its infancy. New analytical tools, such as next generation sequencing and stable isotope probing, have greatly improved our ability to interrogate the response of microorganisms and multicellular organisms to hydrocarbon discharge in marine ecosystems. The development and application of omic approaches, in particular, has led to the characterization of novel biochemical pathways of biogeochemical and toxicological significance. This session will focus on research that utilizes the latest molecular and biogeochemical techniques, (including high throughput sequencing, isotope tracers, and omic approaches) to render a predictive understanding of the biogeochemical processes and metabolic pathways that in turn regulate the impacts and

# Science Sessions

biodegradation of petroleum hydrocarbons released into the marine environment. Participation will be encouraged from researchers that employ interdisciplinary approaches including field observations, experimentation, technology development, and numerical modeling.

## Session Chairs:

Joel E. Kostka Georgia Institute of Technology

Andreas Teske University of North Carolina Chapel Hill

Arthur Penn Louisiana State University-School of Veterinary Medicine

## 016. TIME SERIES STUDIES OF THE IMPACTS OF OIL AND GAS RELEASES IN THE NORTHERN GULF OF MEXICO

During the Deepwater Horizon petroleum blowout event, chemical and physical partitioning of enormous volumes of natural gas, aqueous soluble and insoluble oil components, dispersants and oil-flocculent materials led to the formation of large sub-surface hydrocarbon intrusions, widespread occurrence of surface oil slicks and sheens and coastal and offshore oiled-sediment accumulations. Recent findings of altered deep-marine benthic ecosystems throughout the Gulf, such as deep-sea corals and non-bioturbated deep-marine sediments, suggest that oil deposition and ecologic impacts are related. What are the impacts of sub-surface oil and gas intrusions, sinking of aggregated flocculent oil-rich particles to the sediment and oil accumulation in shallow and deep sediments? What was the fate of new carbon derived from the blowout? What physical, chemical and microbial processes controlled degradation of this material on what time scales and at what rates? How rapidly were benthic macrofaunal communities affected? What can be deduced from pre-blowout and rapid response studies and what has been learned so far from post-blowout time series studies? What records do sediment cores hold in terms of baseline environmental conditions that existed prior to oil drilling and quantitative spatial and temporal changes resulting from the blowout and the eventual recovery?

To answer these questions, time-series studies are critical. We welcome contributions from time-series investigations of surface waters, water column and benthic environments that seek to quantify and distinguish natural versus blowout controlled physical, chemical and ecological effects in the water column, the benthic boundary layer and in surficial sediments. Submissions featuring traditional and new technologies utilized to obtain time-series data in the northern Gulf in the years just before or since the 2010 blowout are encouraged. Contributions that reveal linkages between oil deposition, sedimentary chemical environments and impacts on the upper trophic levels (i.e., fisheries with a benthic dependence) are also invited.

## Session Chairs:

Christopher Martens University of North Carolina at Chapel Hill

Laura Lapham University of Maryland Center for Environmental Science

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## 017. TECHNOLOGICAL, ENVIRONMENTAL AND POLICY DEVELOPMENTS FOR IMPROVED RESEARCH AND OPERATIONS IN THE GULF OF MEXICO

The Remediation Technology Session will assess various aspects of the BP Oil Spill in the Gulf of Mexico including remediation and restoration technologies, environmental impacts and concerns, policy developments and outcomes of clean-up efforts to-date as they relate to research and operations in the Gulf. Session objectives will include presentations, discussions and assessments of the water and soil mitigation technologies used, technologies not used, and future technologies regarding the 2010 BP Oil Spill in the Gulf of Mexico. This session explores the development and adoption of innovative oil spill response technologies and restoration tools resulting from the Deepwater Horizon event. Discussion will include a review of current conventional oil spill response tools, as well as a look at new innovations currently being field tested in the Gulf and beyond. This session aims at inviting industry experts in the oil-spill remediation field and leading business that were involved in the Gulf Oil Spill Clean Up practices and which have used the state-of-the-art in methods and materials for remediation. This session will also include presentations and discussions concerning the water and soil mitigation technologies for oil spills according to the US Environmental Protection Agency.

The session will also explore the use of the Alternative Response Technology Evaluation System (ARTES) during the Deepwater Horizon event. The ARTES program is used to facilitate the development and adoption of innovative oil spill response technologies.

The U.S. EPA plays a major role in responding to both inland and coastal spills ensuring that all cleanup activities are truly protective of the environment. During the last two decades, EPA's research has produced new approaches for effective treatment of commercial oil spills including the development of bioremediation agents and dispersants, guidance documents for implementing bioremediation, a clearer understanding of the environmental fate, impact and persistence of oil spills, and development of new spill treatment approaches. The April 20, 2010 Deepwater Horizon oil spill in the Gulf of Mexico revealed an urgent need to further investigate the environmental and human health impacts of oil spills and the mitigation approaches necessary during the removal process. Given the economic importance of commercial and recreational fisheries, it is imperative to better understand the effects of oil spills on pelagic and coastal ecosystems and to develop technologies to minimize these effects. A special

# Science Sessions

Congressional appropriation enabled EPA to conduct studies to better understand the environmental impact of oil spills on ecosystems and human health and to develop tools, models, methods, and sustainable innovative technologies for environmental remediation and restoration.

## Session Chairs:

**William Belisle** Southern University at New Orleans

**Thomas Azwell** University of California, Berkeley

**Perena Gouma** SUNY Stony Brook

**Brandon Jones** U.S. EPA Office of Research and Development

**Mitch Lasat** U.S. EPA Office of Research and Development

**Anne Sergeant** U.S. EPA, National Center for Environmental Research

## 018. REMOTE SENSING AND THE DEEPWATER HORIZON OIL SPILL

Satellite and airborne sensors played critical roles in the response to the Deepwater Horizon oil spill. Remote sensing data were used to detect, track and help forecast the trajectory of the oil slick, and to detect and monitor the impact of the oil spill on coastal wetlands, tidal channels and embayments. Baseline ecosystem data, acquired by satellite and airborne instruments prior to landfall of any oil, were collected for vast stretches of the Gulf Coast. Additional ecosystem data were collected after the oil made landfall to assess the impact on critical habitats such as marshes, seagrass beds, barrier islands and fisheries, and have been collected in the two years since the spill to assess the long-term impact and recovery of the region. New measurement, monitoring, analysis and forecasting capabilities were developed and deployed. This session solicits oral and poster presentations that highlight the latest results and future plans to improve remote sensing detection and monitoring of oil spills and assessments of their environmental impacts.

## Session Chairs:

**Duane Armstrong** NASA Stennis Space Center

**Eric Lindstrom** NASA

**Ian MacDonald** Florida State University

**Chuanmin Hu** University of South Florida

# Science Sessions

## 019. MODELS AND OBSERVATIONS WORKING TOGETHER TO UNDERSTAND THE DEEPWATER HORIZON OIL SPILL

“All models are wrong; some are useful.” – an observational scientist

“All observations are right; there are generally so few they are useless.” – a modeler

These adages summarize general sentiments voiced in scientific circles. In principle, physical models are powerful tools that can both benefit from physical observations and explain why observed phenomena occur. In practice, it is often difficult to reconcile models and observations even in the best planned experiments. The research recently funded by GoMRI and focused on the Gulf of Mexico provides a suite of examples of modeling and experimental work planned in tandem. These couplings occur at several different spatial and temporal scales and they interface regional physical, chemical and biological oceanography down to mm scale fluid dynamics.

This session seeks abstracts focusing on both difficulties and successes of coupling circulation, biogeochemical, sediment and oil models and observations at all spatial and temporal scales. Particularly, we seek abstracts focusing on, but not limited to, the following aspects of modeling and measuring the Gulf of Mexico: development of mathematical models and numerical simulators to investigate flows across scales and observations of multiscale phenomena; multiphysics/multimodel couplings to bridge different scales; estuarine-shelf exchange processes in models and observations in the northern Gulf of Mexico; oil spill trajectory modeling and development of spill remediation tools in the coastal zone. Ultimately, the unprecedented concentration of work in a tightly constrained geographic area on an equally tightly constrained topic may help reconciling the adages above.

### Session Chairs:

Brad Rosenheim Tulane University

Annalisa Bracco Georgia Institute of Technology

Haosheng Huang Louisiana State University

Dubravko Justic Louisiana State University

Clint Dawson The University of Texas at Austin

Oliver Fringer Stanford University



# Plenary Summary

Five plenary speakers were engaged to set the scene for scientific discourse during the conference; topics included reflection on past events as they relate to oil spill chemistry, our state of the knowledge of ecosystem level science, public health and related community science, socio-economics, and policy. The meeting closed with the five plenary speakers providing wrap up suggestions and research gap analysis, along with a combined Q&A and comment session to solicit input from the conference attendees.

Feedback from the plenary speakers and comments by the audience during the closing plenary session formed the basis for discussion about where we have come, recommendations for future research, and suggestions for a future conference. The primary gaps identified included a lack of socioeconomic and public health research. A major need identified was collaboration between all the funding agencies involved in the Gulf of Mexico to leverage their resources and avoid duplication. Some sample bulleted highlights include:

- Research content had a good cross-cutting inter-disciplinary components of breadth, depth, and diversity
- There was integration of social science and human health research in discussions, though more is needed
- There was a gratifying mix of students and senior researchers – students are our legacy
- Outreach activities show interactions that can inform all stakeholders, needs to continue as we move forward
- Participants engaged in healthy (agree/disagree) dialogue on dispersants
- Encourage more of a balance between risks and rewards of funded research
- Avoid pre-mature synthesis and working now to get groups together for synthesis
- We should avoid redundancy among science funding agencies and inefficient use of resources
- Hold this meeting again and allow time for interactive workshops with open dialog about gaps
- Lack of higher trophic level work underway (some buried in NRDA)

# Plenary Summary

Feedback collected from the speakers and audience during the closing plenary session covered several areas: impressions about the science sessions, identification of gaps in research, and priorities for future work. The sections below represent a synthesis of the information collected from the plenary panel and the audience in the closing session.

## Impressions about Science Sessions:

- **Positives:**

- Research has good cross-cutting inter-disciplinary components of breadth, depth, and diversity
- Research on fundamental processes of the GOM provides valuable baseline and background for future events both for the US and worldwide
- There was integration of social science and human health research in discussions, though more is needed
- There was a gratifying mix of students and senior researchers – students are our legacy, they are 1<sup>st</sup> rate and inspired
- Outreach activities show interactions that can inform all stakeholders, needs to continue as we move forward
- Participants engaged in healthy (agree/disagree) dialogue on dispersants
- Most presenters provided initial results

- **Concerns about:**

- Balance of risks and rewards of funded research: take on risks to make important discoveries and avoid perverse incentives to publish just for the sake of publishing
- Balance of avoiding pre-mature synthesis and working now to get groups together for consistency in synthesizing findings and identifying gaps as we move forward
- Balance of rush to publish research and the quality and verifiability of published research; research needs to be published and the underlying data need to be in databases that are set up
- Need for research to be generalizable for other unknown events
- Redundancy among science funding agencies and inefficient use of resources
- Not hearing conclusions or implications of initial results
- Hold this meeting again and allow time for interactive workshops with open dialog about gaps
- Lack of higher trophic level work underway (some buried in NRDA)

# Plenary Summary

## Identifying Gaps in Research:

- **Disciplines/Types:**
  - Lack of synthesizing research and making conclusions and implications
  - Need more socioeconomic and public health research; Need studies that incorporate the human links (socio-economics and health) with the Gulf ecosystem and integrate with current ecosystem research; This research should leverage the large community of socio-economic experts in the region
  - Lack of “risky” research that has potential for major contributions
  - Need more participatory research with communities and to get the message out better about programs that are doing this
  - Lack of anticipatory research (versus cause and effect research) – will we be able to respond better and quicker next time?
- **Coordination/Leadership:**
  - Need for leadership to coordinate science and funding (to reduce redundancy and inefficiency) from multiple entities (federal, industrial, non-profit, and academic) – need a “committee of committees” or “council of councils”
  - Be good stewards of the funds
  - Lack of consistent approach to have groups come together and identify proof of concepts to make conclusions, syntheses, generalizations of research for unknown future events
  - Incorporate common framework that is used in public health research: (1) *should* something be done; (2) If so, *what* should be done; (3) Then, *how* should it be done; (4) finally, is it working?
- **Communications/Decisions:**
  - Questions about inclusiveness on and information about decision making process for funded research: who sets research agenda and who decides what is important?
  - Lack of understandable, meaningful information for the public, which results in opinions based on emotions rather than facts
  - Work with NOAA on fleet issues and opportunities
  - Streamline post NRDA data sharing

# Plenary Summary

## Priorities for Future Work:

- **Address gaps in research:**
  - Synthesize science, develop conclusions, and explain implications; Invest in early synthesis activities to create common building blocks and allow for mid-course corrections
  - Integration of NRDA data once available (see what gaps still exist)
  - Incorporate socio-economic and human health research (add requirement in future RFPs); Increase emphasis in this area and broaden the interpretation of the theme.
  - Community and individual psychosocial vulnerability and resilience; Support for longitudinal studies in these areas
  - Risk assessment, risk communication
  - Invest in risky, participatory, and anticipatory research, avoid focus on just publications
  - Develop incentives for and support the people who make connections, syntheses, conclusions, and implications of research (including data sharing)
  - Take advantage of ongoing research to continue longitudinal programs and existing samples
  - Training for the future
  - Try to access and use the informal economic that data have been collected in the penalty development and litigation process
  - Now is a good time to look back at the economic impacts on commercial fisheries, tourism, navigation, etc.; Much of needed secondary economic data is now available; the sector-level data required to see “what happened” as opposed to what might be happening
  - Fisheries – trends and harvest data, temporal and spatial distribution of effort;. Connect biophysical to economics in future studies
  - Economic examination of price changes, and impacts on strategic purchasing and market share
  - Need to identify and research “all” the chronic issues in the Gulf beyond just oil (oil/gas, timber, tourism, etc)
  - Need to understand large ecosystems like the Gulf of Mexico; Need to understand the near shore/offshore relationship, the subsurface link to surface; Need holistic models of these processes
- **Focus on broader national and international research applications:**
  - Research needs to be scalable and generalizable for various events, locations, and industries
  - The world needs “lessons learned” (i.e. trend in the North Sea is to go deeper for oil; Nigerian coast’s oil problems; other industry impacts on ecosystems)

# Plenary Summary

- Take research beyond oil and gas and include other stressors and conduct anticipatory research in order to have a broader, more pro-active impact on resilient coastal communities worldwide
- Holistic ecosystem models will drive synthesis
- **Provide leadership and coordination:**
  - Convene a “committee of committees” or “council of councils” or a “convention of grant funders” to prioritize and coordinate science and to maximize funds, resources, and capabilities
  - Convene smaller groups (some by disciplines, other interdisciplinary) to come together (workshops, satellite meetings) more frequently than annual conferences to make mid-course corrections, incentivize and conduct syntheses , and foster discussions and open dialogues
  - Work with stakeholders on fleet issues, sharing, coordination, and other opportunities
- **Get the science out:**
  - Publish science in peer-review literature and back it up with data in databases (data is legacy)
  - Communicate with policy and decision makers so that science can influence decisions
  - Translate science results (or science in progress) in “everyday language” that conveys meaningful information to citizens (human and Gulf ecosystem health, livelihoods, trust in research)
  - Science needs to be positioned to influence decisions, references are important but changing policy is very important

# Participant Feedback

Conference feedback was also garnered through an online survey of conference participants two weeks after the conference. About 30% of 1044 attendees responded to the post-conference survey and comments were similar to the plenary panel.

- Respondents rated the overall conference positively (4.1/5)
- 
- There was mixed response on the number of concurrent sessions (just right vs. too many)
- Most respondents said the online meeting tools were somewhat easy to use, though half did not rate the mobile app
- More than 80% used the printed program during the conference
- Respondents said the conference staff was helpful
- Over 80% said their knowledge/skills increased and they intend to use what they learned and will recommend the conference to others
- Over 75% plan to attend next year

In the comment sections of the participant survey, the most frequently mentioned highlights were the keynote speaker and being able to interact/network with colleagues. The most frequently mentioned suggestions were for:

- Concurrent Sessions
  - improve audio/visual
  - build in time for Q&A and discussion
  - increase time between
  - reduce number
- Networking
  - increase time and opportunities
- Content
  - more public health/social science
  - more workshops/sessions for discussions of results/conclusions
  - integration/synthesis of science

These comments along with the other feedback captured in the participant survey will be used to shape the conferences to follow this one.

# Science Abstracts

## Session: 001 Chemical Methods for Comprehensive Oil Spill Analysis:

Session: 001 - 1

Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 8:30 AM

Type: Oral Presentation

### Mainstreaming new methods into oil spill science: What do we need to do?

**Presenter:** Christopher Reddy – Woods Hole Oceanographic Institution

**Authors:** Ryan Rodgers, Florida State University; Christopher Reddy, Woods Hole Oceanographic Institution

#### Abstract:

For most chronic or acute oil spills, fate-based studies as well as fingerprinting have relied heavily on methods that employ traditional gas chromatography, developed decades ago by the US Environmental Protection Agency. While these methods have proven to be quite powerful, they capture only a fraction of the compounds in spilled oils and even less in transformation products. With nearly three years of research since the Deepwater Horizon disaster and many more years to come of highly focused studies, our need to expand the “analytical window” is and will continue to be an increasing reality. The challenge is how to transfer this new research into mainstream oil spill science so that it may eventually gain the same status and reliability of traditional gas chromatography. We will present several courses of action to do so.

Session: 001 - 2

Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 8:45 AM

Type: Oral Presentation

### Comprehensive chemical characterization of oil using two-dimensional gas chromatography with soft ionization and time of flight mass spectrometry

**Presenter:** David Worton – University of California, Berkeley

**Authors:** David Worton, University of California, Berkeley; Gabriel Isaacman, UC Berkeley; Arthur Chan, UC Berkeley; Kevin Wilson, Lawrence Berkeley National Laboratory; Allen Goldstein, UC Berkeley

#### Abstract:

The complex chemical composition of petrochemical products presents unique analytical measurement challenges. We have dramatically enhanced chemical speciation capabilities by combining two-dimensional

chromatography with soft ionization by vacuum ultraviolet radiation and high resolution time of flight mass spectrometry (GCxGC/VUV-HRTOFMS). With this combined technology, complex hydrocarbons are separated by carbon number and compound class, e.g., normal, branched, cyclic, aromatic, and functionalized compounds. We demonstrate near complete characterization and quantification of the unresolved complex mixture (UCM) typical of petrochemical samples like oil making the concept of the UCM essentially obsolete. This presentation will review recent developments of this technique and demonstrate its utility for characterizing the chemical composition of oil.

Session: 001 - 3

Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 9:00 AM

Type: Oral Presentation

### Quantifying composition alteration through biodegradation for Deepwater Horizon oil in surface environments using GCxGC

**Presenter:** Jonas Gros – EPFL

**Authors:** Jonas Gros, EPFL; Christopher M. Reddy, WHOI; Robert K. Nelson, WHOI; J. Samuel Arey, EPFL

#### Abstract:

In contrast to the numerous studies published about deep-water plumes resulting from Deepwater Horizon blowout, less work is available regarding biodegradation of the oil fraction which eventually reached the surface. However, after the loss of the most volatile and water soluble compounds through mass transfer processes, biodegradation is one of the major processes leading to oil removal from the environment.

We studied beached Deepwater Horizon oil sand patties, sampled 12-19 months after the event, exhibiting different extents of biodegradation, and we applied newly developed data analysis techniques. The compounds biodegraded are chiefly saturates, and several compound families over a wide range of molecular weights appear affected, with preferential losses in the order: normal alkanes, methyl alkanes & alkylcycloalkanes, acyclic & cyclic isoprenoids.

Our quantification of mass removal for numerous compounds of the dominant fraction of moderately weathered Deepwater Horizon oil (saturates), gives significant insights into the final fate of the oil at the surface.

# Science Abstracts

Session: 001 - 4

Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 9:15 AM

Type: Oral Presentation

## Characterization of In-Situ Burn Residues from the Deepwater Horizon Incident

**Presenter:** Buffy Meyer – LSU-Dept of Environmental Sciences

**Authors:** Buffy Meyer, Louisiana State University, Department of Environmental Sciences; Ed Overton, LSU; Heng Gao, LSU; Scott Miles, LSU; Gary Shigenaka, NOAA-ERD

### Abstract:

The Response and Chemical Assessment Team at Louisiana State University analyzed five tarball samples on July 06, 2011 collected from a commercial fisherman's trolling net. GC/MS fingerprinting was performed for each sample to provide oil characteristic and quantitative information. Additionally, the oil fingerprints from these five tarball samples were compared to oil fingerprints from tarballs collected by the Our Mother (8 samples) in January 2011 and the Aubreigh Marie (12 samples) in March 2011. All the tarball samples were compared to oil fingerprints of the MC 252 source oil. It was determined that all of the tarball samples came from the same crude oil, and that oil was a match to the MC 252 crude that spilled in the Gulf in 2010. Based on the hydrocarbon profile, there is a very high probability that all tarball samples were residue from the in-situ burning of the MC 252 oil during the active portion of the spill response.

In-situ burning, or the controlled burning of oil, is typically utilized to remove fairly fresh oil before the oil emulsifies (however, during the Deepwater Horizon incident was performed after some of the oil had already emulsified). The burning process of fresh oil generally consumes the majority of the oil, upwards of 90%, but does leave unburned, fairly viscous and dense residues behind that have a tendency to form tarballs and sink. Our data demonstrates that residues from in-situ burning are not subjected to the normal weathering processes due to the fact that dense globs of oily residue are often encapsulated within a hardened exterior. The data also provides insights into the changes that occur to oil when it is burned and how the physical and chemical characteristics compare to other forms of oil encountered during a spill (e.g., emulsified surface oil, beach- and marsh-stranded oil, etc.).

Session: 001 - 5

Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 9:30 AM

Type: Oral Presentation

## GCMS analysis of TGA pyrolysates of tarballs from the BP oil spill

**Presenter:** Jan Gryko – Jacksonville State University

**Authors:** Jan Gryko, Jacksonville State University; M. A. Nichols, C. M. Holmes, Jacksonville State University

### Abstract:

We have found new, characteristic GCMS patterns in high-temperature pyrolysates of tarballs from the BP oil spill in the Gulf of Mexico in April 2010. The GCMS spectra of original MC252 oil consist of a series of large n-alkane peaks, with smaller peaks corresponding to branched alkanes, aromatics, and other compounds. In contrast, tarball pyrolysates display characteristic, double peaks, consisting of an n-alkane and corresponding n-cycloalkane peaks. The distribution of these double peaks depends on the degree of degradation of the oil residue. Pyrolysates derived from heavily weathered tarballs show double peaks for both light and heavy alkanes ( $9 < n < 30$ ), whereas slightly weathered samples display double peaks only for light alkanes,  $n < 15$ .

Session: 001 - 6

Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 9:45 AM

Type: Oral Presentation

## Characterization of oxygenated hydrocarbons formed upon oil weathering after the Deepwater Horizon disaster

**Presenter:** Christoph Aeppli – Woods Hole Oceanographic Institution

**Authors:** Christoph Aeppli, Woods Hole Oceanographic Institution; Catherine A. Carmichael, Woods Hole Oceanographic Institution; Robert K. Nelson, Woods Hole Oceanographic Institution; David L. Valentine, University of California Santa Barbara; Neal Arakawa, Scripps Institution of Oceanography; Lihini I. Aluwihare, Scripps Institution of Oceanography; Christopher M. Reddy, Woods Hole Oceanographic Institution

### Abstract:

We found that recalcitrant oxygenated hydrocarbons (OxHC) were rapidly formed upon oil weathering after the Deepwater Horizon disaster. These abundant compounds are poorly characterized, both in terms of molecular composition as well as effects, mainly because OxHC are outside traditional analytical windows. We used a variety of bulk and molecular techniques to characterize the OxHC fraction of weathered Macondo well oil. To overcome analytical limitations, we applied



# Science Abstracts

chemical modification that allowed for OxHC analysis based on two-dimensional gas chromatography. We identified several compounds and compound classes that are present in the OxHC fraction. This in turn sheds light on oil weathering processes, which ultimately determine the fate of oil in the environment.

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Session: 001 - 7

Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 10:00 AM

Type: Oral Presentation

## Composition of Polar Components of Oil in the Gulf of Mexico Water Column During and After the Deepwater Horizon Oil Spill

**Presenter:** Elizabeth Kujawinski – WHOI

**Authors:** Elizabeth Kujawinski, WHOI; Krista Longnecker, WHOI; Melissa C. Kido Soule, WHOI; Molly Redmond, UCSB; David L. Valentine, UCSB

### Abstract:

Polar components of crude oil are a minor fraction of crude oil but are more likely to dissolve in the water column, are more resistant to biodegradation and may be more toxic to marine fauna, than their nonpolar counterparts. As a result, they may have a disproportionate impact on the Gulf of Mexico ecosystem and thus, it is important to examine the composition of these components in the water column during and after the oil spill. We have employed ultrahigh resolution mass spectrometry (ESI FT-ICR MS) to characterize the complex mixtures of oil, dispersants and dissolved organic matter in water samples collected from a variety of depths and distances from the wellhead. Our preliminary results indicate that heteroatom-containing compounds such as naphthenic and sulfonic acids are present and enhanced in surface and deepwater samples with high hydrocarbon content. We used multivariate statistics to resolve compounds (1) that were selectively degraded, (2) that were produced from metabolism of other hydrocarbons or (3) that remained unchanged.

Session: 001 - 8

Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 10:15 AM

Type: Oral Presentation

## Ambient Ionization Fourier Transform Ion Cyclotron Resonance Mass Spectrometry for Comprehensive Chemical Fingerprinting of Petroleum and Deposits

**Presenter:** Leonard Nyadong – National High Magnetic Field Laboratory

**Authors:** Leonard Nyadong, National High Magnetic Field Laboratory, Florida State University; Vladislav V. Lobodin, Future Fuels Institute, Florida State University; Brian M. Ruddy, Department of Chemistry and Biochemistry, Florida State University; John P. Quinn, National High Magnetic Field Laboratory, Florida State University; Christopher L. Hendrickson, National High Magnetic Field Laboratory, Florida State University, Department of Chemistry and Biochemistry, Florida State University, Future Fuels Institute, Florida State University Alan G. Marshall, National High Magnetic Field Laboratory, Florida State University, Department of Chemistry and Biochemistry, Florida State University, Future Fuels Institute, Florida State University, marshall@magnet.fsu.edu, Ryan P. Rodgers, National High Magnetic Field Laboratory, Florida State University, Department of Chemistry and Biochemistry, Florida State University, Future Fuels Institute, Florida State University, rogers@magnet.fsu.edu

### Abstract:

Ambient atmospheric pressure ionization (API) methods that take advantage of chemical ionization (CI) processes such as direct analysis in real time (DART), AP laser-induced acoustic desorption CI (AP/LIAD-CI) and LD/AP photochemical ionization (LD/APPCI) allow analysis of compounds spanning a broad range of polarity without any requirement for prior sample preparation, making them particularly useful for the analysis of complex mixtures such as petroleum. However, reliable/facile determination of sample chemical composition requires coupling of those techniques to ultrahigh resolution Fourier transform ion cyclotron resonance mass spectrometry (FT-ICR MS). Desorption electrospray ionization (DESI), DART, AP/LIAD-CI, LD/APPCI coupled with a 9.4 T FT-ICR MS will be presented as complementary and powerful approaches for comprehensive chemical fingerprinting of Macondo Well Oil (MWO), oil-contaminated Pensacola beach sands, crude oil deposits, and weathered crude oil samples. [Work supported by NSF DMR-06-54118, the Florida State University Future Fuels Institute, BP/The Gulf of Mexico Research Initiative, and the State of Florida]

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Session: 001 - 9

Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 11:00 AM

Type: Oral Presentation

# Science Abstracts

## Using Electrospray Ionization Time-of-Flight Mass Spectrometry to quantify bis(2-ethylhexyl) sulfosuccinate (DOSS)

**Presenter:** Susan Chiasson – Tulane University

**Authors:** Susan Chiasson, Tulane University; Amelia Neuberger, Tulane University; Lynn Vogel Koplitz, Loyola University; Deborah A. Grimm, Tulane University; Erin K Grey, University of Notre Dame; Caz M. Taylor, Tulane University

### Abstract:

In response to the Deepwater Horizon oil platform explosion and subsequent gush of oil into the Gulf of Mexico from the Macondo well, Corexit 9500A and Corexit 9527A dispersants were applied in an effort to disperse the oil. Bis(2-ethylhexyl) sulfosuccinate (DOSS) is a known surfactant found in Corexit 9500A and 9527A dispersants, and a method using ESI-TOF was developed to quantify DOSS using 50% methanol and 50% acetonitrile as the solvent mixture. This method facilitates a quick, quantitative analysis (5 minutes per sample) of bis(2-ethylhexyl) sulfosuccinate.

Session: 001 - 10

Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 11:15 AM

Type: Oral Presentation

## Molecular-Level Characterization of Petroleum Seeps and Asphalt Volcanoes from the Santa Barbara Basin by FT-ICR Mass Spectrometry

**Presenter:** Amy McKenna – Florida State University

### Abstract:

We present the first molecular level characterization of natural petroleum seeps and asphalt volcanoes discovered off the coast of Southern California by Fourier transform ion cyclotron resonance mass spectrometry (FT-ICR MS). Although natural petroleum seeps to the ocean account for nearly half of all input, only a small number of seafloor features associated with active seepage have been characterized. Here, we describe the detailed, molecular-level characterization of polar species and condensed aromatic structures petroporphyrins accessible only by ultrahigh resolution FT-ICR mass spectrometry. Collectively, the results reveal an immense compositional diversity of polar species, condensed aromatic structures, and vanadyl and nickel porphyrins that rivals heavy oil and refinery residues in complexity. Comparison of the molecular composition between petroleum seeps and hydrocarbon material deposited in asphalt volcanoes reveals the inherent geochemical complexity associated with these structures. Work supported by NSF

DMR-06-54118, BP/The Gulf of Mexico Research Initiative, and the State of Florida.

Session: 001 - 11

Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 11:30 AM

Type: Oral Presentation

## Fingerprinting Hydrocarbons in Oil, Tarballs, and Sediment from Coastal Texas to Florida During the Deepwater Horizon Oil Spill

**Presenter:** Thomas Lorenson – US Geological Survey

**Authors:** Thomas D. Lorenson U.S. Geological Survey, Pacific Coastal and Marine Science Center; Robert J. Rosenbauer, Pamela L. Campbell, Angela Lam, Frances D. Hostettler, Burt Thomas, and Florence L. Wong, U.S. Geological Survey, Pacific Coastal and Marine Science Center, Santa Cruz, California, U.S.A.

### Abstract:

Hydrocarbons were analyzed from sediment and tarballs collected from the northern Gulf of Mexico coast (nGOM) and compared to the Macondo-1 (M-1) well oil, the source of the Deepwater Horizon oil spill (DWHs). Sediment was collected before and after the M-1 well oil made significant local landfall and analyzed for a suite of diagnostic oil biomarkers then grouped using multivariate statistical analysis. M-1 oil-impacted sediments are confined to the shoreline adjacent to the where the DWHs oil slick was documented to make landfall from central Louisiana to the Florida panhandle. After the oil spill landfall, M-1 well oil was identified in some sediment and tarballs collected from coastal sites in Louisiana, Alabama, Mississippi, and Florida, but none in Texas. Prior to oil spill landfall, none of the sediment hydrocarbon extracts from the nGOM coast showed a significant statistical correlation the M-1 well oil. The same is true for tarballs with the exception of one tarball from the Florida Keys that correlates with M-1 oil, however natural seepage could also be a source. Natural oil seepage offshore Louisiana is abundant, continuous, and needs to be systematically mapped, fingerprinted, and volumetrically measured to better understand the impact of natural oil and to distinguish seep oil from the DWHs residues. Collection of natural seep oils at sea and further monitoring of oil, tarballs, and sediment along the coastline is warranted to assess both the impact of natural seepage and for any additional DWHs derived residue.

# Science Abstracts

Session: 001 - 12

Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 11:45 AM

Type: Oral Presentation

## Chemical fingerprinting of hopane biomarkers in Deepwater Horizon oil spill samples collected from Alabama shoreline

**Presenter:** Vanisree Mulabagal – Auburn University

**Authors:** Vanisree Mulabagal

Auburn University; Fang Yin, Auburn University; Gerald F John, Auburn University; Joel S. Hayworth; Auburn University; T. Prabhakar Clement, Auburn University

### Abstract:

We compare chemical fingerprinting analysis of hopanes in Deepwater Horizon (DH) source oil, three other reference crude oils, DH emulsified mousse that arrived on Alabama's shoreline in June 2010, and seven different tar balls collected from Alabama beaches from 2010 to 2012. Hopane fingerprints and hopane diagnostic ratios show that all seven tar ball samples originated from DH oil. The degree of weathering of various tar balls was determined using the concentration of C<sub>30</sub>αβ-hopane as an internal conservative marker. Quantitation data for C<sub>30</sub>αβ-

hopane concentration levels show that most of the weathering observed in DH-related tar balls found on Alabama's beaches is likely a result of evaporation during transport across the Gulf of Mexico prior to beach deposition. The physicochemical characterization data presented in this study indicate that virtually all the sticky, fragile, tar balls currently found on Alabama shoreline are from the BP oil spill.

Session: 001 - 13

Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 12:00 PM

Type: Oral Presentation

## Evaluating the fate, transport and degradation state of oil in the Gulf of Mexico using fluorescence EEM

**Presenter:** Laodong Guo – University of Wisconsin-Milwaukee

**Authors:** Laodong Guo, University of Wisconsin-Milwaukee; Zhengzhen Zhou, University of Southern Mississippi; Alan Shiller, University of Southern Mississippi

### Abstract:

Seawater samples were collected from the Gulf of Mexico during the Deepwater Horizon oil spill in May-June 2010 and after the oil spill in October 2010 and October 2011. The fluorescence excitation emission

matrix (EEM) technique coupled with parallel factor (PARAFAC) modeling and measurements of bulk organic carbon and other optical properties were used to characterize the oil components released from the Macondo well, and to elucidate the chemical evolution and transformation of oil in the water column from the time of maximum oil impact to its recovery, 15 months after the spill. Three major fluorescent oil components were identified, with their maximum Ex/Em at 224/328 (C<sub>1</sub>), 264/324 (C<sub>2</sub>) and 232/346 (C<sub>3</sub>) nm, respectively. The fluorescent oil component ratios, C<sub>2</sub>/C<sub>1</sub> and C<sub>3</sub>/C<sub>1</sub>, increased consistently from maximum oil impact to oil spill was stopped, and from 2010 to 2011, and could be quantitatively linked to the degradation status of oil in the water column and thus be used as indices to effectively track the fate and transport of oil in the Gulf of Mexico.

Session: 001 - 14

Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 12:15 PM

Type: Oral Presentation

## Optical fluorescence signatures of waters in the northern Gulf of Mexico during the Horizon oil spill: Comparison to pre-spill conditions

**Presenter:** Eurico D'Sa – Louisiana State University

**Authors:** Eurico D'Sa Louisiana State University, Baton Rouge; Edward Overton, Louisiana State University, Baton Rouge, LA; Angelina Freeman, Environmental Defense Fund, Washington, D.C.; Steven Lohrenz, University of Massachusetts

### Abstract:

Excitation-emission matrix spectroscopy (EEMs) was used to characterize the chromophoric dissolved organic matter fraction of samples collected in the northern Gulf of Mexico during the Deepwater Horizon oil spill in May 2010 and compared to samples collected in January 2009 in the general area impacted by the oil spill. Parallel factor (PARAFAC) modeling of samples collected in 2009 identified the presence of three fluorescence components, two resembling humic-like terrestrial material with broad emission at wavelength greater than 400 nm, and one protein-like or plankton-derived component. In 2010, seawater samples collected at four locations, namely in the area of Deepwater Horizon spill site, and three coastal areas (Mississippi delta, Barataria Bay, and Mobile Bay) impacted by the oil spill identified four components, with two of these components similar to the pre-spill conditions. Of the other two components in the oil spill data, one humic-like component appeared blue-shifted while a fourth component was similar to a protein-like component that has been shown to be indistinguishable from fluorescence of some polycyclic aromatic hydrocarbons (PAHs). EEMs of

# Science Abstracts

some outlier seawater samples not used in the PARAFAC analysis had signatures that suggested the presence of PAHs contamination. GC-MS was used to further examine for PAHs in some of these water samples collected in the oil spill impacted waters.

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Session: 001 - 15

Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 2:00 PM

Type: Oral Presentation

## Oil Spill Source Identification by Principal Component Analysis of Electrospray Ionization Fourier Transform Ion Cyclotron Resonance Mass Spectra

**Presenter:** Yuri Corilo – National High Magnetic Field Laboratory - Florida State University

**Authors:** David C. Podgorski, Amy M. McKenna †, §, Christopher M. Reddy‡, Alan G. Marshall †, §, Ryan P. Rodgers\*, †, §, §Department of Chemistry and Biochemistry, Florida State University, †National High Magnetic Field Laboratory, Florida State University  
‡Department of Marine Chemistry and Geochemistry, Woods Hole Oceanographic Institute

### Abstract:

One fundamental challenge with oil spills is to identify the source when the source contains more than one petroleum product, or when extensive weathering has occurred. Here, we focus on a heavy fuel oil release that spilled 58,000 gallons from two suspected tanks ruptured when the motor vessel Cosco Busan struck the San Francisco-Oakland Bay Bridge in 2007. Ultrahigh resolution ESI FT-ICR MS allows elemental composition assignment of thousands of heteroatom-containing species in neat samples from both tanks, not amenable to gas chromatography. Combined with the analysis of field samples collected at various intervals up to two years post spill, Principal Component Analysis (PCA) identifies a suite of environmentally persistent polar petroleum biomarkers that enables identification of the source of the spill. Work supported by NSF DMR-06-54118, the Florida State University Future Fuels Institute, BP/The Gulf of Mexico Research Initiative, and the State of Florida.

Session: 001 - 16

Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 2:15 PM

Type: Oral Presentation

## Surrogate Oil for Scientific Testing

**Presenter:** Michael Green – BP - Gulf Coast Restoration Organization

**Authors:** Oliver Pelz, BP - Gulf Coast Restoration Organization, oliver.pelz@bp.com, John Brown, Exponent, jsbrown@exponent.com

### Abstract:

Limited volumes of Macondo (MC252) crude oil were collected during the Deep Water Horizon oil spill, raising concerns about the availability of source oil for future testing. To address this need, a program was undertaken to identify a surrogate for Macondo (MC252) crude oil. The presentation will cover the selection, collection, transport and storage of the surrogate oil. Aspects of the geography, geology, oil family, physical properties, chemical composition, and aquatic toxicity testing of the various oil candidates examined will be discussed. In addition a summary of the request process for surrogate oil will be presented.

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Session: 001 - 17

Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 2:30 PM

Type: Oral Presentation

## Airborne chemical data provide time-critical decision support during offshore blowouts

**Presenter:** Thomas Ryerson – NOAA Chemical Sciences Division

**Authors:** Thomas Ryerson, Stéphane Bauguitte; James Lee; euan nisbet, Axel Wellpott, D Lowry, Rebecca Fisher, Ally Lewis, Jim Hopkins, Grant Allen, Sebastian O'Shea, Mathias Lanoiselle, James France, richard lidster, shalini punjabi, Alistair Manning, Stephen Mobbs, Martin Gallagher, Hugh Coe, John A Pyle, Richard Camilli, Don Blake, Elliot Atlas, Joost de Gouw, Carsten Warneke, Jeff Peischl, David Parrish, Ravi Ravishankara, NOAA

### Abstract:

A research aircraft responded to the Total SA Elgin platform blowout and natural gas leak in the North Sea in 2012. Within 72 hours of abandoning the platform, a flow rate of  $1.3 \pm 0.2$  kg CH<sub>4</sub>/sec was calculated from the airborne chemical data and disseminated to responders and the public. Data from a second flight showed that the platform could be safely re-occupied; as a result, Elgin gas production was restored ~30 days sooner than originally anticipated. Savings in taxes restored to the UK Treasury more than paid for the research flights.

Airborne responses to the 2010 Deepwater Horizon spill and the 2012 Elgin leak used chemical data to provide unique and essential

# Science Abstracts

information to responders and the public. Both were possible only because the aircraft were fitted with the necessary chemical instruments at the times of the disasters. These examples have demonstrated key deliverables that would be provided by a future dedicated, operational, rapid-response airborne chemical measurement capability in the U.S., especially as it would relate to an offshore Arctic spill scenario.

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Session: 001 - 18

Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 2:45 PM

Type: Oral Presentation

## Asphaltene composition and content as a measure of oil losses related to the Deepwater Horizon Oil Spill

**Presenter:** Michael Lewan – U.S. Geological Survey

**Authors:** Michael Lewan, A. Warden, R.F. Dias, Z.K. Lowry, T.L. Hannah, P.G. Lillis, R. Kokaly, T.M. Hoefen, G.A. Swayze, C. Mills S.H. Harri, and G.S. Plumlee, U.S. Geological Survey

### Abstract:

The composition and content of asphaltenes in spilled and original oils from the Deepwater Horizon incident provide information on the amount of original-oil lost and the processes most responsible for the losses within the first 80 days of the active spill. Spilled oils were collected from open waters, coastal waters and coastal sediments during the incident. Although all of the spilled oils show minimal biodegradation, their precipitated asphaltenes show a significant increase in oxygen content and  $^{13}\text{C}$  enrichment. Bench- and roof-top experiments involving evaporation, photo-oxidation, microbial degradation, dissolution, dispersion, and burning indicate that the combined effects of photo-oxidation and evaporation are responsible for these compositional changes and loss of  $61 \pm 3$  vol% of the original oil from the surface spilled oils during the incident. This mean percentage of original-oil loss is considerably larger than previous estimates of evaporative losses based on GC-amenable hydrocarbons.

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Session: 001 - 19

Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 3:00 PM

Type: Oral Presentation

## Bioremediation of Jiyeh oil-polluted soil using autochthonous microorganisms

**Presenter:** Hanafy Holail – Beirut Arab University

**Authors:** Prof. Hanafy Holail, Beirut Arab University; Prof. Zakia Olama, Beirut Arab University

### Abstract:

Abstract: Bioremediation of Jieh oil-polluted soil was carried out using autochthonous microorganisms undergoing in vitro biostimulation strategy. Chemical analysis of the soil under test showed that the soil was low in essential minerals such as nitrogen and phosphorus (100:5.3:0.02 C:N:P ratio) and heavily contaminated with fuel oil (15000ppm/g contaminated soil). The microbiological analysis of the soil revealed the presence of total heterotrophic bacteria (THB >1100 CFU/g soil) and hydrocarbon utilizing bacteria (93 CFU/g soil). The influence of nutrient additives on the biodegradation of fuel-oil by autochthonous microbial community dynamics was investigated using Plackett-Burman statistical design. The total petroleum hydrocarbons (TPHs) were monitored during the biodegradation processes under shaken and static conditions using FTIR spectroscopy. The hydrocarbon consumption reached 88% and 83 % in the optimized trials corresponding to 1.7 and 1.1 fold increase when compared to a control basal medium under shaken and static conditions respectively. GC-MS analysis showed that aliphatic hydrocarbons were C7-C15 while aromatics were restricted to monoaromatics. Alpha-amylase and lipase activities as bioindicators of microbial activities were determined in the different trials. Data revealed that the highest amylase activity was 6236.9 and 5971 DNU, while lipase activity was 1.7 and 1.6 U under shaken and static conditions respectively.

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Session: 001 - 20

Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 3:15 PM

Type: Oral Presentation

## Novel Bamboo-Type TiO<sub>2</sub> Nanotube Arrays with Enhanced Photocatalytic Effect for Decomposition of Dispersed Oil and Organic Pollutants

**Presenter:** Xinning Luan – Louisiana State University

**Authors:** Xinning, Luan, Department of Mechanical Engineering, Louisiana State University; Dongsheng, Guan, Department of Mechanical Engineering, Louisiana State University; Ying, Wang, Department of Mechanical Engineering, Louisiana State University,

### Abstract:

Low-cost and environmentally benign TiO<sub>2</sub> is an excellent photocatalyst which can be used for oil-spill cleanup in the Gulf of Mexico, decomposing persistent organic pollutants for full recovery of local ecosystem after petroleum pollution. We use facile anodic oxidation under alternating voltage conditions to synthesize novel bamboo-type TiO<sub>2</sub> nanotube arrays with better photocatalytic effect than conventional smooth-walled nanotubes, due to the higher surface area provided by ridges on tube walls. Growth mechanism of bamboo-type nanotubes is



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explored, and we can precisely control morphologies of bamboo-type nanotubes such as lengths and ridge spacing. For example, ridge spacing is reduced from 400 to 100 nm and the tube length is increased from 8 to 16.5  $\mu\text{m}$ . All the  $\text{TiO}_2$  nanotubes are converted to photoactive anatase by heat treatment. Their photocatalytic activities are studied with commonly-used methyl blue as the model pollutant in water, and our results demonstrate that the bamboo-type nanotubes show much higher photo degradation efficiency than smooth ones under UV irradiation.

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Session: 001 - 21

Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 3:30 PM  
Type: Oral Presentation

## Radiocarbon analysis of the Gulf Oil Spill

**Presenter:** Jeff Chanton – Florida state university

**Authors:** Jeffrey Chanton, Florida state university; Jennifer Cherrier, Florida A&M University; Judith Sarkodeeadoo, Florida A&M University; W.M. Graham, University of Southern Mississippi, Samantha Joye, University of Georgia, David Hollander, University of South Florida, Charlotte Brunner, University of Southern Georgia

### Abstract:

The oil spill released large volumes of oil and gas of distinct isotopic composition to the northern Gulf of Mexico allowing Graham et al. (2010) to use stable carbon isotopes ( $\delta^{13}\text{C}$ ) to infer the introduction of spilled oil into the planktonic food web. Surface ocean organic production and measured oil are separated by 5-7‰ in  $\text{d}^{13}\text{C}$  space, while in radiocarbon ( $\text{D}^{14}\text{C}$ ) space, these two potential sources are separated by more than 1000‰. Thus  $\text{D}^{14}\text{C}$  provides a more sensitive tracer to infer introduction of Macondo oil into the food web and sediments. We measured  $\text{D}^{14}\text{C}$  and  $\delta^{13}\text{C}$  in plankton collected from within 100km of the spill site as well as in coastal and offshore DIC to constrain surface production values. On average, plankton values were depleted in  $^{14}\text{C}$  relative to surface DIC and we found a significant linear correlation between  $\text{D}^{14}\text{C}$  and  $\delta^{13}\text{C}$  in plankton. Our results support the findings of Graham et al. (2010), but infer that methane input may be important. We have also mapped the distribution of radiocarbon in surficial sediments on the seafloor and will present this data.

Session: 001 - 22

Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 3:45 PM  
Type: Oral Presentation

## Polycyclic Aromatic Hydrocarbons (PAHs) Dynamics in the Northern Gulf of Mexico

**Presenter:** Puspa Adhikari – Louisiana State University

**Authors:** Puspa Adhikari, Louisiana State University; Kanchan Maiti, Louisiana State University; Edward Overton, Louisiana State University

### Abstract:

Removal of PAHs from surface water via sorption on particles and their downward settling plays important role in distribution, dynamics and sinks. Here we apply a novel approach, using particle reactive natural radioisotope  $^{234}\text{Th}$  and its parent  $^{238}\text{U}$  as well as sediment traps, to understand the vertical fluxes of PAHs from surface water to pelagic depths in and around DWH oil spill sites in GOM-during April 2012. We have also calculated dissolved PAHs that give a ballpark. Surface-tethered, free-floating sediment trap arrays were deployed for 3-d to get a direct measurement of sinking particles and associated PAHs. Large volume dissolved and size-fractionated particulate samples were also collected using niskin bottles and submersible in situ pumps to determine PAHs conc and water column inventories. Particulate and dissolved  $\Sigma\text{PAHs}$  ranged between 0.5-0.8 & 17.9 to 36.8 ng/L. PAHs flux using U-Th disequilibria provides vertical removal integrated over 2-3 weeks. Using both traps and Th-based approach provides a comprehensive understanding about fate and residence time of PAHs in NGOM.

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Session: 001 -

Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## Variability in oiled sand-patties collected: How different are samples collected within meters on a beach?

**Presenter:** Catherine Carmichael – Woods Hole Oceanographic Institution

**Authors:** Catherine A. Carmichael, Woods Hole Oceanographic Institution, Bryan D. James, University of Toronto; Christoph Aeppli, Woods Hole Oceanographic Institution; Robert K. Nelson, Woods Hole Oceanographic Institution; Ellen Murphy, Reed College; Jagos Radovic, IDAEA-CSIC, Barcelona, Spain; Christopher M. Reddy, Woods Hole Oceanographic Institution

### Abstract:

A recent study by Aeppli et al (2012) revealed that sand patties oiled from the Deepwater Horizon disaster were heavily weathered. Abiotic and biotic processes oxygenated >50% of the petroleum hydrocarbons in these samples collected from the beaches along the coastline from Florida to Louisiana.

However, we were logistically limited to collect and analyze every sand patty in a certain area. As a means to test the variability of hydrocarbons weathering in sand patties collected within a few meters, we analyzed 25 samples from Horn Island, MS. In these samples, the oxygenated hydrocarbon fraction, measured by TLC-FID, was  $59 \pm 9\%$ ; this variability is slightly larger than the analytical uncertainty (RSD <10%). Similarly, analysis by gas chromatography revealed that 23 of the samples are weathered to identical degrees (e.g., revealed by constant n-C<sub>18</sub>/phytane ratios of  $0.81 \pm 0.12$ ). However, two of the 25 samples showed greater alkane biodegradation.

Measurement of the bulk oxygen content ( $5.9 \pm 0.8\%$  by mass) showed some variability. Nevertheless, this variability is small compared to that in oxygen content previously observed (0.3 up to 14%) in a large data set comprising samples of very different degrees of weathering. In summary, it appears that samples collected from a small region are representative of other sand patties of similar size and physical appearance.

Session: 001 -

Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## Relating PAH content to overall stability of organic matter containing DWH oil

**Presenter:** Zeynep Dincer – Texas A&M University

**Authors:** Zeynep Dincer, Texas A&M University; Matthew Pendergraft, Tulane University; José Sericano, Geochemical and Environmental Research Group; Franco Marcantonio, Texas A&M University; Terry L. Wade, Geochemical and Environmental Research Group; Thomas S. Bianchi, Texas A&M University; Alex Kolker, The Louisiana Universities Marine Consortium; Brad E. Rosenheim, Tulane University

### Abstract:

Results from coupled polycyclic aromatic hydrocarbon (PAH), total petroleum hydrocarbon (TPH) and ramped pyrolysis radiocarbon analysis of oil extracted from sediments and plant detritus sampled from Bay Jimmy, Barataria Bay, Louisiana are presented. TPH and PAH, both indicators of the presence of oil, ranged from 93 to 410,000 ug/g and 39 to 21,000 ug/g, respectively. Samples from the area nearest to the source (Area A) had the highest TPH and PAH concentrations. Cores had homogeneous distribution with depth except in Area A, which decrease from a surface value of 30,000 ng/g to 430 ng/g at a depth of 9 cm. Ramped-pyrolysis radiocarbon analysis was applied to bulk samples to relate different observed pyrolysis reaction rates to PAH content, as Macondo well oil has been observed to at lower temperatures relative to background organic material. Isotopic results are used to interpret ramped pyrolysis thermographs in terms of oil content and mixing with background organic material.



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Session: 001 -

Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## Precursors of oxygenated hydrocarbons in weathered oil identified by comprehensive two-dimensional chromatography and chemometric analysis

**Presenter:** Gregory Hall – U.S. Coast Guard Academy

**Authors:** CDR Gregory J. Hall, Ph.D., U.S. Coast Guard Academy (dsc); Glenn S. Frysjer, U.S. Coast Guard Academy (dsc); Christoph Aeppli, Woods Hole Oceanographic Institution; Catherine A. Carmichael, Woods Hole Oceanographic Institution; Jonas Gros, Swiss Federal Institute of Technology at Lausanne; Karin L. Lemkau, Woods Hole Oceanographic Institution; Robert K. Nelson, Woods Hole Oceanographic Institution; Christopher M. Reddy, Woods Hole Oceanographic Institution

### Abstract:

Following the release of oil from the Macondo well, a wide range of abiotic and biotic processes acted on it. A recent study revealed that surface slicks, rock scrapings, and oiled sands were oxidized into oxygenated hydrocarbons (OxHC) with this fraction comprising up to 50% of the extractable hydrocarbons. The precursors of these compounds, however, were not identified despite using a wide range of traditional analytical tools include gas chromatography (GC). To search for the hydrocarbon precursor of the OxHC, we analyzed over 40 samples by comprehensive two-dimensional gas chromatography (GCxGC), perhaps one of the largest studies of its kind to date, in order to assess any characteristic disappearance or persistence of individual compounds that correlated with the formation of the OxHC. We then employed partial least squares regression to elucidate the GCxGC peaks that could be the precursors of OxHC in our field samples. We found that the formation of a fraction of OxHC correlated best with the disappearance of saturated hydrocarbons, indicating a previously under-reported chemodynamic process in oil spill weathering.

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Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## Time Evolution of Combustion Enthalpies of BP Oil Spill Residue

**Presenter:** Colin Holmes – Jacksonville State University

**Authors:** Colin Holmes, Jacksonville State University; Jan Gryko, Jacksonville State University

### Abstract:

The combustion enthalpy of Deepwater Horizon oil spill tarballs is between 60 and 80% of the combustion enthalpy of fresh crude oil, which is ~ 45 MJ/kg. The combustion enthalpy of tarballs did not change significantly with time. Some tarballs collected in April 2011 have even higher energy content than the samples collected in July 2010. On the other hand, the combustion enthalpies of floating mousse tarmats are much lower, (~ 40% of crude oil) because these samples contain significant amount of sea water and dispersants. However, the floating foams still contain large amount of oil residue and have relatively high caloric values. It is interesting to note that the methylene chloride extracts of dry tarballs have higher caloric value than un-extracted tarballs, approx. 40 - 42 MJ/kg. This slightly higher combustion enthalpy is due to the fact that combustion process of a tarball sample is not complete, because tarballs contain approx. 80% of sand by mass. However, caloric value of dichloromethane extracts is lower than the fresh crude oil, indicating that high-energy hydrocarbons evaporated from the tar balls. Comparing the combustion enthalpies of BP oil residue samples with those of crude oil, we see that natural processes are much more efficient at removing high energy hydrocarbons from the oil residue than simple evaporation under UV lamp. This is due to fact that natural weathering includes many factors, such as sunlight, wind, and mechanical action of sea waves, which greatly increase contact area between the oil residue and air.

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Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## Characterization of the Water-Soluble and Interfacially Active Species from the Deepwater Horizon Crude by Electrospray Ionization FT-ICR Mass Spectro

**Presenter:** Jackie Jarvis – NHMFL/FSU

**Authors:** Jacqueline M. Jarvis, Florida State University; Winston K. Robbins, Florida State University; Alan G. Marshall, Florida State University; Ryan P. Rodgers, Florida State University

### Abstract:

It is inevitable that some petroleum crude oil will enter into the environment, either through anthropogenic or natural occurrences. Knowledge of water-soluble organic (WSO) compounds and compounds that exist at the crude oil/water interface helps in understanding of emulsion stability and in remediation efforts. Here, Fourier transform ion cyclotron resonance mass spectrometry (FT-ICR MS) is utilized to

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characterize the water-soluble and interfacially active species in the Deepwater Horizon (DWH) crude oil.

WSO were isolated by liquid-liquid extraction,<sup>1</sup> and interfacial material (IM) was isolated in a separate procedure from the DWH crude oil. The parent DWH crude oil along with the WSO and IM fractions were analyzed with a custom-built 9.4 T FT-ICR mass spectrometer. Data were calibrated and processed with a custom software package (PREDATOR). Work supported by NSF DMR-06-54118, BP/The Gulf of Mexico Research Initiative, and the State of Florida.

(1) Stanford, L. A.; Kim, S.; Klein, G. C.; Smith, D. F.; Rodgers, R. P.; Marshall, A. G. *Environ. Sci. Technol.* 2007, 41, 2696-2702.

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Session: 001 -

Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## Detection and Quantitation of Alkylated Chrysene in Deepwater Horizon (DH)-related oil spill samples by Triple Quadrupole Gas Chromatography/Mass Spec

**Presenter:** Gerald John – Auburn University

**Authors:** Gerald F John, Auburn University; Fang Yin, Auburn University; Vanisree Mulabagal, Auburn University; Joel S. Hayworth, Auburn University; T. Prabhakar Clement, Auburn University

### Abstract:

The petrogenic polycyclic aromatic hydrocarbons (PAHs) are ubiquitous organic contaminants of environmental concern. The study of oil spill accidents related to petrogenic PAHs has led to the inclusion of additional PAHs and alkylated PAHs as routine target analyte in many environmental analyses. Due to poor water solubility and resistance to weathering, alkylated chrysenes serves as internal biomarkers in assessing the degradation of the aromatic fractions in a manner similar to that of hopane used for aliphatic fractions. In this study we describe a GC/MS/MS based analytical method to characterize and quantify alkylated chrysenes in Deepwater Horizon (DH) source oil, emulsified mousse and a number of tar balls collected from Alabama Shoreline from June 2010 to September 2012. In addition, we also completed an artificial weather experiment where the source oil was allowed to weather under controlled conditions, to quantify the impacts of photo-oxidation on the distribution of alkylated chrysenes. The details of results will be presented.

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Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## Characterization of oiled materials collected before and after Hurricane Isaac at Fort Morgan, AL

**Presenter:** Karin Lemkau – Woods Hole Oceanographic Institution

**Authors:** Karin L. Lemkau, Woods Hole Oceanographic Institution; Helen K. White, Haverford College; Christopher M. Reddy, Woods Hole Oceanographic Institution

### Abstract:

Hurricane systems in the Gulf of Mexico (GoM) have the potential to mobilize material from both offshore and near coastal environments. As such, it was speculated that Hurricane Isaac, which made landfall in September 2012, would contaminate GoM beaches with oiled materials persisting from the Deepwater Horizon (DWH) disaster. As part of a multi-year program of collecting oiled samples from GoM beaches, oil-soaked sand patties were collected from Fort Morgan, AL beaches one week before and two days after the landfall of hurricane Isaac. While oil-soaked sand patties (3 to 30 mm diameter) were considerably more abundant prior to Isaac, the chemical composition of the oil extracted in all samples was comparable and similar to previous reports of heavily weathered oil. In addition, black mats (6" by 8") that were visually consistent with salt marsh peat that had washed onto the beaches after Isaac were examined. Stable carbon (<sup>13</sup>C) isotope measurements and terrestrial plant wax n-alkane signatures were used to confirm that these mats were dominated by near coastal salt marsh material as opposed to an offshore source. The mats contained only trace amounts of oil from the DWH disaster indicating that Hurricane Isaac did not mobilize oiled materials at Fort Morgan.

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Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## DART MASS SPECTROMETRY FOR ENVIRONMENTAL ANALYSIS OF THE MACONDO OIL SPILL

**Presenter:** Vladislav Lobodin – NHMFL

**Authors:** Vladislav V. Lobodin, Florida State University; Brian M. Ruddy, Florida State University; Leonard Nyadong, Florida State University; Ryan P. Rodgers, Florida State University; Alan G. Marshall, Florida State University

### Abstract:

The wide area affected by the 2010 Macondo oil spill requires analysis of thousands of environmental samples. Therefore, rapid sample prescreening for the initial estimation of severity of the pollution is needed to select the most representative samples for more detailed analysis.

Direct Analysis in Real Time (DART) enables analysis of solid and liquid samples without prior sample preparation and thus provides unsurpassed sample throughput. Because the reliability of chemical identification by mass spectrometry improves with increasing mass resolving power and mass accuracy, the combination of DART with FT-ICR MS enables quick and reliable compositional assessment that is especially essential for analysis of compositionally complex environmental organic mixtures. Preliminary method development with FT-ICR guided the final screening procedure with less expensive and more available instrument configurations (DART/TOF-MS). Work supported by NSF DMR-06-54118, the Florida State University Future Fuels Institute, BP/The Gulf of Mexico Research Initiative, and the State of Florida.

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Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## Comparing laboratory- and field-weathered oil from the Macondo well

**Presenter:** Charlotte Main – National Oceanography Centre

**Authors:** Charlotte E. Main

National Oceanography Centre; Robert K. Nelson, WHOI; Christoph Aeppli, WHOI; Catherine A. Carmichael, WHOI; Karin L. Lemkau, WHOI; Christopher M. Reddy, WHOI

### Abstract:

Investigations into the impacts of crude oil present years after a spill require the study of its chemical composition and likely toxic effects. Standard toxicological tests typically use laboratory-weathered oil. However, in the oceanic environment, natural processes can result in significant changes to the hydrocarbon composition of crude oil, which in turn can mislead fate-based and toxicological studies that rely on lab-weathered oils.

To prepare a field-weathered oil, we extracted > 1 kg of sand patties collected on Gulf Shores Beach, Alabama, in September 2012. Over 200 g of oil was isolated and analyzed with a wide range of bulk and molecular analytical tools, including comprehensive two-dimensional gas chromatography (GC×GC), which was used to confirm the origin of the oil. To prepare the lab-weathered oil, we heated Macondo oil at 40-50°C until we could match the earliest retention time of hydrocarbons via gas chromatogram to the field oil. Collectively, we found that the field samples were affected by, at least, biodegradation, evaporation, and dissolution preferentially removing some hydrocarbons while adding oxidized hydrocarbons. In contrast, laboratory-weathered oil has undergone only evaporation. The extent to which observed compositional differences affects toxicological assays is not known and investigation of this is planned for future studies. The large volume of naturally weathered oil extracted from the sand patties, which can be shared across the community, now represents a valuable resource for future studies into its toxic effects.

Session: 001 -

Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## Advanced Petroleum Fingerprinting Using Comprehensive Two-dimensional Gas Chromatography (GC×GC)

**Presenter:** Robert Nelson – Woods Hole Oceanographic Institution

**Authors:** Catherine A. Carmichael, Woods Hole Oceanographic Institution; Jagos R. Radovic, Institute of Environmental Assessment and Water Studies-CSIC, Barcelona, Spain; Christoph Aeppli, Woods Hole Oceanographic Institution; Charlotte E. Main, University of Southampton-National Oceanography Center; Christopher M. Reddy, Woods Hole Oceanographic Institution

### Abstract:

Traditional one-dimensional (1D) gas chromatographic (GC) techniques have achieved impressive results in petroleum analysis but have limitations for fingerprinting and tracking oil spills. Comprehensive two-

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dimensional gas chromatography coupled with time-of-flight mass spectrometry (GC×GC-TOFMS) or a flame ionization detector (GC×GC-FID) can expand past the limitations of 1D-GC. The power of GC×GC is based on the combination of two GC columns with orthogonal stationary phases e.g. non-polar (100% dimethylpolysiloxane) and polar (50% phenyl-, 50% dimethylpolysiloxane). GC columns are connected via a cryogenic modulator, which concentrates the components eluting from the first column and then focuses this material into a narrow band. This narrow band is injected onto the second column and separated on a different chromatographic phase. Thus, the technique is comprehensive as all of the material eluting from the first dimension column is transferred to the second dimension column. The addition of the second dimension increases the peak capacity of a chromatogram by ~20 times (determined as the number of baseline separated peaks that fit within the chromatogram).

GC×GC is an ideal tool for petroleum fingerprinting using biomarkers (molecular fossils). Historically, researchers have avoided using certain biomarkers because they are known to co-elute with other components making analysis difficult at best on 1D instruments. An example of co-eluting compounds that are commonly avoided are a C27 sterane (C27 $\alpha\beta\beta$ -20R) and a C29 diasterane (DiaC29 $\beta\alpha$ -20S). These components are resolved from one another on the GC×GC plane making it possible to use these compounds to discriminate crude oils. Numerous other examples of co-eluting components have been identified and are highlighted on this poster.

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## Session: 001 -

Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 16:30 - 18:00  
Type: Poster

### Physical Approach to finding Crude Oil Content Index in Liquid Samples at Gulf of Mexico after DWH Oil Spill 2010

**Presenter:** Sadegh Partani – Louisiana State University

**Authors:** Sadegh Partani, Visiting Ph.D. Candidate at Louisiana State University; Reza Ghiassi, Faculty of Civil Engineering, University of Tehran, Iran; Ahmad Khodadadi D, Faculty of Engineering, University of Tarbiat Modares, Tehran, Iran; Chunyan Li, Louisiana State University; Mohsen Saeedi, Iran University of Science and Technology

#### Abstract:

Hence the sampling and chemical analysis of oil content is much expensive, the index as a representative of oil content is demanded.

Hence this index intend to determine the oil content in physical approach regardless of chemical reactions and adsorption, biological uptake, source analysis and oil content age, it can be a variable that for indicating of pollution should help the blank and initial condition.

For this research, water and surface water samples which are released online by EPA have been used. Three variables have been selected for data mining between more than 35 variables that had been measured. The related clusters after basic statistical analysis showed Vanadium and Nickel can be considerable indices' factors which led the research to final index.

Statistical analysis regarding to physical and hydraulic parameters also show that climate parameters have minor effects on the concentration of mentioned metals in the samples.

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## Session: 001 -

Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 16:30 - 18:00  
Type: Poster

### Characterizing oil degradation and mixing in bulk samples from coastal environments using ramped-pyrolysis

**Presenter:** Matthew Pendergraft – Tulane University

**Authors:** Matthew Pendergraft, Tulane University; Brad Rosenheim, Tulane University;

Arndt Schimmelmann, Indiana University;

David Finkelstein, University of Massachusetts Amherst

#### Abstract:

Bulk isotopic or compound-specific techniques are normally used to track oil pollution as it degrades and mixes into the environment. Here we employ a novel ramped-pyrolysis technique coupled with isotopic analyses to separate bulk samples into fractions, characterizing <sup>14</sup>C-free oil degradation and mixing in coastal environments with <sup>14</sup>C-rich modern biomass. Samples from coastal areas for 881 days after the 2010 BP Deepwater Horizon oil spill were subjected to a smooth temperature ramp in anoxic conditions to pyrolyze organic material. Through time, the temperatures of maximum pyrolysis generally increased. Preliminary radiocarbon analyses from a tar ball sampled from Grand Isle, LA 678 days after the spill yielded 97-98% oil composition along with a higher temperature of maximum pyrolysis, suggesting stabilization of oil fractions. Additionally, hydrogen isotope measurements of tar balls suggest incorporation of non-Macondo oil. We present isotopic results from ramped-pyrolysis of sediment, oil and tar to test the effects of degradation and mixing on pyrolysis of oil and OC.

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Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## Photooxidation of triaromatic steroids in Macondo well oil

**Presenter:** Jagos Radovic – IDAEA-CSIC/WHOI

**Authors:** Jagos R. Radovic, IDAEA-CSIC/WHOI; Christoph Aeppli, WHOI; Robert K. Nelson, WHOI; Sergi Diez, IDAEA-CSIC; Josep M. Bayona, IDAEA-CSIC; Christopher M. Reddy, WHOI

### Abstract:

The identity of oil samples is traditionally confirmed by comparing distinct ratios of biomarker molecules, i.e. hopanes, steranes, and triaromatic steroids (TAS), which are assumed to be unaffected by medium to long-term weathering processes. However, in a survey of field samples in 2011 and 2012 collected along Gulf of Mexico beaches, we observed that they had conserved hopane and sterane ratios but the TAS were depleted relative to hopane.

To investigate how photooxidation may affect Macondo well (MW) oil and seven TAS, neat oil was irradiated using natural sunlight during a two-month period. Samples were collected (daily, weekly, monthly) and analyzed by comprehensive two-dimensional gas chromatography (GC×GC), Fourier transform infrared spectrometry (FTIR), and thin layer chromatography with flame ionization detection (TLC-FID). The results were compared to observations from field samples containing MW oil

Losses of all TAS compounds were observed, which correlated with an increase in oxidized oil fraction, suggesting that they can be photooxidized, and should be used with caution when fingerprinting weathered MW oil samples. Their common aromatic structure might be the reason for this behavior.

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Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## Photochemical and Photocatalytic Transformations of Surface Crude Oil in Seawater Systems

**Presenter:** Phoebe Ray – University of New Orleans

**Authors:** Phoebe Z. Ray, Sarah King, Amy Olson, Jeremy Stroud, Syeda Quadri, Richard Cole, Matt Tarr, University of New Orleans

### Abstract:

Short and long term impacts from the Deepwater Horizon oil spill are not fully understood. Many of the fundamental photochemical processes have not been investigated. In this study, surface oil samples were placed in a thin film over Gulf water and irradiated with simulated sunlight. Dichloromethane extracts were analyzed using gas chromatography, fluorescence, and absorbance. The aqueous layer was collected and analyzed using HPLC, LC-MS, and Microtox. Systems were also modified by addition of nano-TiO<sub>2</sub> (nanoparticles or nanotubes). Benzoic acid was also used as a probe to measure hydroxyl radical in the water phase. The toxicity of water in contact with oil during irradiation was observed through Microtox analysis. Identification of polar photoproducts was performed by LC-MS. GC-MS was used to identify components and biomarkers in the oil layer. The irradiated oil showed substantial hydroxyl radical production. TiO<sub>2</sub> nanotubes showed increased oil photodegradation compared to pure oil. Microtox analysis showed an increase in water toxicity with irradiation.

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Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## CHARACTERIZATION OF OXYGEN COMPOUNDS IN ENVIRONMENTAL AND PETROLEUM SAMPLES BY LC FT-ICR MASS SPECTROMETRY

**Presenter:** Steven Rowland – NHMFL/FSU

**Authors:** Steven M. Rowland, Florida State University; Mmili M. Mapolelo, Florida State University; Winston K. Robbins, Florida State University, Tallahassee; Alan G. Marshall, Florida State University; Ryan P. Rodgers, Florida State University

### Abstract:

The molecular level characterization of interfacial materials, water-soluble species, production deposits, and environmentally degraded crude oils has brought to light an ever expanding range of oxygenated compounds. Analysis of these compounds by electrospray ionization Fourier transform ion cyclotron resonance mass spectrometry (ESI FT-ICR MS) accesses only the most polar functionalities (organic acids). Liquid chromatography (LC) can separate by polarity, for higher dynamic range and less charge competition for each fraction during subsequent mass analysis. Here we describe on- and off-line chromatographic techniques to separate oxygen species according to their chemical functionality; FT-ICR MS can then provide a comprehensive approach to characterize oxygenated compounds in complex matrices originating



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from petroleum crude oil. Work supported by NSF DMR-06-54118, the Florida State University Future Fuels Institute, and the State of Florida.

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**Session: 001 -**

Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## New Insights into the Weathering of Macondo Well Oil: Analysis of Contaminated Sands from Pensacola Beach

**Presenter:** Brian Ruddy – FSU/NHMFL

**Authors:** Brian Ruddy, FSU/ NHMFL; Markus Huettel, FSU; Joel Kostka, GATech; Vlad Lobodin, NHMFL; Ben Bythell, NHMFL; Amy McKenna, NHMFL; Christoph Aeppli, WHOI; Cris Reddy, WHOI; Bob Nelson, WHOI; Alan Marshall, NHMFL; Ryan Rodgers, NHMFL,

### Abstract:

Of the estimated 4 million barrels (5 million spilled, but 1 million recovered) of crude oil released into the Gulf of Mexico from the Deepwater Horizon oil spill, a fraction washed ashore onto sandy beaches from Louisiana to the Florida panhandle. Here, we incorporate ultrahigh resolution Fourier transform ion cyclotron resonance mass spectrometry for assignment of high molecular weight, nonvolatile species. A core of oiled sands collected from an intertidal zone of Pensacola Beach was analyzed at various depths. The results display a greater than two-fold increase in compositional complexity, particularly oxygen compounds relative to the original Macondo well oil. GC-MS analysis of anion exchange fractions unequivocally verifies the presence of abundant ketone fragments in the sand extracts.

The work was supported by the NSF DMR-06-54118, OCE-1044939 and OCE-1057417, the Florida State University Future Fuels Institute, the State of Florida, and the BP/The Gulf of Mexico Research Initiative.

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**Session: 001 -**

Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## Portable GCMS for the Analysis of Dredge Material

**Presenter:** Amber Russell – BTS

**Authors:** Amber Russell, BTS; Anthony Bednar, USACE; Charolett Hayes, BTS; William Jones, USACE

### Abstract:

Site characterization can be a time consuming and labor intensive process, where traditional laboratory analysis can delay data availability. Field based technologies that provide high quality near real-time chemical data regarding contamination, allow for onsite decisions and reducing costs. A Flir Systems field portable Gas Chromatograph Mass Spectrometer (GCMS) was deployed in July of 2008 to an active dredge on the lower Mississippi River impacted by an oil barge sinking incident. The GCMS was used for determination of polycyclic aromatic hydrocarbon (PAH) contaminants in dredge material. Sediment and water samples were collected as for traditional analysis. The GCMS required only slight modifications to fixed laboratory methods for the quantification of PAHs allowing for rapid data generation, availability, and dredging decisions to be made based on sound scientific data. The need for rapid detection of PAH's in sediment and water necessitated the development of an oil spill screening test kit, which provides even faster semi-quantitative detection of petroleum hydrocarbons in soil and water matrices.

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**Session: 001 -**

Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## Exploring the heterogeneity of oil in sand patties from the Gulf of Mexico

**Presenter:** Patrick Williams – Haverford College

**Authors:** Patrick L. Williams, Haverford College; Christopher M. Reddy, WHOI; Helen K. White, Haverford College

### Abstract:

Oil-soaked sand patties originating from the Deepwater Horizon oil spill were collected from Gulf of Mexico beaches in June and July, 2012. Sand patties of various color, size, thickness, and distance from the surf were compared to explore the heterogeneity of oil present. Gas chromatography-flame ionization detection (GC-FID) was used to determine the composition and quantity of oil present and the amount of saturated, aromatic, and oxygenated fractions in extracts was quantified using a thin layer chromatography-flame ionization detection (TLC-FID). The presence of oxygen functional groups was examined via fourier transform infrared spectroscopy (FT-IR) to provide greater insight into the degree to which the oil was weathered by biodegradation and photooxidation. Significant variations in oil composition and degrees of oxidation were observed both between sand patties and within sand patties. Future work will continue to utilize FT-IR to explore these variations and the diversity of oxygenated compounds present in oil-soaked sand patties.

# Science Abstracts

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Session: 001 -

Track: Chemical Methods for Comprehensive Oil Spill Analysis

Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## **Quantitation of US EPA priority Polycyclic Aromatic Hydrocarbons (PAHs) in Deepwater Horizon related oil spill samples by GC/MS/MS**

**Presenter:** Fang Yin – Auburn University

**Authors:** Fang Yin, Auburn University; Gerald F John, Auburn University; Vanisree Mulabagal, Auburn University; Joel S. Hayworth, Auburn University; T. Prabhakar Clement, Auburn University

### **Abstract:**

In the current work we describe a GC/MS/MS based analytical method for the characterization and quantitation of US EPA priority PAHs present in Deepwater Horizon (DH) oil, Evaporated DH (EDH) oil, mousse and DH- related oil spill samples collected from Alabama Shoreline. A simple extraction and cleanup procedures have been used in sample preparation step. The chromatographic separation was achieved by triple quadrupole-gas chromatography/mass spectrometry (QqQ-GC/MS/MS) in Multiple Reaction Monitoring (MRM) mode using a mixture of 16 PAH standards and four isotopically labeled internal standards. The method was further applied to develop PAHs fingerprints for DH-oil, mousse and a total number of six tar mats (TM-1 to TM-6) and their PAHs profiles have been compared. Quantitation of PAHs was performed based on calibration curves developed using standard PAHs concentrations ranging from 0.05 to 0.4 µg/mL which are spiked with 0.050 µg/mL of four isotopically label internal standards (IS). The total PAHs content in DH, EDH oil and mousse samples are  $1441 \pm 10$ ,  $822 \pm 4$  and  $133 \pm 4$  mg/kg, respectively. Whereas total PAH content measured in tar mat samples TM-1 to TM-6 were in the range of 134 to 185 mg/kg.

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# Science Abstracts

## Session: 002 Coastal Inshore Impacts of Oil: From Mousse to Food Webs:

Session: 002 - 2

Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Tuesday, January 22 8:45 AM  
Type: Oral Presentation

### Hydrocarbons in near shore coastal waters one year after to Deepwater Horizon Oil Spill

**Presenter:** Ed Overton – Louisiana State University

**Authors:** E.B. Overton, Louisiana State University, M.S. Miles, LSU, B.M. Meyers, Heng Gao, LSU

#### Abstract:

During the Fall 2011 time frame, near shore coastal waters at several locations in and around the “Birds Foot” delta and locations further west in areas of Barataria Bay were surveys for buried oil. All locations were adjacent to areas heavily impacted by the oil spill in the summer of 2010. The survey included disruption of the bottom sediments with sampling probes and the motor’s propeller while looking for signs of surfacing oil slicks. Seventy four archival sediment samples were collected at these sites. Our results showed that the extracts from 4 sediments samples were a match to Macondo 252 crude oil; 69 samples were considered as background; and 1 sample was confirmed as petrogenic contamination other than MC 252 crude oil. The extracts from MC 252 oil contaminated samples show clear biomarker patterns in terms of the hopanes (m/z 191), the diasteranes and regular steranes (m/z 217), the 14β(H) steranes (m/z 218), and the triaromatic steroids (m/z 231), and matched a couple of PAH homologue ratios that are unique to the Deepwater Horizon riser source oil. The background samples, on the other hand, did not match any of the biomarker patterns or PAH homologue ratios. Additionally, the ratio of GC resolvable peaks to the unresolved complex mixture (RSV/UCM) of less weathered oil are significantly larger due to the fact that less weathered oil has more GC resolvable peaks and a low UCM, resulting in a higher ratio. The RSV/UCM relationship was opposite in weathered oil samples where the GC resolvable peaks are lower and the UCM is well-pronounced, generating a much lower RSV/UCM ratio. The RSV/UCM ratios of the samples representing the background were constant. Quantitatively, the extracts from oily sediments have significant levels of alkanes (494~5919 ppm) and PAHs (41000~149119 ppb); however, the extracts from background samples have lower level of alkanes (0.7~6.0 ppm) and PAHs (20~1200ppb). This work provides important information to monitor the fate and transport of petroleum contaminates released from the Deepwater Horizon spill and provides information regarding differences between background and oil contamination that can be used as reference parameters.

Session: 002 - 3

Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Tuesday, January 22 9:15 AM  
Type: Oral Presentation

### Expanded Chemical Profiles of MC252 Crude

**Presenter:** Scott Milroy – The University of Southern Mississippi

**Authors:** Scott P. Milroy, The University of Southern Mississippi; Andreas Moshogianis, The University of Southern Mississippi

#### Abstract:

While much of the attention paid to petrochemical contaminants from the Deepwater Horizon oil spill has focused almost exclusively on BTEX and PAHs, there are a wide variety of other diesel-range (DRO) and oil-range (ORO) organics which can have deleterious, chronic effects on exposed organisms. To assist in those assessments, it was necessary to perform an exhaustive profile of petrochemical constituents among exemplars of both the source and weathered MC252 crude to provide environmental researchers with additional information with which to examine petrochemical residues as consistent with, or excluded from, a DWH source.

The unique petrochemical profile of “Source Oil B” and that of weathered “OFS” oil (Item ID A0030R; COC 20110803-Milroy-070) was established by Jones Environmental Forensics Laboratory (Milroy 2012, in preparation), from analyses of: PAH-16 by GC/MS; EPH (C8-C40) by GC-FID; TPH-CWG (C5-35) by GC-FID; BTEX/MTBE by headspace GC-FID; Phenols by HPLC; Biomarkers by GC/MS; and SVOC by GC/MS.

Results demonstrate that PAH signatures of the Source and OFS oils are each consistent with those included in the OSAT-UAC (2010) Summary Report for the Sub-sea and Sub-surface Oil and Dispersant Detection, specific to the petrogenic PAH profile of MC252 crude.

Relative concentrations of 8-carbon (nC8) to 40-carbon (nC40) petroleum hydrocarbons in the Source Oil reflects an enrichment in low molecular weight (LMW) hydrocarbons in the nC8-nC14 range. By contrast, weathered OFS is dominated instead by high molecular weight (HMW) hydrocarbons, most notably in the >nC15-nC16 and >nC16-nC21 range. Within the Source Oil, virtually all size fractions of the aliphatics are represented; in contrast, weathered OFS aliphatics become enriched in the HMW petroleum hydrocarbons and depauperate in LMW hydrocarbons. This same pattern is reflected in the aromatic petroleum hydrocarbon signatures, where OFS is dominated by HMW aromatics, most notably in the >EC16-EC21 fraction.

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Session: 002 - 4

Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Tuesday, January 22 9:30 AM

Type: Oral Presentation

## Variations in organic carbon chemistry in the Gulf Coast and coastal marshes following the Deepwater Horizon oil spill

**Presenter:** JoAnn Holloway – U.S. Geological Survey

**Authors:** JoAnn M Holloway, U.S. Geological Survey; William H Orem, U.S. Geological Survey; George Aiken, U.S. Geological Survey; Matthew Varonka, U.S. Geological Survey; Kenna Butler, U.S. Geological Survey; Raymond F. Kokaly, U.S. Geological Survey; Sarai Piazza, U.S. Geological Survey

### Abstract:

Integrated remote sensing and water quality sampling were conducted to evaluate the extent of impact to marshes following the Deepwater Horizon spill. Oil was observed “dissolved” in the water column with a hydrocarbon distribution resembling that of the surface oil slick. While oils maintained many of the more volatile lower molecular weight components near the spill site, these were mostly gone in the onshore Barataria Bay samples, leaving mostly higher molecular weight components. Dissolved organic carbon (DOC) was elevated in three open-water sites, and in one Barataria Bay marsh site collected in 2010. With the exception of this one marsh sample, DOC concentrations were similar in impacted and visibly unimpacted sites in Barataria Bay in 2010. There was an increase in specific UV absorbance (SUVA), an index of aromaticity, with increasing DOC concentrations at some repeatedly sampled sites, likely derived from the progressive decay of oil-killed vegetation. An October 2011 survey of Barataria Bay marshes showed greater concentrations of DOC associated with pore waters in visibly unimpacted marshes, reflecting the senescence of the intact vegetation.

Session: 002 - 5

Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Tuesday, January 22 9:45 AM

Type: Oral Presentation

## Transport and decomposition of MC252-oil in permeable sediment

**Presenter:** Markus Huettel – Florida State University

**Authors:** Markus Huettel, Department of Earth, Ocean and Atmospheric Science, Florida State University; Joel Kostka, Georgia Institute of Technology; Alissa Zuijdgheest, Swiss Federal Institute of Technology, Zurich; Corine Samaras, FSU; Chris Hagan, FSU; John Kaba, FSU; Brian Wells, FSU; Stacia Dudley, FSU; Matt Smith, FSU

### Abstract:

After the Deepwater Horizon accident, crude oil was transported to the coast in the northeastern Gulf of Mexico where it was deposited on beach and sublittoral sandy sediments. In this contribution, we present results from studies that addressed the transport and degradation of this oil in saturated and unsaturated sands, including data on the fate of polycyclic aromatic hydrocarbons. Our results reveal the rapid transport of hydrocarbons into the surface layers of the sand and the role of dispersants for this process. Immediate increases in respiration and dissolved inorganic carbon production rates support the hypothesis that a fraction of this crude oil contained highly degradable components that were promptly consumed by the sedimentary microbial community.

Session: 002 - 6

Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Tuesday, January 22 10:00 AM

Type: Oral Presentation

## Macondo 252 Oil in Louisiana Salt Marshes

**Presenter:** R. Turner – Louisiana State University

**Authors:** Ed B. Overton, M.Scott Miles, Buffy M. Ashton, Heng Goa, R.Eugene Turner, Linda Hooper-Bui, Giovanna McClenachan, Erick M. Swenson, Charles S. Milan, Jim M. Lee, Louisiana State University

### Abstract:

We analyzed 300+ samples collected from south Louisiana salt marshes before, during and after the Macondo Oil Spill using gas chromatography/mass spectrometry to determine petroleum hydrocarbons. Chromatographs were examined to determine the presence of oil from the Macondo 252 spill. Sample concentrations ranged from 1 to 8,000 mg/Kg dry weight of alkanes and 100 to 152,200 µg/Kg dry weight of aromatics. Peak concentrations appeared in fall, 2010, were lower in 2011, and within one order of background values by summer 2012. Hurricane Isaac introduced some remnant Macondo Oil back into the marsh in fall 2012. The concentrations of oil only vaguely correspond to shoreline condition indices represented by the SCAT categories. The concentrations of total alkanes and aromatics might range 3 orders of magnitude within 10 m of each other parallel to shoreline, and were sometimes of similar concentration at the edge and >50 m into the marsh. Relative evaporative and biodegradation indices are compared to explore the degree of recovery in time and space, and to develop baseline values to measure the degree of oiling.

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Session: 002 - 7

Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Tuesday, January 22 10:15 AM

Type: Oral Presentation

## **Recovery of Ecological Structure and Function of Coastal Marshes Impacted by the Deepwater Horizon Oil Spill**

**Presenter:** Qianxin Lin – Louisiana State University

**Authors:** Qianxin Lin, Louisiana State University; Irving Mendelssohn, Louisiana State University

### **Abstract:**

The release of a US government-estimated 4.9 million barrels of oil from the Deepwater Horizon (DWH) event exposed the nation's largest and most productive wetland-estuarine environment to an unprecedented potential for environmental damage. We conducted a series of field and greenhouse experiments to assess oil impacts to coastal salt marshes and their subsequent recovery of ecological structure and function. In the salt marshes of northern Barataria Bay, we established replicated field stations that received heavy, moderate and no oiling. To better understand the processes controlling oil impacts and recovery of coastal wetlands, we experimentally exposed in the greenhouse marsh sods of *Spartina alterniflora* and *Juncus roemerianus* to different degrees of oil coverage.

Impacts of Macondo oil to coastal wetlands in northern Barataria Bay were severe in some areas and moderate in others. Average concentration of total petroleum hydrocarbons (TPH) of surface soil in heavily oiled marshes was > 500 mg g<sup>-1</sup> seven months after oil landfall. Heavy oiling almost completely killed fringing coastal marsh plants, and left many bare, un-vegetated shoreline marshes. There has been variable recovery in heavy oiled shoreline marshes 22 months after oil landfall. In the absence of complete recovery, live belowground biomass was significantly lower compared to unoiled controls, and consequently shear strength of the marsh soil decreased, which might make these marshes more vulnerable to erosion and wetland loss.

However, in moderately oiled marshes, the TPH concentration was < 100 mg g<sup>-1</sup> 7 months after oiling. Here, impact and recovery were species-specific, i.e., greater recovery for *Spartina* than for *Juncus*. Our parallel greenhouse mesocosm study supported field results and indicated that *Spartina* was much more tolerant to shoot oil coverage and repeated oiling than *Juncus*. A number of environmental and biotic factors control ultimate recovery of oil-impacted wetlands.

Session: 002 - 8

Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Tuesday, January 22 11:00 AM

Type: Oral Presentation

## **Cleanup of Heavily Oiled Salt Marsh during the Deepwater Horizon Oil Spill: II. Comparisons of Ecological Effects and Initial Recovery**

**Presenter:** Scott Zengel – Atkins

**Authors:** Scott Zengel, Atkins; Nicolle Rutherford, NOAA; Jacqueline Michel, RPI

### **Abstract:**

The Deepwater Horizon oil spill resulted in heavy persistent oiling conditions in the salt marshes of Northern Barataria Bay, Louisiana, more so than elsewhere in the Gulf of Mexico. Due to the degree and nature of oiling, traditional marsh cleanup methods were not effective. There was concern that marsh recovery in this area could be at risk without further intervention. The competing concern was that aggressive cleanup could cause further marsh damage, delaying or limiting recovery, as has been observed following many spills. Due to these factors, an adaptive marsh treatment testing program was developed. The goal was to identify treatments that would remove and/or reduce detrimental oiling conditions and enhance marsh recovery without causing further marsh damage. Treatment methods that showed initial promise were replicated in standardized test plots, for comparison with sets of control and reference plots. To date, oiling conditions have been monitored monthly in each test plot for one year, and again one year later. Vegetation, fiddler crab (*Uca* spp.), and marsh periwinkle (*Littoraria irrorata*) parameters have been evaluated for one and two growing seasons post-cleanup. Oiled sediment chemistry and shoreline erosion have also been examined. Persistent heavy oiling and continuing ecological effects were observed in the test plots more than one year after oiling. Signs of improved oiling conditions and enhanced initial habitat recovery were observed during the first growing season in test plots for one set of cleanup treatments (at 9 months post-treatment); more so than for plots that were not treated. This presentation will summarize new test plot data collected more than two years after oiling and during the second growing season after treatment, as well as new data collected for adjacent sites that were operationally treated.

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Session: 002 - 9

Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Tuesday, January 22 11:15 AM

Type: Oral Presentation

## Long -Term Changes in Marsh Vegetation Coverage and Vigor in Barataria Bay and Terrebonne Bay

**Presenter:** Michael Kearney – University of Maryland

**Authors:** M.S. Kearney, Department of Environmental Science and Technology University of Maryland College Park; J.A. Riter, Department of Environmental Science and Technology, University of Maryland, College Park, R.E. Turner, Department of Oceanography and Coastal Sciences, Louisiana State University, Baton Rouge, LA 70803

### Abstract:

The Macondo Oil Spill is the latest in stressors large and small that have affected coastal wetlands in Louisiana for millennia. We used 27 Landsat Thematic Mapper (mainly) late summer images from 1984 to 2011 to reconstruct long-term temporal and spatial records of changes in marshes in Barataria Bay and Terrebonne Bay. A spectral mixture model was used to delineate changes in vegetation condition in these marshes with distance from the local Gulf of Mexico shoreline; up to four zones running parallel to these shorelines were defined. The most seaward zones in both bays were characterized by an overall progressive decline in marsh vegetation in the last 27 years, whereas vegetation coverage (and apparent vigor) in the most landward zones in both systems changed very little. The most dramatic changes in vegetation in both bays were associated with Hurricane Katrina in 2005 and Hurricane Gustav in 2008, especially in the most seaward areas. The Macondo Oil Spill in 2010 was followed by a sharp drop in late summer vegetation coverage and vigor. However, with factors like sudden dieback strongly influencing marshes across Louisiana Coastal Area this past summer, the linkage between oil intrusion and marsh condition at the scale defined by Landsat TM imagery (approx. 30 m pixel) is not yet clear.

Session: 002 - 10

Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Tuesday, January 22 11:30 AM

Type: Oral Presentation

## Effects of oil on the rate and trajectory of Louisiana marsh shoreline erosion

**Presenter:** Giovanna McClenachan – Louisiana State University

**Authors:** Giovanna McClenachan, Louisiana State University; R. Eugene Turner, Louisiana State University

### Abstract:

Oil can have long-term detrimental effects on marsh plant health, both above- and below ground. However, there is little data available that quantifies the accelerated erosion that oil may cause to marshes and the trajectory of change. We collected data on soil strength, shoreline erosion, and other soil characteristics at 30 closely spaced oiled and non-oiled sites in Bay Batiste, Louisiana. These sites have been sampled bi-monthly since November 2010. All oiled sites in Bay Batiste are contaminated with Macondo 252 oil (oil from the Deepwater Horizon oil spill, 20 April – 15 July 2010). Preliminary results suggest that the oil is weakening the soil and causing an accelerated rate of shoreline erosion. There may be a ‘threshold’ effect in which soil parameters change dramatically with a relatively small increase in oil concentration in the soil. We will also discuss separating the influence of the background erosion rate occurring before the spill from the increased erosion due to the marsh oiling.

Session: 002 - 11

Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Tuesday, January 22 11:45 AM

Type: Oral Presentation

## Assessing the affects and recovery of sediment-associated hydrocarbons on bioturbation and sediment properties following the BP oil spill

**Presenter:** Samuel Sturdivant – Duke University

**Authors:** S. Kersey, Sturdivant, Duke University Marine Lab; Robert Diaz, Virginia Institution of Marine Science

### Abstract:

In 2010 the BP oil spill discharged approximately 5 million barrels of crude oil into the Gulf of Mexico. Although the spill location was offshore, wind and currents advected oil into many adjacent coastal marshes. The mixing of sediments through infauna bioturbation is an important ecosystem function that regulates sediment geochemical and physical properties. The sessile nature of infauna makes them susceptible to changes in the surrounding environment. Consequently, any long-term impacts from the BP spill that affects infauna will alter their ability to bioturbate, and cascade to other ecosystem processes such as nutrient and organic matter cycling. We deployed Wormcam, a real-time in situ benthic observing system, at an oiled and unoled marsh location in Terrebonne Bay, LA. Levels of bioturbation were significantly less at the oiled site, documented by reduced depth, length, and production of burrows. Infauna avoided distinct hydrocarbon layers in the sediment, and this altered behavior diminished the area of influence of these

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bioturbators. This study is one of the first to provide in situ observation of the BP spill on processes structuring the sediment-water interface.

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Session: 002 - 12

Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Tuesday, January 22 12:00 PM  
Type: Oral Presentation

## Salt Marsh Sediment Biogeochemical Response to the Deep Water Horizon Oil Spill (Skiff Island, LA, & Cat Island, Marsh Point, & Salt Pan Island, MS)

**Presenter:** Calista Guthrie – Mississippi State University

**Authors:** Calista L. Guthrie, Mississippi State University; Karen S. McNeal, Mississippi State University; Deepak R. Mishra, University of Georgia; Gary A. Blakeney, Mississippi State University

### Abstract:

The impact of the BP Oil Spill on coastal wetlands can be better understood through investigating carbon loading and the microbial activity of salt marsh sediments. As a result of carbon influx, porewater H<sub>2</sub>S is expected to increase in wetland sediment, making it more toxic and inhospitable to marsh vegetation. High H<sub>2</sub>S levels due to increased microbial activity can lead to plant browning and die back. Preliminary analyses at Marsh Point, MS indicated that sulfate reducing bacteria are more active in contaminated sediments, producing H<sub>2</sub>S concentrations 20x higher than in non-contaminated sediments. This difference indicated that effects of contamination on sulfur cycling should be spatially explored. The study was expanded to include three additional Gulf Coast locations where sediment electrode profiles, degree of hydrocarbon contamination, and microbial community profiles were measured to explore potential sedimentary geochemical processes impacting salt marsh dieback, which may be enhanced as a result of the oil spill.

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Session: 002 - 13

Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Tuesday, January 22 12:15 PM  
Type: Oral Presentation

## Multiple Stressors Impact Marsh Sediment Bacterial Diversity after the Gulf of Mexico Oil Spill

**Presenter:** Annette Engel – University of Tennessee

**Authors:** Annette S. Engel, University of Tennessee ; Chang Liu (Louisiana State University), Laurie Anderson (South Dakota School of Mines and Technology), Linda Hooper-Bui (Louisiana State University), R. Eugene Turner (Louisiana State University)

### Abstract:

Despite recognition that microorganisms are critical to marsh ecosystem biogeochemical cycling and overall health, there has been limited research on how microbial geochemistry and diversity from coastal marshes in Louisiana have responded to the Deepwater Horizon oil spill. Microbial diversity and marsh physicochemistry have been evaluated from nine marshes that were sampled multiple times, including before the oil spill. Marsh sediment communities were dominated by Proteobacteria before the spill, but diversity decreased after the spill and communities became dominated by Firmicutes or a mixed assemblage of Proteobacteria-Firmicutes-Bacteroidetes. Diversity shifts were significantly correlated to the presence and composition of alkane and aromatic hydrocarbon compounds at the marsh edge, as well as the effects of changing salinity as a consequence of freshwater diversions of the Mississippi River. The microbial community compositional changes may lead to functional shifts within the marsh sediments, which could compromise the physical stability of the marshes through time.

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Session: 002 - 14

Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Tuesday, January 22 2:00 PM  
Type: Oral Presentation

## Microbial Community Analysis of Deepwater Horizon Tarballs

**Presenter:** Nikaela Flournoy – University of Alabama Tuscaloosa

**Authors:** Nikaela Yarbrough, The University of Alabama; Suja Rajan, The University of Alabama, Melanie Beazley, The University of Alabama, Patricia Sobecky, The University of Alabama

### Abstract:

During a three month period in 2010, the Deepwater Horizon (DWH) oil spill released an estimated 4 million barrels of crude oil into the Gulf of Mexico (GoM). To date, the DWH oil spill is among the largest in marine and U.S. history. Within weeks of the DWH spill impacting the GoM region, significant quantities of weathered crude oil, i.e., tarballs, inundated coastal Alabama beach areas. Tarballs associated with the DWH oil spill are predominantly comprised of heavier chain hydrocarbon components due to the physical, chemical and biological processes that weather and alter the characteristics of the spilled oil. Although the occurrence of crude oil and tarballs in the GoM can result from natural seepage of hydrocarbons from the GoM seafloor, spectral analysis and locale of tarballs examined in our study were indicative of Macondo oil from a coastal site that was heavily impacted by the DWH events of April 2010. Using tarballs collected from the Alabama barrier island, Dauphin Island, in June 2010, we sought to characterize the microbial composition and diversity of DWH tarballs for this study. The tarballs were analyzed



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by a combination of culture-dependent (e.g., bacterial isolations) and culture-independent molecular methods. Our preliminary findings provide insight into the tarball-associated microbial communities and their hydrocarbon biodegradation capabilities. Comparisons of microbial communities associated with tarballs collected in 2010 and 2011 from a second coastal Alabama location will also be presented.

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Session: 002 - 15

Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Tuesday, January 22 2:15 PM

Type: Oral Presentation

## Louisiana brackish and salt marsh greenhouse gas fluxes following the Deepwater Horizon oil spill and salinity manipulations

**Presenter:** Brian Roberts – Louisiana Universities Marine Consortium (LUMCON)

**Authors:** Brian J. Roberts, Louisiana Universities Marine Consortium (LUMCON); John M. Marton, Louisiana Universities Marine Consortium (LUMCON); Aaron M. Marti, University of Wisconsin-Stevens Point

### Abstract:

We quantified the effects of the Deepwater Horizon oil spill and altering salinity on gaseous carbon fluxes from oiled and unoiled Louisiana marshes. We measured CO<sub>2</sub> and CH<sub>4</sub> fluxes monthly along transects of increasing distance from marsh edges at 4 sites (2 unoiled, 2 oiled) in Terrebonne Bay and quantified the effects of altered salinity (5, 15, 25, 35 ppt) on CO<sub>2</sub> and CH<sub>4</sub> production on laboratory-incubated soils from 10 marshes (5 unoiled, 5 oiled) in Terrebonne and Barataria Bays. We found an increase in CO<sub>2</sub> flux with distance from marsh edges and a significant, positive correlation with soil organic matter properties (%OM, % C, %N, C:N). Methane fluxes were correlated with CO<sub>2</sub> fluxes, soil temperature and water content. In laboratory assays, both CO<sub>2</sub> and CH<sub>4</sub> production were greater in Terrebonne (higher OM and water content) than Barataria soils. CO<sub>2</sub> production increased as the magnitude of salinity was increased relative to field conditions. The slope of this response was positively related to soil OM and water content. Oil had no effect on carbon flux in either field measurements or laboratory incubations 2 years post-exposure. These results have important implications for wetland carbon models and how fluxes may respond to sea level rise and salt water intrusion.

Session: 002 - 16

Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Tuesday, January 22 2:30 PM

Type: Oral Presentation

## EFFECT OF OIL CONTAMINATION ON INFAUNA OF LOUISIANA AND MISSISSIPPI MARSHES WITH IMPLICATIONS FOR MARSH FUNCTIONING

**Presenter:** Charlotte Brunner – University of Southern Mississippi

**Authors:** Charlotte A. Brunner, Dept of Mar Sci, Univ of Southern Miss; Kevin M. Yeager, Dept of Earth and Environ Sci, Univ of Kentucky; Kevin B. Briggs, Mar Geosci Div, NRL; Joseph Keim, Dept of Biol Sci, Univ of Southern Miss; Patrick Louchouart, Dept of Mar Sci, Texas A&M Univ–Galveston; Rachel S. Hatch, Dept of Earth and Environ Sci, Univ of Kentucky; Kimberly J. Schindler, Dept of Earth and Environ Sci, Univ of Kentucky

### Abstract:

Heavy coating of marshes by BP oil reduced stocks of macrofauna and Foraminifera with implications for marsh functioning. Marsh sites were examined before and after oiling by the Macondo well blowout of 2010: Belle Fontaine (BF) and the Rigolets (RIG) in Mississippi Sound and Bay Jimmy (BJ) in Barataria Bay, La. The sites were analyzed for standing stock and species composition; sediment parameters and [PAH]; and radionuclides to assess mixing and rates of sedimentation.

Heavy oiling reduced standing stock and depth of habitation (DOH) of foraminifera. Un-oiled and lightly oiled sites had standing stocks >1,200 specimens/10cm<sup>2</sup> and DOH >10 cm, with corresponding mixing depths of 0.75-4.5+ cm as defined by <sup>7</sup>Be and <sup>234</sup>Thxs. In contrast, the DOH was 2-3 cm and the standing stock was 400-800 live specimens at heavily oiled BJ, including deformed specimens.

The macrofaunal abundance at RIG increased 320% one year after the spill. However, macrofaunal abundance at BJ was only 52% of that at RIG. The faunal reduction at BJ suggests reduced marsh bioturbation due to heavy oiling.

# Science Abstracts

Session: 002 - 17

Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Tuesday, January 22 2:45 PM

Type: Oral Presentation

## **Individually and Combined: Effects of Deepwater Horizon Water-In-Oil Emulsion and the Dispersant, Corexit, Upon Early Fish Development**

**Presenter:** Kevin Kleinow – Louisiana State University

**Authors:** Kevin Kleinow, Louisiana State University; Allen Bui, Zakia Perveen, Louis Thibodeaux, Arthur Penn, Sylvia Fritz-Kleinow, Louisiana State University

### **Abstract:**

The Deepwater Horizon (DH) incident released massive amounts of Louisiana crude oil into the Gulf of Mexico. Before reaching coastal marshes that serve as fish nurseries, significant alterations of the oil occurred by remediation attempts, emulsification with water and other weathering processes. Exposure of zebrafish to DH water-in-oil emulsions (WIO) examined the toxicological significance of WIO in regards to fish development. Direct contact of the eggs and embryos to “battered” emulsion (250mg) resulted in a high incidence of edema/axial deformities and subsequent mortality (40-90%). Suspended non-contact water exposures at the same “battered” dose resulted primarily in axial changes alone and mortality < 10%. Significant delays to hatch were evident. These results were largely independent of dispersant concentrations less than 100mg/l. Fluorescence microscopy indicated minimal transfer of fluorescent polycyclic aromatic hydrocarbons while qRT-PCR of CYP1A and oxidative stress genes indicated a high level of responsiveness to emulsion exposures. Exposure format and developmental data suggest that WIO represents a transport and exposure modality of hazardous oil components in a persistent non-diluted non-dispersant responsive format. (GMRI)

Session: 002 - 18

Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Tuesday, January 22 3:00 PM

Type: Oral Presentation

## **Biomarkers of Polycyclic Aromatic Hydrocarbons exhibited in coastal species from the Gulf of Mexico after the Deepwater Horizon Oil Spill**

**Presenter:** Arianne Leary – University of North Florida Biology department

**Authors:** Arianne Leary, University of North Florida Biology Department; Jim Gelsleichter, University of North Florida Biology Department; J Marcus Drymon, Dauphin Island Sea Lab

### **Abstract:**

The Deepwater Horizon Oil Spill (DHOS) released large quantities of liquid petroleum into the Gulf of Mexico. It is vital to determine the effects on Gulf wildlife from oil-related pollutants, particularly the polycyclic aromatic hydrocarbons (PAHs), which are the most toxic components of oil. The goal of this study is to evaluate the PAH exposure and effects as a result of the DHOS to coastal species that reside in oil impacted areas in the Gulf of Mexico, such as the red drum, red snapper, king mackerel and sandbar, blacknose and Atlantic sharpnose sharks. This study evaluated these species for PAH biomarkers such as Phase I and II detoxification enzymes, PAH metabolites and other commonly employed PAH biomarkers. Individuals of some of these same species were collected from un-oiled areas on Florida's coast as reference data. Animals collected from oil impacted sites have significantly higher concentrations than reference data for some PAH metabolites, therefore this trend between sites is anticipated for the other PAH biomarkers that will be evaluated.

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Session: 002 - 19

Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Tuesday, January 22 3:15 PM

Type: Oral Presentation

## Can Exposure to the Deepwater Horizon Oil Spill be Detected in Marsh Fish Otoliths?

**Presenter:** Paola Lopez-Duarte – Rutgers University

**Authors:** Paola Lopez-Duarte, Rutgers University; Joel Fodrie, University of North Carolina Chapel Hill; Olaf Jensen, Rutgers University; Andrew Whitehead, University of California Davis; Fernando Galvez, Louisiana State University; Benjamin Dubansky, Louisiana State University; Ken Able, Rutgers University,

### Abstract:

Following the 2010 Deepwater Horizon (DwH) catastrophe, both the immediate and chronic effects of oil pollution on salt marsh communities of the Northern Gulf of Mexico have been of intense concern. One study focusing on short-term responses (Whitehead et al. 2011) demonstrated a link between oil contamination and genomic and physiological responses of marsh-resident killifish (*Fundulus grandis*). In the present study, we target the Whitehead et al. (2010) samples to determine if it is possible to detect a trace metal (i.e., vanadium and nickel) signature associated with the DwH oil spill in fish otoliths. Trace elements in the water column are incorporated into otoliths in daily increments. Changes in the levels of trace elements can be quantified over time using laser ablation with highly sensitive mass spectrometry. Because otoliths provide a record of the fish's chemical environment and growth rate, the goals of the study are to first identify the time of exposure to oil and second to compare growth rates before, during, and after the exposure at oiled and not oiled sites.

Session: 002 - 20

Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Wednesday, January 23 3:30 PM

Type: Oral Presentation

## Oil Spill Effects on Salt Marsh Fish Assemblages: Selection of Appropriate Indicator Species

**Presenter:** Paola Lopez-Duarte – Rutgers University

**Authors:** Paola Lopez-Duarte, Rutgers University; Joel Fodrie, University of North Carolina Chapel; Olaf Jensen, Rutgers University; Christopher Filosa, Rutgers University; Shanina Halbert, Haverford College; Kathleen O'Connor, Colby-Sawyer College; Brian Roberts, Louisiana Universities Marine Consortium (LUMCON); Ken Able, Rutgers University

### Abstract:

Our long-term objective is to determine the immediate and chronic effects of the 2010 Deepwater Horizon Oil Spill on northern Gulf of Mexico marsh fish communities. In summer 2012, we sampled healthy, undisturbed marshes near Cocodrie, LA, to develop collection methodologies and establish a baseline for fish habitat use, species composition, and size distribution. We further sampled 6 pairs of oiled and unoled sites (n = 12 total) in Terrebonne and Barataria Bays. Over half the fish caught to date (8,000+) have been identified as *Fundulus grandis* with *Adenia xenica* and *Cyprinodon variegatus* being the next most abundant species (~20% each). Because of their high abundance, wide distribution across oiled and unoled sites, and presumed high site fidelity, our efforts will be focused on the effects of oil on *F. grandis*. Otolith-based age analysis suggests most individuals are age 0 or 1 and therefore would not have experienced the immediate effects of the spill. Further analysis is underway to determine if species composition, size, and growth vary between oiled and unoled sites.

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Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Wednesday, January 23 3:45 PM

Type: Oral Presentation

## The effect of oil dispersants and salinity on the biodegradation of south Louisiana crude oil and impacts on Gulf killifish *Fundulus grandis*

**Presenter:** Adam Kuhl – LSU AgCenter

**Authors:** Adam J Kuhl, LSU Aquaculture Research Station, Louisiana State University Agricultural Center; Andrew Nyman, School of Renewable Natural Resources, LSU AgCenter; Christopher Green, LSU Aquaculture Research Station, Louisiana State University Agricultural Center

### Abstract:

Chemical dispersants like COREXIT are an important technology in the remediation of oil spill in the aquatic environment and their chemistry and toxicity is influenced by environmental conditions. The purpose of this work is to investigate the effect of salinity on biodegradation of dispersed and non-dispersed crude oil in laboratory mesocosms, the resultant acute toxicity, and a sublethal physiological response (EROD and GST induction) in juvenile Gulf killifish (*F. grandis*). Results demonstrate a marked increase in PAH concentrations and resultant acute and sublethal toxicity in chemically dispersed oil versus non-dispersed oil. Additionally, the toxicity of the dispersed oil was detectable at the greatest dilutions and persisted through 16 weeks of biodegradation. Moreover, dispersant alone was acutely toxic at the



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manufacturers recommended dispersant:oil ratio without activating the AhR response system. This toxicity increased at salinities outside the iso-osmotic conditions.

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Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Wednesday, January 23 10:30 AM  
Type: Oral Presentation

## ACUTE AND SUBLETHAL IMPACTS OF MC252 OIL AND DISPERSANT ON EARLY LIFE STAGES OF *Crassostrea virginica*

**Presenter:** Susan Laramore – Harbor Branch Oceanographic @ FAU

**Authors:** Susan, Laramore, Florida Atlantic University; William, Krebs, Florida Atlantic University; Amber, Garr, Florida Atlantic University

### Abstract:

The impact of Deepwater Horizon on larval eastern oysters, *Crassostrea virginica* was assessed by static acute toxicity and short-term sublethal exposures to water accommodated fractions (WAF) of oil, dispersed oil (CEWAF) and dispersant (Corexit 9500A). Endpoints evaluated via static acute toxicity tests included LC50's, fertilization, trochophore and D stage development, and swimming ability. The impact of short-term (24 hour) sublethal exposure of D stage larvae to CEWAF (16 mg/L) on survival, growth, umbo development and settlement was also evaluated.

Fertilization was impacted by 2.5 mg/L dispersant, 100 mg/L CEWAF, but not by WAF (100-1200 mg/L). Trochophore development was affected by 2.5 mg/L dispersant, 25 mg/L CEWAF and 100 mg/L WAF. D stage development was impacted by 1.25 mg/L dispersant, 12.5 mg/L CEWAFs and 200 mg/L WAF. Abnormal shell development of D stage larvae was noted at higher concentrations than seen for D stage development. Swimming activity decreased at concentrations below LC50 levels.

Survival and settlement of D stage oysters exposed to sublethal concentrations of CEWAF were negatively impacted compared to controls, but there was no significant impact on size or rate of umbo development.

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Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Wednesday, January 23 10:45 AM  
Type: Oral Presentation

## Assessment of oil impact on eastern oyster health

**Presenter:** Jerome La Peyre – Louisiana State University Agricultural Center

**Authors:** Jerome, La Peyre, Louisiana State University Agricultural Center; Qinggang Xue and Sandra Casas, Louisiana State University Agricultural Center

### Abstract:

Eastern oysters are important economically and ecologically and are vulnerable to disturbances by human activities. To assess the impact of oil contamination, hatchery raised Gulf oysters were deployed at 4 sites, 2 known to have been contaminated by the Macondo oil spill and 2 spared. Oysters were sampled in April, August and October, 2012 and analyzed with a suite of biological effect measurements including whole organism responses (survival, growth, condition, reproductive potential, dermo infection intensities), tissue responses (histopathology), cellular and immunological responses (hemocyte density, viability, phagocytosis, reactive oxygen species production) and subcellular responses (lysosomal stability, Hsp70 proteins, glutathione concentration, lipid peroxidation). Preliminary results indicated differences between sites in some of those parameters, which are however more likely associated with physiochemical conditions (salinity, temperature) than to oil contamination. While a comprehensive analysis of the collected samples is under way studies using proteomic and transcriptomic approaches may be needed to detect more subtle and specific changes in oyster responses to oil.

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Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Wednesday, January 23 11:00 AM

Type: Oral Presentation

## **Acute toxicity of three dispersants alone and in combination with crude oil on *Callinectes sapidus* megalopae**

**Presenter:** Rachel Fern – Texas A&M University-Corpus Christi

**Authors:** Rachel Fern, Texas A&M University-Corpus Christi; Kim Withers, Texas A&M University-Corpus Christi, Center for Coastal Studies

### **Abstract:**

During the Deepwater Horizon incident in 2010, approximately 1.8 million gallons of Corexit® dispersants were approved for use directly onto the released oil. Blue crab (*Callinectes sapidus*) megalopae are pelagic and are likely to be one of the first organisms exposed to spilled oil and applied dispersants in open-ocean and nearshore waters. The commercial and ecological significance of this species makes establishing toxicity effects of oil and dispersants vital. This study examined acute toxicity of Corexit® 9500, Corexit® 9527, and Microblaze® (a product that may enhance bio-degradation of the released oil and the Corexit dispersants) alone and in combination with crude oil. In addition, Microblaze® was applied to crude oil dispersed with each Corexit® dispersant to investigate the combined effect of Microblaze® on the toxicity of the Corexit® 9500, 9527 and crude oil mixtures. Blue crab megalopae were exposed for 48 hours to varying dosages of each treatment. Preliminary results indicate that oil treated with dispersants was more toxic than either oil or dispersants alone. Microblaze® was essentially non-toxic. Analyses of oil residue in surviving megalopae and Microblaze® on oil-dispersant combinations are on-going. Such research may provide essential baseline data needed to determine the optimal dosing of dispersants. It will aid also in the creation of future recovery plans, which balance dispersant use and dosage with anticipated crab fishery impacts.

Session: 002 - 25

Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Wednesday, January 23 11:15 AM

Type: Oral Presentation

## **Putting the Canary Back in the Coal Mine: Crickets and Ants in the Saltmarshes Post-Macondo Blowout**

**Presenter:** Linda Hooper-Bui – LSU

**Authors:** Linda M. Hooper-Bui, LSU AgCenter, R. Strecker, B. Hesson, G. Soderstrum, M. Accardo, D. Aguillard, E. Thompson, and X. Chen. LSU AgCenter.

### **Abstract:**

Our research has shown that insects and spiders are good bioindicators of environmental pollution from catastrophic oil spills. Even when environmental toxicologists are unable to measure volatiles in samples of the oil pollution, we observed impacts that indicated that volatiles were active on insects and spiders during times when the marsh sediment was exposed to insolation and bacterial degradation. We conducted a 'common garden' experiment also known as an in situ bioassay where we placed insects in floating cages 20m from the streamside edge of oiled and unoiled saltwater marshes. More than two years post-spill, insects in cages in oiled marshes exhibited a greater mortality than those in unoiled reference marshes indicating that volatile compounds, possibly from the emulsion, plays a role in insect/spider mortality in oiled marshes. In spill season 1 (2010), ant abundance had decreased by 66% in oiled marshes when compared to reference marshes. By September 2011 or spill season 2, ants in oiled areas had decreased by 97%. In 2012, we were unable to find mature ant colonies in heavily oiled areas and found more than 50 colonies in similar unoiled areas. Only incipient colonies were found in oiled areas in April and May 2012. By July 2012, all but two of those incipient colonies had perished.

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Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Wednesday, January 23 11:30 AM

Type: Oral Presentation

## Silent Spring Revisited: Insects and Spiders in Louisiana's Saltwater Marshes after the Macondo Blowout

**Presenter:** Brooke Hesson – LSU

**Authors:** Brooke Hesson, Gerald Soderstrum, L.M. Hooper-Bui, O. Osisioma, R. Strecker, X. Chen, B. Adams, LSU AgCenter; E. Overton, R. Turner, LSU

### Abstract:

The sounds of a healthy salt marsh community include buzzes, clicks, chirps, and splashes. Healthy ecosystems can handle small disturbances or stressors such as small pulses of oil from deep seeps in the Gulf of Mexico (GOM). Stressed ecosystems such as the saltwater marshes that fringe the northern GOM experienced a huge pulse of additional disturbance as a result of escaping oil from the Macondo blowout on April 20, 2010 and the subsequent cleanup efforts. We studied the effect of crude-water emulsion on the insects and spiders in saltwater marshes and compared them to the same taxa in unaffected marshes. We also compared insect and spider species richness and abundance from May 2010 – before the emulsion made landfall – to those species collected in May 2011. In most areas, we sampled for insects, spiders, and hydrocarbons not only on the edge – where we could visibly see oil – but also 20m deep into the marsh. Selected paired sites – oiled and unoiled – were sampled 100m into the marsh in 2011. All sampling had contemporaneous unoiled reference sites and comparable samples before the emulsion made landfall. Our sweep-net collections showed decreases in abundance of native katydids, ants, green seedbugs, and spiders in response to the intrusion of crude-water emulsion into the marsh and to the subsequent efforts to remediate it. Conversely, cordgrass bugs increased 10x in oiled saltwater marshes compared with unoiled marshes. This may provide indirect evidence of plant stress in response to a large-pulse oiling event. Our results and observations indicate widespread ‘silencing’ of insect and spider activity in Louisiana saltwater marshes affected by the BP Macondo blowout.

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Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Wednesday, January 23 11:45 AM

Type: Oral Presentation

## EFFECTS OF OIL CONTAMINATION ON MIGRATORY SHOREBIRDS IN THE GULF OF MEXICO

**Presenter:** Jessica Henkel – Tulane University

**Authors:** Jessica R. Henkel, Tulane University; Bryan J. Sigel, Nevada State College, Kyle Coblentz, Tulane University; Caz M. Taylor, Tulane University

### Abstract:

The U.S. coastline of the Gulf of Mexico (GOM) is an important wintering and stopover region for migratory shorebirds. The Deepwater Horizon oil (DWH) spill impacted more than 650 miles of this coastline. Given the already declining population trend of many species of shorebirds, this disaster has the potential to impact populations from long-term exposure to toxins, degraded habitats, and altered food chains. Our research addresses the impacts of the DWH oil on six species of shorebirds that winter or stopover along the northern GOM. From October 2010 – May 2012 we took samples from 676 migratory shorebirds trapped at 6 non-breeding sites that experienced varying levels of contamination from the spill. Of birds sampled, 21 were visibly oiled. Three oiled birds were trapped more than 1 year after the DWH well was capped. Preliminary results of plasma metabolite analyses indicate fattening rates, and therefore foraging success, during spring migration were lower at oiled sites in comparison with control sites during Spring 2011. This difference was not observed during Spring 2012.

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Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Wednesday, January 23 12:00 PM

Type: Oral Presentation

## Response of Seaside Sparrows to the Deepwater Horizon oil spill

**Presenter:** Sabrina Taylor – Louisiana State University

**Authors:** Sabrina Taylor, Louisiana State University; Philip Stouffer, Louisiana State University; Stefan Woltmann, Louisiana State University/Austin Peay University

### Abstract:

Seaside Sparrows are salt-marsh specialists that were potentially exposed to the Deepwater Horizon oil spilled in 2010. To test for adverse effects, we are examining space use, relative abundance, nest success, carbon isotopes, and the expression of a gene activated by PAHs on birds from

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replicated oiled and unoiled plots. Preliminary results suggest that birds remain on small territories on the marsh during the breeding season, but that they don't preferentially forage on edges where they would be most exposed to contaminants. We detected fewer birds on oiled plots, and fewer young were produced on oiled plots. However, there is no evidence that carbon from oil has been incorporated into feathers or food items. Future work will address gene activity, dispersal, and population processes on a larger number of sites.

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Session: 002 -

Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## The combined effect of environmental and anthropogenic stressors on fish health

**Presenter:** Thijs Bosker – University of Connecticut

**Authors:** Thijs Bosker, University of Connecticut; Christopher Perkins, University of Connecticut; Joseph Griffitt, University of Southern Mississippi, joe.griffitt@usm.edu; Maria Sepulveda, Purdue University, mssepulv@purdue.edu

### Abstract:

The 2010 Deepwater Horizon oil spill affected close to 500 miles of coastline, across five states. Considering the size of the disaster, and the variety of habitats affected, great challenges to effectively remediate and protect the entire coastline still remain. Differences in environmental conditions, such as salinity, dissolved oxygen levels and temperature, can have drastic effects on the uptake and effects of contaminants on aquatic organisms. However, there is poor understanding on how aquatic organisms respond and adapt to the combined effects of extreme environmental factors (e.g. hypoxia and high temperatures), typical of highly variable coastal ecosystems, in the presence of contaminants from the Deepwater Horizon oil spill. With this in mind, we are starting a three year project to study the impact of multiple environmental and anthropogenic stressors on fish development and reproduction. This data will subsequently be used to (1) develop a model that predicts potential population level effects; (2) identify biomarkers which can easily be assessed in the field and are predictive of population level impacts, and (3) identify scenarios (the combination of environmental and anthropogenic stressors) which are most likely to result in population level effects.

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Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## Oiling Increases Marsh Sediment CO<sub>2</sub> Effluxes

**Presenter:** Michael Davis – University of Southern Mississippi

**Authors:** Knox Flowers, University of Southern Mississippi; Jerrid Boyette, University of Southern Mississippi, Kevin Kuehn, University of Southern Mississippi, Micheal Davis, University of Southern Mississippi

### Abstract:

There are justifiable concerns over the effects of the Deepwater Horizon incident on marsh ecosystem processes. In 2011, we conducted intensive field studies to assess the effects of the oil spill on marsh sediment respiration rates (CO<sub>2</sub> flux rates) in 9 different marshes sites along the Mississippi coast (6 oiled and 3 unoiled). At each site, we measured diurnal sediment CO<sub>2</sub> fluxes on three separate dates (September, October, December) using LiCor LI8100 Automated CO<sub>2</sub> Soil Flux System. A strong effect of oil exposure was observed, with sediment CO<sub>2</sub> efflux being 64% greater in oiled marsh sites compared to unoiled sites (1.31 vs. 0.80  $\mu\text{mol CO}_2/\text{m}^2/\text{s}$ ,  $p = 0.069$ ). Current data are unable to discern the biological driver behind the observed CO<sub>2</sub> flux rates. The phenomenon is likely of microbial origin, however it is unclear whether the response is caused by saprophytic microbes growing on decomposing/damaged plant roots or by hydrocarbon-degrading microbes utilizing oil/dispersant residues.

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Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## Historical baselines of body-size distributions as ecological indicators of oyster reef recovery from the Deepwater Horizon oil spill: A progress repo

**Presenter:** Gregory Dietl – PRI/ Cornell

**Authors:** Gregory Dietl, Paleontological Research Institution; Jessica Lambert, Paleontological Research Institution; Stephen Durham, Cornell University

### Abstract:

The near- and long-term ecological effects of the Deepwater Horizon oil spill in the Gulf of Mexico are only just beginning to be assessed. We used time-averaged death assemblages of intertidal oysters (*Crassostrea virginica*) from multiple sites in Louisiana to establish a pre-spill baseline

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of body size structure to assess the effects of the oil spill. This baseline was compared to live, post-spill collected data from 2011 and 2012. Because a reduction in growth is a common sublethal response to exposure to oil-related contaminants for oysters, we expected average body size of adult oysters (>65 mm shell length) from impacted relative to control areas to decrease. Body size data were analyzed using a Before-After-Control-Impact (BACI) design. Preliminary results indicate no significant interaction between time (before/after) and treatment (control/impact) (BACI contrast = 1.8256, se = 2.97, p = 0.5603), suggesting that adult body size structure of intertidal oyster reefs was unaffected by or had a short recovery time following the oil spill.

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Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## Similarity among microbial communities from Louisiana coastal marshes reveals potential to respond to disturbance

**Presenter:** Chanda Drennen – University of Tennessee

**Authors:** Chanda Drennen, University of Tennessee

### Abstract:

Changes in the diversity and structure of microbial communities from *Spartina* (cord grass) coastal marsh ecosystems may provide insights into a systemic response to disturbance, such as an oil spill. We conducted an analysis of microbial community alpha- and beta-diversity retrieved from sediment horizons in Louisiana marshes from east (American Bay) and west (Terrebonne Bay) of the Mississippi River from before the Deepwater Horizon oil spill. Although there were shared communities at the phylum- and order-level among all marshes and sediments from all depths, sediments at the surface (0-1 cm) and at depth (1-2 cm) from the same marsh were more similar to each other than to the same depths at other marshes. Marine and soil bacterial orders that were shared included, but were not limited to, the Bacillales, Erysipelotrichales, Enterobacteriales, Clostridiales, Gammaproteobacteria\_incertae\_sedis, Alteromonadales, Actinobacteridea, and Lactobacillales. These microbial groups could represent a “core” marsh sediment community that would help a marsh recover from disturbance or recurrent stress.

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Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## The Deepwater Horizon oil spill and the mercury cycle: Stable isotope tracing of methylmercury production and bioaccumulation in the Northern Gulf of

**Presenter:** Alexandra Harper – Florida State University

**Authors:** Alex, Harper, Florida State University; Jeffrey, Chanton, Florida State University; William, Landing, Florida State University

### Abstract:

The ecological and health effects of mercury pollution are greatly exacerbated by the environmental transformation of the less harmful forms of Hg to the extremely toxic monomethylmercury (MMHg; CH<sub>3</sub>Hg<sup>+</sup>) compound. MMHg is produced in anoxic sediments by sulfate-reducing bacteria. More depleted  $\delta^{34}\text{S}$  values in organisms that consume these bacteria indicate a greater contribution of reduced sedimentary sulfur transferred to the aquatic ecosystem during methylation. It is widely understood that the Deepwater Horizon oil spill resulted in oxygen depletion. My research aims to determine the effect of the BP oil spill on near-shore methylation by sulfur-reducing bacteria and whether the oil spill exasperated the MMHg toxicity of consumer organisms throughout the Northern Gulf of Mexico food web. We use the reduced isotope  $\delta^{34}\text{S}$  signal in consumer organisms as an indicator of sedimentary derived MMHg and assess stable isotopes  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  to trace MMHg throughout the Northern Gulf of Mexico food web.

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Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## Impacts of the Deepwater Horizon Oil Spill on Soil Microbial Communities of Salt Marshes in the Northern Gulf of Mexico

**Presenter:** Aixin Hou – Louisiana State University

**Authors:** Aixin Hou, Louisiana State University; Nabanita Bhattacharyya, Louisiana State University; Kris Ackoury, Louisiana State University; Lauren Navarre, Louisiana State University; Jizhong Zhou, University of Oklahoma; Qianxin Lin, Louisiana State University; Irving Mendelssohn, Louisiana State University

### Abstract:

The coastal wetlands in the northern Gulf of Mexico are a national resource, supporting the largest and most productive wetland-estuarine environment in the United States. However, these habitats are prone to

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petroleum contamination due to their location in a zone of oil production, transportation, and refining. This study employed conventional and molecular assays to determine the possible impacts of the Deepwater Horizon oil spill on salt marsh soil microbial communities in northern Barataria Bay. The ratio of oil degrading bacteria to total heterotrophic bacteria in surface sediment increased by approximately a factor of 50 and 25 at heavily oiled and moderately oiled sites, respectively, relative to reference sites 16 months after the oil spill. A significant positive correlation was found between oil degrading bacterial abundance and total petroleum hydrocarbon (TPH) concentration in the sediment ( $n=21$ ,  $r=0.630$ ,  $P=0.002$ ). Total bacterial abundance remained similar across all sites, and thus the populations of non-oil degrading bacteria decreased correspondingly at oiled sites with a greater reduction in heavily oiled sites. GeoChip analyses indicated that oil input significantly changed the microbial community structure and function of the oiled sediments seven months following oil landfall, including altering the diversity of bacteria and the relative abundance of the functional genes involved in both the carbon degradation category and the nitrogen category.

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Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## Rhizosphere Microbiome Composition and Association with Dominant Plants in a Louisiana Salt Marsh impacted by Oiling

**Presenter:** Elizabeth Jarrell – Tulane University

**Authors:** Elizabeth R Jarrell, Tulane University; John Pardue, LSU; Michael J Blum, Tulane University

### Abstract:

Oil exposure can impede biogeochemical processes and other ecosystem functions in coastal marshes by disrupting rhizosphere microbial populations and their associations with dominant plants. Understanding the structure and function of rhizosphere microbiomes is therefore central to determining ecological outcomes of shoreline oiling during events like the Deepwater Horizon (DWH) blowout. Accordingly, we are examining how rhizosphere microbiome composition corresponds to plant performance and oiling as part of a broader study investigating biogeochemical parameters controlling the fate of weathered DWH oil in marsh environments. Spatial and time-series samples of rhizosphere soil, roots, and leaf tissue are being evaluated for two ecologically dominant plants, salt marsh cordgrass (*Spartina alterniflora*) and black mangrove (*Avicennia germinans*), across an oil exposure gradient near Port Fourchon, Louisiana. Population genomic and metagenomic analysis of

microbiome taxonomic and functional composition is being linked to measures of plant biomass, vegetation cover, net photosynthesis, and plant genotypic diversity. This approach will reveal patterns of individual, population, and ecosystem response to oil exposure, providing indicators of recovery while advancing basic understanding of how disturbance mediates relationships between microbial communities and keystone coastal wetland plants.

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Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## Impacts and Recovery of the Deepwater Horizon Oil Spill on Vegetation Structure and Function of common reed *Phragmites australis*: A Mesocosm Study

**Presenter:** Chad Judy – Louisiana State University

**Authors:** Chad Judy, Louisiana State University; Irving Mendelssohn, Louisiana State University; Aixin Hou, Louisiana State University

### Abstract:

The aim of this study was to determine the impacts of the Deepwater Horizon (DWH) oil spill on the common reed *Phragmites australis*, and the processes controlling species effects and recovery, via a greenhouse mesocosm study. In the greenhouse, DWH source oil, weathered approximately 40% by weight, was applied to the aboveground shoots of *P. australis* growing in marsh sods to produce the following treatment-levels: (1) oil coverage of the lower 30% of shoot-height, (2) the lower 70% of shoot-height, (3) repeated oil coverage of the lower 70% of shoot-height, (4) 100% oil coverage of shoots, (5) oil applied to the soil at a rate of 8 L m<sup>-2</sup>, and (6) unoiled controls. The 70% repeated treatment-level involved a re-application of oil every four days. Each treatment-level was replicated 5-times. Results are still being analyzed; however, preliminary data suggest a strong resilience of *P. australis* when oil was applied only to the aboveground biomass, with negative impacts apparent when oil was added to the soil profile. The photosynthesis rate, chlorophyll, total biomass, and stem density appeared to all be impacted by the addition of 8 L m<sup>-2</sup> of DWH to the soil profile. When oil was applied to the aboveground biomass at 100% and 70%, the induction of new stem growth occurred, not from the base of the plants, but from the nodes on the stems. The stem branching was most noticeable at 100% oiling with no branching occurring in the controls or 30% oiling treatment-levels. Due to the apparent negative results of adding oil directly to the soil profile, a second experiment was designed to better understand impacts due to soil oiling. Aboveground biomass was harvested from the sods that



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had received shoot oiling and allowed to regrow for two months, at which point DWH source oil was applied to the marsh sods at rates of 4, 8, 12, and 16 L m<sup>-2</sup>. Although this experiment is still ongoing, visual effects are already obvious. Based on our research, complete mortality of *P. australis* is unlikely from exposure from weathered DWH oil. However, vertical growth, stem density, and other processes of the plant were impacted, with oiling to the soil having much greater impacts than oiling of aboveground shoots.

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Type: Poster

## **Penetration of Louisiana Crude Oil through Red Mangrove Roots and Leaves in the Presence and Absence of Dispersants: Mass Transfer Analyses Based on M**

**Presenter:** Urpiana Koklonis – Florida International University

**Authors:** Urpiana Koklonis; Florida International University; Berrin Tansel; Florida International University; Mengshan Lee; Florida International University; Jillian Berbakov; Florida International University

### **Abstract:**

Oil spills into coastal waters are a threat for vegetation near the shorelines. The Red mangroves (*Rhizophora mangle*) is a protected species which is commonly affected by the accidental oil spills near coastal areas. Effect of Corexit 9500A on the Red mangrove plants was evaluated in laboratory conditions using Louisiana crude oil and Corexit 9500A. Red mangrove leaves and roots were exposed to salt water contaminated at different concentrations of crude oil and dispersant mixtures. Mass transfer characteristics were evaluated through microscopic examination and assessment of tissue samples. Oil penetration profile and mass transfer coefficients on the root and leaf tissues were estimated using mass transfer theory.

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Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## **INVESTIGATION OF POLYCYCLIC AROMATIC HYDROCARBON ACCUMULATION IN COASTAL ALABAMA WATERFOWL AFTER THE DEEPWATER HORIZON OIL SPILL**

**Presenter:** Charles Martin – LOUISIANA STATE UNIVERSITY

**Authors:** Charles W. Martin, Louisiana State University

### **Abstract:**

The explosion of the Deepwater Horizon platform and the subsequent discharge of oil into Gulf of Mexico has been portrayed as one of the most devastating environmental disasters in recent history. Among the greatest concerns was of the toxicological effects on migratory birds, including waterfowl that overwinter in the area. Here, we present comparisons of polycyclic aromatic hydrocarbon concentrations in liver tissue and isotopic carbon signatures from muscle tissues in greater/lesser scaup (*Aythya* spp) and buffleheads (*Bucephala albeola*) taken from oiled areas in Alabama and unimpacted areas in Florida. Additional comparisons of redhead (*A. americana*) liver concentrations were made with previous reports. In all analyses, we found that concentrations were below detection limits and  $\delta^{13}\text{C}$  did not differ between collection areas. Possible explanations include the rapid incorporation of oil into alternate food web pathways, degradation of oil prior to arrival, or low levels in coastal Alabama. Although we found little evidence of accumulation, additional study in heavily oiled regions, increased replication, and more sensitive detection methods are needed to determine the generality of this conclusion.

# Science Abstracts

Session: 002 -

Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## Determination of Marine BioToxins in Gulf-Harvested Seafood

**Presenter:** Ashley Meredith – Miss State Chem Lab

**Authors:** Ashley Meredith, Cindy Foster, Alison Robertson, Harold Floresquintana, Ashli Brown, and Darrell Sparks, MSCL

### Abstract:

Marine biotoxins pose a significant health risk to humans when they are consumed as a component of contaminated shellfish. Therefore, monitoring programs have been developed to ensure public safety. An effective way of analyzing for these contaminants is with liquid chromatography couple to mass spectrometry. However, samples must be prepared properly when using this technique. In this study, the suitability of a Geno/Grinder was evaluated as a potential replacement to Ultra Turrax Homogenizer. Samples of seafood were spiked with okadaic acid and dinophysistoxin-1 and then homogenized separately using the two techniques. Then the samples are twice extracted with methanol followed by centrifugation. An aliquot of each sample is hydrolyzed for 40 minutes and then neutralized prior to filtering. Analysis is performed using an Agilent 6430 LC-QQQ mass spectrometer. The two homogenization techniques will be compared in terms of extraction recovery.

Session: 002 -

Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## Impact of oil on concentrations of microbial genes related to carbon and nitrogen cycling in Bay Jimmy, LA sediments

**Presenter:** Andrew Ogram – University of Florida

**Authors:** Hee-Sung Bae, University of Florida; JH Joo, University of Florida; Stephanie Schwarz, University of Florida; John White, LSU; Ron Delaune, LSU Jim Wang, LSU; Andrew Ogram, University of Florida

### Abstract:

In an effort to identify the potential impacts of oil contamination on microbial groups that control critical biogeochemical cycles in estuarine sediments, the concentrations of genes involved in nitrogen and carbon cycling were compared in oiled and unoled areas of Bay Jimmy, LA. DNA was extracted from replicate cores that had been sectioned in 2 cm

increments at depths from 0 to 10 cm. Concentrations of 16S rRNA genes, approximately representative of total Bacterial numbers, were higher by a factor of two in unoled than in oiled surface sediments (0-2 cm sections). The concentrations of 16S rRNA genes converged in 2-4 cm and deeper sections, however, suggesting that general impacts of oil may be limited to the surface sections. Similar trends were observed with concentrations of *nifH*, characteristic of nitrogen fixation. Genes representative of Archaeal and Bacterial ammonia oxidizers were increasingly impacted with depth, perhaps due to differences O<sub>2</sub> availability. Much more significant impacts were observed with genes representing sulfate reduction (*dsrB*) and nitrate reduction (*nirS* and *nirK*), which showed decreasing, but significant impacts to the 4-6 cm sections. This may be related to availability of appropriate electron donors in oiled sediments. The impact of oil on concentrations of genes characteristic of methanogens (*mcrA*) increased with depth, possibility due to availability of electron donors. These trends suggest that the impacts of oil on sediment microbial communities may be complex. Further work is required to determine the mechanisms behind these trends.

Session: 002 -

Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## Effects of Weathered Oil on Wetland Soil Denitrification Potential

**Presenter:** Jason Pietroski – LSU-Department of Oceanography and Coastal Science

**Authors:** Jason Pietroski, Louisiana State University (Department of Oceanography and Coastal Science); Ron D. Delaune, and John R. White; Louisiana State University (Department of Oceanography and Coastal Science)

### Abstract:

Coastal wetlands provide many important ecological functions including water quality improvement, wildlife habitat, buffers against flood surges, mitigation of shoreline erosion control, carbon storage, and recreational opportunities. The recent BP-Macondo oil spill has raised concerns that oil can affect many of their important ecological functions in coastal wetlands. Much research has been conducted on oil effects on macrophytes. There has been little research on the effects of oil on soil biogeochemical processes in coastal wetlands. Denitrification is an important microbial-mediated process removing bioavailable nitrogen (nitrate) from wetland systems, resulting in the production of nitrogen gas. Therefore, we investigated the effects of weathered oil on the



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denitrification potential of organic salt marsh soils. Soil properties measured include bulk density, total carbon, nitrogen and phosphorus, and soil microbial biomass. The effects of oil on potential denitrification in coastal wetland soils will be presented.

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Session: 002 -

Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## Impact of the Deep Water Horizon Oil Spill on the Plant Community of Dauphin Island and Surrounding Areas

**Presenter:** Kristin Rockett – University of Alabama in Birmingham

**Authors:** Kristin Rockett, University of Alabama in Birmingham; Safaa Al-Hamdani, Jacksonville State University; Karolina Pajeroska-Mukhtar, University of Alabama in Birmingham

### Abstract:

This study was carried out to study the possible impact of Deep Water Horizon Oil Spill on the plant community of selected locations within Dauphin Island and the surrounding area. Three locations were selected with the study including Point of Pine, Public Beach within the Dauphin Island area, and Dauphin Island Airport. The dominant species within the three locations was *Spartina patens*. In addition, *Spartina alterniflora* and *Bolboschoenus robustus* were also found at the various locations. Soil and plant tissue were analyzed for micro and macronutrients. The presence of the oil was evaluated in two ways including physical observation of the oil present as a liquid or as a tar ball and the presence of Vanadium in the soil. Plants at the three locations were sampled for chlorophyll a and b and photosynthetic rate three times between June 2011 and July 2012. The data analysis showed that possible contamination exists in the area of Point of Pine, which showed higher concentration of Vanadium and heavy metals in comparison to the other two locations. In general, the plant community showed the least photosynthetic rate at Point of Pine location. This might be influenced by the presence of the heavy metal, which could impact the reduction in photosynthetic pigment concentration and induce possible toxic metabolic effects. Additionally, this study showed *Spartina alterniflora* had the highest photosynthetic rate in comparison to the other selected species at Point of Pine location where all the three species exist.

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Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## Effects of oil and dispersants on phytoplankton communities in northern Gulf of Mexico estuaries: nutrient and light interactions

**Presenter:** Jessie Rosanbalm – University of West Florida

**Authors:** Jessie Rosanbalm, University of West Florida; Tiffany Baskerville - Florida A&M University; Jennifer Cherrier - Florida A&M University; Ashvini Chauhan - Florida A&M University; Wade H. Jeffrey - University of West Florida

### Abstract:

In light of the Deepwater Horizon oil spill, it is important to understand how oil and its constituents can affect the phytoplankton communities in the Gulf of Mexico because phytoplankton are the base of classical food webs. The affect of oil and dispersant on natural phytoplankton assemblages in Pensacola Bay was determined at the community level in enclosed microcosm experiments treated with water accommodated fractions of oil, dispersant, and dispersed oil. Half of the samples also received nitrogen and phosphorus ammendments. To determine the effects of UVR on the phototoxicity of Macondo oil and Corexit 9500A, this incubation was performed with and without UVR. Following this acute exposure, samples were analyzed for chlorophyll-a concentration, photosynthetic efficiency, and community structure. Dispersed oil has the largest negative effect on chlorophyll-a concentration, but it causes increases in photosynthetic efficiency. None of the treatments have a significant impact on community structure following acute exposure. Incubation without UVR minimizes the effects of hydrocarbons and dispersants, indicating phototoxicity is an important component of the toxicity of Macondo oil.

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Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

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Type: Poster

## THE EFFECTS OF LIGHT SLOP CRUDE OIL ON THE GROWTH OF A *Skeletonema costatum* STRAIN ISOLATED FROM THE LAKE PONTCHARTRAIN BASIN ESTUARY (LPBE)

**Presenter:** James Wee – Loyola University New Orleans

**Authors:** James Wee, Loyola University New Orleans; Ngan Nguyen, Loyola University New Orleans; Johnathan Patterson, University of Washington; Rose Ann Cattolico, University of Washington; David John, University of South Florida; John Paul, University of South Florida; David Millie, Palm Island Enviro-Informatics

### Abstract:

A *S. costatum* strain isolated from the LPBE was raised in f/2 culture medium formulated with aged LPBE water. Experimental treatments included uncontaminated f/2, oil-emulsified f/2 (1:9, 24 hours, 200 rpm) and oil-emulsified f/2 diluted with uncontaminated f/2 to produce media containing 25%, 50% and 75% of oil-emulsified f/2. Day 4 to day 10 growth curve slopes were compared; uncontaminated f/2, 25% and 50% treatments showed similar growth curves, the 75% treatment inhibited growth before recovering at day 4, while no growth occurred in the undiluted, oil-emulsified f/2 treatment. The slopes for the uncontaminated f/2 culture media and 25% treatments were the same ( $p < 0.001$ ), suggesting that oil contamination in the 50% treatment can inhibit growth. Final analyses from a subsequent experiment are pending but assess: (1) recovery following initial growth inhibition in the 75% treatment, (2) affects on photosynthesis via qPCR analyses of RUBISCO, (3) cellular fatty acid content as a measure of physiological commitment to food storage reserves. Ni, V, As, SO<sub>4</sub> & TPH were evaluated.

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Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## Spatial and temporal trends in PAH levels of oysters (*Crassostrea virginica*) from the Florida Gulf Coast following the Deepwater Horizon oil spill

**Presenter:** John Weinstein – The Citadel

**Authors:** John E. Weinstein, The Citadel; Jonte A. Miller, The Citadel; C. Edward Proffitt, Florida Atlantic University; David L. Kimbro, Florida State University; Stephen P. Geiger, Florida Fish and Wildlife Conservation Commission; Loren D. Coen, Florida Gulf Coast University

### Abstract:

The objective of this study was to document PAH content in whole oyster tissue from the Florida Gulf Coast following the Deepwater Horizon oil spill. Among regions and sampling dates, Tampa Bay oysters sampled in April 2011 had significantly higher levels of PAH compared to all other regions and sampling dates. Across all regions, PAH levels in this study were similar to those levels reported for NOAA Mussel Watch locations in the two years preceding the oil spill. Multivariate analysis suggested that the PAH fingerprint of oysters at most collection sites was different relative to that of Deepwater Horizon oil. Diagnostic isomer ratio analysis suggested that the primary source of PAHs in these oysters was either combustion alone or mixed combustion and petroleum sources. Individual PAH analyte levels reported here were generally two orders of magnitude below any public health levels of concern for seafood. Collectively, these results suggest that the Deepwater Horizon oil spill had no appreciable impact on oyster PAH content along the Florida Gulf Coast.

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Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## The Effects of the BP Oil Spill on the Epicuticular Wax of Cordgrass

**Presenter:** Yolander Youngblood – Southern University at New Orleans

**Authors:** Don Harris, Southern University at New Orleans; Yolander Youngblood, Southern University at New Orleans

### Abstract:

On April 20, 2010 an oil rig off the coast of Louisiana ruptured spilling millions of gallons of crude oil into the Gulf of Mexico. This oil spill affected every part of the gulf coast region destroying many plants. When oil comes in contact with plants it suffocates them by preventing stomata from receiving oxygen from the air. Oil is known to retard plant growth and even kill plants with time. To better evaluate the effects of the oil on the plants, the epicuticular wax of *Spartina spartinae* was observed. This is an abundant plant that is vital a part of the ecosystem of Louisiana's gulf shores. Certain stresses a plant undergoes can manifest in the shapes and patterns of wax structures covering the plant. Nearly a year after the spill *Spartina spartinae*(cord grass) was collected and the epicuticular wax of the plant from various areas affected by the BP oil spill was studied. The waxes of the plant were compared to known structures found in Monocots to see if there was much variation in shapes and patterns. From the results, it is not clear if there is a difference in the pattern and shapes of wax structures found on the plants now versus before the oil spill.

organisms has a characteristic shape, and pattern. The wax is in addition to the cuticle on the plant. The characteristic shape and pattern is due to the genetic make-up of the organism and the environment. Environmental stresses or pollution can alter the shape and pattern of epicuticular wax. I am particularly interested in *Serenoa repens* and *Sabal palmetto* because I have observed its characteristic shape and pattern under natural conditions using Scanning Electron Microscopy (SEM). When pollution is present the epicuticular wax shape and pattern may be altered. Samples of *Serenoa repens* collected in early 2011 showed little difference in epicuticular wax shapes and patterns versus that of plants not affected by the oil spill. Since that time the same area has now been affected by strong persistent winds from Hurricane Isaac. This data will show if this strong environmental factor affected the epicuticular wax on the leaves.

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Track: Coastal Inshore Impacts of Oil: From Mousse to Food Webs

Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## Effects of Hurricane Isaac and BP oil spill on shapes and patterns of foliar epicuticular wax found on *Sabal palmetto* and *Serenoa repens*

**Presenter:** Yolander Youngblood – Southern University at New Orleans

**Authors:** Angee Taylor, Jackson State Community College, Yolander R. Youngblood, Ph.D., Southern University at New Orleans

### Abstract:

The epicuticular waxes of leaves are the first barrier to environmental stress for many plants. Each epicuticular wax layer for each group of

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## Session: 003 Data Management and Informatics: Supporting Gulf of Mexico Research:

### Session: 003 - 1

Track: Data Management and Informatics: Supporting Gulf of Mexico Research

Date: Wednesday, January 23 2:00 PM  
Type: Oral Presentation

### The Deep-C Data Center

**Presenter:** Shawn Smith – COAPS/Florida State University

**Authors:** Shawn, Smith, COAPS/Florida State University; Jeff, Chanton, EOAS/Florida State University

#### Abstract:

The mission of the Deep-C data center is to accept, distribute, and ensure the long-term archival of Deep-C-funded data sets, analyses, or products. An overview will be presented of data center policies for acceptance and release of data sets, metadata practices, and collaborations with Gulf Research Initiative Information and Data Cooperative. The authors will provide a summary of the data management system and tools used to collect data and metadata along with the products and services to display and disseminate Deep-C data. Data sets managed by Deep-C are derived from cruises, moorings, drifters, aircraft, satellites, land-based samples, laboratory analyses, and numerical models. Geologic, geomorphologic, ecological, hydrographic, and physical oceanographic data have been collected on a diverse series of cruises. The status of our cruise data collections and other Deep-C data holdings will be provided. Finally, we will discuss the need for access to historical observations in the Gulf of Mexico and further collaboration with other data centers.

### Session: 003 - 2

Track: Data Management and Informatics: Supporting Gulf of Mexico Research

Date: Wednesday, January 23 2:15 PM  
Type: Oral Presentation

### Draft Specifications of the ECOGIG Data Warehouse Data Model and Physical Architecture

**Presenter:** Samantha Joye – University of Georgia

**Authors:** Edward Robinson, University of Georgia; Samantha B. Joye, University of Georgia

#### Abstract:

ECOGIG is an interdisciplinary consortia aimed at understanding the distributions of hydrocarbons in the environment and how physical, chemical, and biological factors regulate these distributions. The draft

specification for the ECOGIG data warehouse and associated data marts will be presented, focusing mainly on the data model of the warehouse and what resources it will offer. Specifications for some completed data marts that make up part of the ECOGIG Data Warehouse will be discussed in detail. We will present detailed descriptions of all of the data sets contained in the ECOGIG data warehouse with an eye towards defining appropriate ways to access the data. All of these data types are captured and appropriately structured in the ECOGIG Data Model in a manner that assures their integrity. The data model and proposed physical architecture of the ECOGIG Data Warehouse will allow detailed and flexible exploration of this data in the future through a high-performance user interface. Future concerns regarding this data warehouse include how to best serve and interact with other members of the GOMRI Initiative through the development of interfaces, including APIs and Meta-data specifications.

### Session: 003 - 3

Track: Data Management and Informatics: Supporting Gulf of Mexico Research

Date: Wednesday, January 23 2:30 PM  
Type: Oral Presentation

### Integrated Network for Monitoring Bird Populations along the Northern Coast of the Gulf of Mexico

**Presenter:** Frank Moore – University of Southern Mississippi

**Authors:** Frank R. Moore, University of Southern Mississippi; Peter Marra, Smithsonian Migratory Bird Center

#### Abstract:

Birds are a conspicuous and remarkable natural resource of the Gulf of Mexico (GOM). Hundreds of species and millions of individuals are supported by beaches, barrier islands, marshes, and coastal forests. Aside from breeding birds (e.g., colonial nesting waterbirds), the GOM receives a huge pulse of diversity twice yearly as millions of migrating shorebirds and songbirds arrive in coastal habitats, making it an essential refueling and overwintering area for intercontinental migrants. Today, anthropogenic pressures and natural disturbances result in loss and fragmentation of sensitive coastal ecosystems, creating tension between the importance of coastal areas for economic development and their value for birdlife. Coastal conservation efforts should be informed by data that explain how birds use the marine-land interface, document temporal and spatial population trends, and reveal the major stressors driving abundance and distribution. Our comprehensive plan includes the establishment of a network of regional hubs that stretch from Texas to Florida (see figure at <http://www.usm.edu/GOMNetwork>) to monitor

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coastal bird populations, conduct research, and present educational/outreach programs to the public. The network integrates data gathered from weather surveillance radar with local sampling of individuals on the ground, and brings together data that reinforce one another in their capacity to offer insights into the health of the GOM and its associated bird populations.

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## Session: 003 - 4

Track: Data Management and Informatics: Supporting Gulf of Mexico Research

Date: Wednesday, January 23 2:45 PM  
Type: Oral Presentation

### Supporting Gulf of Mexico Research with Historical Data

**Presenter:** Julie Bosch – NOAA's National Coastal Data Development Center (NCDDC)

**Authors:** Julie Bosch, NOAA's National Coastal Data Development Center (NCDDC); Sue McLean, NOAA/NESDIS Marine Geology and Geophysics Division; Hernan Eduardo Garcia, PhD, NOAA's National Oceanographic Data Center (NODC), Jan Kurtz, Environmental Protection Agency (EPA), Kurtz.Jan@epamail.epa.gov, Alyssa Dausman, United States Geological Survey (USGS), adausman@usgs.gov

#### Abstract:

The data record for the Gulf of Mexico spans decades and encompasses a wide range of physical, biological, chemical, geological and socioeconomic disciplines. Coastal and offshore monitoring programs and oceanographic and hydrographic surveys performed by Federal, state, academic and private organizations provide observations used to assess the ecosystem and evaluate environmental trends. These data form the foundation of our understanding of the Gulf and provide a basis for, and will be built by, current and future research efforts. Federal agencies including the United States Geological Survey (USGS), Environmental Protection Agency (EPA), and National Oceanic and Atmospheric Administration (NOAA) are stewards of these resources and make these data publicly available through a variety of methods. A summary of resources for Gulf of Mexico data is provided along with highlights of online access and examples of Federal data holdings and available product file formats to illustrate how researchers can access and use the variety of data and data sources that are available.

## Session: 003 - 5

Track: Data Management and Informatics: Supporting Gulf of Mexico Research

Date: Wednesday, January 23 3:00 PM  
Type: Oral Presentation

### NOAA's Management of Subsurface Monitoring Data from the Deepwater Horizon Event

**Presenter:** Scott Cross – NOAA's National Coastal Data Development Center (NCDDC)

**Authors:** Scott L. Cross, NOAA National Coastal Data Development Center; Mark W. Miller, NOAA Office of Response and Restoration; Benjamin Shorr, NOAA Office of Response and Restoration

#### Abstract:

The response to the Deepwater Horizon oil spill produced an oceanographic dataset that is remarkable in its size and diversity. Early in the response, the National Incident Commander formed a Subsurface Monitoring Unit (SMU) to facilitate the collection and rapid analysis of data to help characterize the location and movement of subsurface hydrocarbon. The resulting dataset includes roughly 2000 CTD casts and 1500 Niskin-bottle samples, as well as data from aircraft-deployed profilers, drifters, gliders, acoustic profilers, and a number of other sensors. A SMU data-management team was formed and co-led by NOAA Office of Response and Restoration and the National Coastal Data Development Center. During the response the team established standard data-management procedures for shipboard researchers, collated field and laboratory data, and reprocessed data as required. Post-response, the focus turned to data inventory, quality control, metadata development, and long-term archival. The SMU data are available through the National Oceanographic Data Center and National Geophysical Data Center.

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Session: 003 - 6

Track: Data Management and Informatics: Supporting Gulf of Mexico Research

Date: Wednesday, January 23 3:15 PM  
Type: Oral Presentation

## Data Gap Analysis Framework for Objective-based Coastal and Marine Planning

**Presenter:** Susan Rogers – Hart Research Institute/Gulf of Mexico Research Initiative Information and Data Cooperative- GRIIDC

**Authors:** Susan Rogers Harte Research Institute; Jim Gibeau Harte Research Institute; Felimon Gayanilo Harte Research Institute

### Abstract:

This work aims to identify gaps in scientific data collections that must be filled to evaluate the achievement of environmental goals as determined by society. There are several objective-based scoring systems which can identify environmental indicators to measure progress toward goals. There is often, however, a lack of data to provide meaningful measurements of these indicators. A method for determining which goals have sufficient data for measurement of progress and for determining where and what type of data gaps exist is needed. This work will present a framework for determining data gaps and thereby guiding the development of specific, measurable environmental goals in an objective-based coastal and marine planning program. Examples of marine environmental social objectives are food provision, sense of place, tourism and recreation, artisanal fishing, clean water, and carbon storage. As an example, we are using a Driver, Pressure, State, Ecosystem Services, and Response (DPSESR) approach to score a social objective for various ecological indicators and which also identifies data requirements. The framework is a protocol for evaluating the performance of an existing data collection for addressing specific social goals. Recommendations will be made on incorporating gap analysis into objective-based planning, particularly regarding the quality and quantity of existing data and data gaps that hinder measuring progress toward goals. Integrating a data gap analysis framework for an objective-based scoring system can guide future scientific data collections towards community goals, improve data access, and provide data assessment and validation for various planning purposes.

Session: 003 - 7

Track: Data Management and Informatics: Supporting Gulf of Mexico Research

Date: Wednesday, January 23 3:30 PM  
Type: Oral Presentation

## High accuracy positioning supports ecosystem science and sea level change impacts in the Gulf Coast and beyond

**Presenter:** David Newcomer – National Geodetic Survey

**Authors:** David Newcomer, National Geodetic Survey, Dr. Philippe Hensel, National Geodetic Survey, Denis Riordan, National Geodetic Survey

### Abstract:

Microtidal coastlines such as those in the Gulf of Mexico are especially vulnerable to flooding and sea level change impacts due to the restricted vertical range which coastal habitats occupy. Local to regional subsidence can also cause local sea level change to be many times more than the global average. Assessing coastal vulnerabilities and planning restoration strategies in such areas require accurate positioning, since vertical error in the centimeter range can mean the difference between being inundated or not. High accuracy elevations in high subsidence areas are problematic because published bench mark heights quickly become obsolete. Efforts at obtaining modernized heights, providing updated positional adjustments, and working with local research and management communities to establish high accuracy vertical positioning to vital coastal monitoring infrastructure are providing Gulf Coast users with reliable positioning data which can support coastal resiliency in the face of a changing environment.

Session: 003 - 8

Track: Data Management and Informatics: Supporting Gulf of Mexico Research

Date: Wednesday, January 23 3:45 PM  
Type: Oral Presentation

## Controlled Vocabularies, Metadata Content Standards and the Gulf of Mexico Research Initiative Information and Data Cooperative (GRIIDC) Data System

**Presenter:** Matthew Howard – GRIIDC

**Authors:** Matthew, Howard, Department of Oceanography - Texas A&M University; Fabio, Moretzsohn, Harte Research Institute - Texas A&M University-Corpus Christi; Gayanilo, Felimon, Harte Research Institute - Texas A&M University-Corpus Christi,



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## Abstract:

A controlled vocabulary (CV) is a set of terms used to name data objects and describe concepts within a domain of study. An optimum CV is widely used, well-documented, managed by an authoritative body and has a term for every object or concept one wants to express. The GRIIDC data system encompasses many domains so multiple CVs are used. These are merged and unneeded terms are omitted. Composite CVs can be registered to be reused or referenced by others. Content standards define the required set of metadata elements needed to describe a data set. Content standards and CVs constrain what can be searched for and the meaning of returns. If format and encoding standards are also used, powerful automated search, sort and filtering becomes possible. The ISO 191XX family of geographic information standards is becoming the metadata standard of choice in the U.S. and elsewhere. GRIIDC is requiring the use of ISO 191XX by its data providers. This presentation will discuss the selection process of CVs and metadata content standards used in the GRIIDC data system.

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Session: 003 - 9

Track: Data Management and Informatics: Supporting Gulf of Mexico Research

Date: Wednesday, January 23 4:00 PM  
Type: Oral Presentation

## Metadata Challenges and Solutions for Highly Varied Data Collections

**Presenter:** William Nichols – Harte Research Institute for Gulf of Mexico Studies

**Authors:** William Nichols, Harte Research Institute for Gulf of Mexico Studies; Felimon Gayanilo, Harte Research Institute for Gulf of Mexico Studies

## Abstract:

The Gulf of Mexico Research Initiative Information and Data Cooperative (GRIIDC) is charged with storing, managing, and distributing the research data developed from projects funded by the Gulf of Mexico Research Initiative (GoMRI). For these data to be most useful to future researchers, data documentation, or metadata, is essential. Additionally, GRIIDC relies upon metadata for a number of functions including data discoverability, system planning and scheduling, and reporting throughout the data lifecycle. The data generated by these projects are highly varied, in discipline, scale, and size, and as a result GRIIDC faces serious challenges; the varied nature of the data and different community practices make standardization difficult and metadata generation onerous. This presentation will describe the systems and procedures GRIIDC has implemented to address these challenges, including the development of adapted ISO metadata schema, custom schematron-

based validation rules, incremental documentation cycles, and flexible metadata creation tools.

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Session: 003 - 10

Track: Data Management and Informatics: Supporting Gulf of Mexico Research

Date: Wednesday, January 23 4:15 PM  
Type: Oral Presentation

## Enabling Large Data Transfer on Standard Networks

**Presenter:** Felimon Gayanilo – GoMRI/GRIIDC

**Authors:** Felimon Gayanilo, Harte Research Institute for Gulf of Mexico Studies, Texas A&M University - Corpus Christi; Patrick Krepps, Harte Research Institute for Gulf of Mexico Studies, Texas A&M University - Corpus Christi

## Abstract:

High-speed networks using cutting-edge fiber optic technologies with 10Gbps have become a common infrastructure in large installations to meet increasing demands and performance constraints of large scientific applications. As research advances, a corresponding increase in the complexity of the solutions increases. Very often, these solutions demand for large and distributed datasets for analyses and the solutions themselves also generate large datasets. The emergence of data centers and data portals that provide access to large scientific datasets have resolved much of the problem related to data requirements but introduces new problems in moving large datasets. This is most prevalent to a large number of scientists who are relegated to 1GBbps connections or less. Single-stream (e.g. SFTP, SCP, HTTP) and multi-stream (e.g. GridFTP, BSCP, UDT) data transfer technologies that do not require huge installations, and approaches to avoid congestion and sub-optimal utilization of available network resources are explored here. The end-to-end data transfer statistics or throughput based on data transport (downloading and distribution) records to the Gulf of Mexico Research Initiative Information and Data Cooperative (GRIIDC) data servers by participating researchers will be utilized. Finally, the authors will outline procedures to assist in the selection of the best possible combination of technology and approach.



# Science Abstracts

Session: 003 -

Track: Data Management and Informatics: Supporting Gulf of Mexico Research

Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

## Development of a Service-Oriented Architecture (SOA) application in support of ecosystem-based management

**Presenter:** Lori Adornato – SRI International

**Authors:** Lori Adornato, SRI International; Ximena Avila, SRI International, Linden Wright, SRI International, Stephanie Farrington, Florida Atlantic University, John Reed, Florida Atlantic University

### Abstract:

As multi-platform land- and sea-based mobile and fixed observing systems generate huge amounts of diverse types of data, the challenge of making sense of these data and generating useful products increases. This is particularly true of the Deepwater Horizon oil spill, where large quantities of dissimilar, asynchronous data were collected using myriad sensors on a variety of platforms. SRI demonstrated an oceanographic application using a newly developed information management and analysis platform to import and compare data from different sources by leveraging a platform and client application that was built with government investments. This small project provided a service-oriented architecture (SOA) application that was used to synthesize a portion of the data collected on the Cooperative Institute for Ocean Exploration, Research and Technology's (CIOERT's) Florida Shelf Edge Exploration (FLoSEE) cruise in July 2010. Adoption of the SOA approach for oceanographic data processing will ultimately allow for very cost-effective implementation of the information management platform for the broader environmental science community. Platform capabilities demonstrated include data sharing, security, and service composition, using a sample set of services.

Session: 003 -

Track: Data Management and Informatics: Supporting Gulf of Mexico Research

Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

## Solving the Scope and Scale Problem of Managing DWH Environmental and IH Data

**Presenter:** Dennis Beckmann – BP

**Authors:** Dennis D. Beckmann, BP

### Abstract:

Scientists studying natural resources in the Gulf of Mexico may want to look at data gathered in response to the DWH incident. Environmental samples were collected to aid in responding to the spill, and these include samples to establish pre-impact conditions in various areas of the Gulf of Mexico, and samples to identify the nature and extent of potential impacts. BP also collected industrial hygiene samples and data to monitor potential exposure and to protect the health and safety of response workers.

There are several databases and tools that can help scientists locate and review this type of data. This poster will identify the data streams that are available, provide example views of data search, preview, and download capabilities, and show the unique capabilities of a data management system that can extract data from all of the systems.

Session: 003 -

Track: Data Management and Informatics: Supporting Gulf of Mexico Research

Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

## Use of weather surveillance radar to identify critical habitats used by intercontinental migratory landbirds along the northern coast of the Gulf of M

**Presenter:** Jill Gautreaux – University of Southern Mississippi

**Authors:** Jill Gautreaux, University of Southern Mississippi; Jeffrey Buler, University of Delaware; Frank Moore, University of Southern Mississippi

### Abstract:

Two-thirds of bird species breeding in eastern N. America annually migrate from temperate breeding grounds to tropical wintering locations, engaging in non-stop movement directly across the Gulf of Mexico (GOM). Thus, millions of migrants concentrate in woodlands along the northern Gulf coast during spring and fall passage. These coastal landscapes are some of the most rapidly developing areas in the U.S. with population growth rates five times higher than that of inland areas. Anthropogenic pressures, along with human-created (e.g., oil spills) and natural disturbances (e.g., hurricanes), result in rapid degradation of sensitive coastal ecosystems, creating tension between importance of coastal landscapes for economic development and their value for energetically constrained migratory birds. There is urgency in conserving coastal habitats and identifying important stopover areas across the entire GOM to create a framework for monitoring critical habitats,

# Science Abstracts

designing management and restoration strategies, and informing conservation goals. A network of weather surveillance radar stations exists along the coastline, and their sampling ranges encompass a significant portion of habitats critical to migratory birds in a highly heterogeneous landscape with urban development adjacent to fragile chenier plains, bottomland hardwood forests, and coastal marshes. We analyzed archived Level II weather surveillance radar data for spring migratory periods of four years at six stations. Reflectivity, a measure of returned radio energy from objects in a sampled volume of airspace and an index of relative bird density, was used to determine distributions of migrants across the landscape, effectively mapping stopover areas across five states and highlighting important coastal stopover habitats. Reflectivity was averaged across years for each sampling volume and laid over the 2006 USGS National Land Cover Dataset for assessing habitat relations within each radar range.

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Session: 003 -

Track: Data Management and Informatics: Supporting Gulf of Mexico Research

Date: Wednesday, January 23 8:30 - 10:30  
Type: Poster

## Imaging data - recent issues of integrity and data processing

**Presenter:** Alon McCormick – University of Minnesota

**Authors:** Alon McCormick, University of Minnesota; Greg Haugstad, University of Minnesota; Mark Sanders, University of Minnesota

### Abstract:

It is better appreciated now than ever before how important it is to protect and archive original data in imaging, since image data are invariably processed in some fashion before interpretation, and the interpretation may be affected by the data processing. Moreover, it is important to protect the full set of original data so that cropping, enhancement, loss of resolution, etc. produced by data processing can always be re-examined.

In this presentation we will review some of the recent trends and issues being addressed by imaging-centered research laboratories.

Session: 003 -

Track: Data Management and Informatics: Supporting Gulf of Mexico Research

Date: Wednesday, January 23 8:30 - 10:30  
Type: Poster

## NOAA models and tools support high accuracy positioning needed for ecosystem restoration and ecological research

**Presenter:** David Newcomer – National Geodetic Survey

**Authors:** Christine Gallagher, National Geodetic Survey; David Newcomer, National Geodetic Survey

### Abstract:

NGS provides the framework for all positioning activities in the Nation. The foundational elements - latitude, longitude, elevation and shoreline information - contribute to informed decision making in support of coastal community resilience, ecosystem services, and ecological integrity. NGS' authoritative spatial data, models and tools are available for measuring and monitoring elevation change on the order of millimeters per year. NGS has worked closely with many partners including the National Estuarine Research Reserve System to help our partners establish infrastructure and resources to track the status of key indicators of ecosystem integrity in the face of many challenges including intense storms, oil spills, changing local sea levels, and changing land elevations. This presentation will provide an overview of the National Spatial Reference System, latest advances in positioning, and explain models and tools for connecting to the reference frame, including transformations between datums and models for monitoring crustal movement.

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Session: 003 -

Track: Data Management and Informatics: Supporting Gulf of Mexico Research

Date: Wednesday, January 23 8:30 - 10:30  
Type: Poster

## Cruise Report – CARTHE Sediment and Water Column Sampling, DWH Spill Site West to Mississippi Canyon

**Presenter:** Brad Rosenheim – Tulane University

**Authors:** Brad E. Rosenheim, Tulane University; Matthew Pendergraft, Tulane University; Robert Carney, Louisiana State University; Valerie Cruz, University of Southern Mississippi; Charlotte Brunner, University of Southern Mississippi; Jeff Chanton, Florida State University

# Science Abstracts

## Abstract:

The CARTHE benthic sampling cruise took place in July, 2012, and sampled multi-cores and water column profiles from 8 stations extending between the DWH spill site and Grand Isle. Stations included two shelf-slope transects, one through the Mississippi Canyon. Hundreds of core increments from 96 sediment cores were extruded on board the R/V Pelican and 62 water samples were prepared for radiocarbon analysis of DIC. The primary objective of water column sampling is to constrain radiocarbon variability in DIC of the water column around the spill site and the outflow of the Mississippi River. Sediment sampling was conducted to probe sedimentary organic matter for isotopic and specific compound evidence of oil pollution, rates of bioturbation, and foraminiferal assemblage reproducibility. Preliminary results of the analyses stemming from this cruise will be presented in this poster.

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## Session: 003 -

Track: Data Management and Informatics: Supporting Gulf of Mexico Research

Date: Wednesday, January 23 8:30 - 10:30  
Type: Poster

## Digital Object Identifier (DOI) use for persistent citation of datasets

**Presenter:** Lauren Showalter – Harte Research Institute/Gulf of Mexico Research Initiative Information and Data Cooperative-GRIIDC

**Authors:** Lauren Showalter Harte Research Institute; Dr. Jim Gibeaut Harte Research Institute; Felimon Gayanilo Harte Research Institute

## Abstract:

The Digital Object Identifier (DOI) is a system for providing a persistent citation for an object. These objects can include publications, physical samples, and more recently digital datasets. The use of DOIs to cite datasets is an important development for large scale data archival, and is a useful tool to ensure proper citation of data that is shared to large communities of researchers. The Gulf of Mexico Research Initiative Information and Data Cooperative's (GRIIDC) mission is to ensure a data and information legacy that promotes continual scientific discovery and public awareness of the Gulf of Mexico ecosystem. The use of DOIs will allow the data being collected by Gulf of Mexico Research Initiative (GoMRI) researchers to be referenced from a persistent location once it has been archived to either a national repository or GRIIDC. Presented here are the best practices in issuing DOIs to ensure the reliability and usability of these identifiers.

## Session: 003 -

Track: Data Management and Informatics: Supporting Gulf of Mexico Research

Date: Wednesday, January 23 (special request) 8:30 - 10:30  
Type: Poster

## A Topic Map Approach to Organizing the GoM Oil Spill Incident Topics, Relationships, and Literature

**Presenter:** Yejun Wu – Louisiana State University

**Authors:** Yejun Wu, Louisiana State University, School of Library and Information Science

## Abstract:

The Gulf of Mexico Oil Spill Incident has generated lots of literature, including research papers, government policies, and news reports. Organizing the body of literature and revealing the major issues become a challenge. An interdisciplinary topic map is being built to organize the body of literature and to facilitate understanding and research of the impact of the Gulf of Mexico Oil Spill Incident. Topic maps are a new semantic approach to information organization; which are designed to enhance navigation and information retrieval in large sets of information resources. A topic map has three constructs: (1) topics, which represent "subjects of discourse", (2) associations, which represent relationship between the subjects, (3) occurrences, which are information resources relevant to a given topic. Such a topic map can be used to display the major issues related to the oil spill incident and to navigate the information resources. Our formative evaluation reveals that it can help high school students learn oil spill topics.

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## Session: 004 Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Session: 004 - 1

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Monday, January 21 2:00 PM  
Type: Oral Presentation

### API Joint Industry Task Force on Oil Spill Preparedness and Response: Dispersant Research Coordination Update

**Presenter:** Thomas Coolbaugh – ExxonMobil Research & Engineering

**Authors:** Thomas Coolbaugh, ExxonMobil Research & Engineering; Tim Nedwed, ExxonMobil Upstream Research Company; Erik DeMicco, ExxonMobil Research & Engineering

#### Abstract:

As part of a number of efforts that were defined within the American Petroleum Institute's 2010 Joint Industry Task Force on Oil Spill Preparedness and Response recommendations, a project was undertaken to examine the broad range of research that has been focused on dispersant use following an oil spill. A primary goal was to provide a means to share oil spill response-related information with the academic, government and industrial research communities and to provide opportunities to examine research findings, both past and present. This has included the organization of a conference for researchers at universities primarily near the Gulf of Mexico, i.e., principal investigators from the Gulf of Mexico Research Initiative consortia, and the development of a process for collecting and discussing current and future research.

The presentation will provide a status report of the project and ongoing plans.

Session: 004 - 2

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Monday, January 21 2:15 PM  
Type: Oral Presentation

### Biodegradation of DOSS and Dispersed South Louisiana Crude Oil at Two Temperatures

**Presenter:** Albert Venosa – U.S. EPA

**Authors:** Albert D. Venosa, U.S. Environmental Protection Agency; Pablo Campo, University of Cincinnati; Makram T. Suidan, American University of Beirut

#### Abstract:

This report covers the quantitative biodegradability of the primary surfactant in the oil spill dispersant Corexit 9500, dioctyl sulfosuccinate or DOSS, in the presence and absence of crude oil. Our laboratory experiment was conducted at two temperatures, 5 °C and 25 °C. Using two cultures from the Gulf of Mexico, we set up a factorial experiment involving 3 treatments in sacrificial triplicate microcosms, S. Louisiana crude (SLC) oil alone, Corexit 9500 alone, and SLC dispersed by Corexit 9500 plus killed controls. We monitored the temporal changes in the alkane and PAH fractions and DOSS. In the killed controls at the 25 °C temperature, DOSS hydrolyzed to mono-octyl sulfosuccinate (MOSS) and 2-ethyl hexanol (2-EH) but not at 5 °C. The “meso” culture rapidly degraded DOSS, alkanes, and aromatics. The “cryo” culture also metabolized alkanes and aromatics, but the lag phase lasted 28 days before biodegradation ensued while DOSS persisted. These findings are unique in the oil spill research field and advance the science to new areas not encountered before in the literature.

Session: 004 - 3

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Monday, January 21 2:30 PM  
Type: Oral Presentation

### Non-Toxic Sugar-Based Phase Selective Gelators for Crude Oil Gels

**Presenter:** George John – The City College of New York-CUNY

**Authors:** George John, The City College of New York; Malick Samateh, The City College of New York; Subbiah Nagarajan, The City College of New York; Swapnil Jadhav, The City College of New York

#### Abstract:

Large-scale oil spills are known to cause irrecoverable damage to the environment and ecosystem.<sup>1,2</sup> There is a clear need for new and improved oil remediation solutions. Present technologies have

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limitations, both in containing the oil spread and in allowing recovery of the spilled oil.<sup>3-5</sup> We present efficient, biobased small molecule solidifiers for oil remediation and spill clean-up.<sup>6</sup> By varying the sugar head group (mannitol, sorbitol and xylitol) and alkyl tail group (C<sub>4</sub>-C<sub>14</sub>) through a biocatalytic synthesis we have synthesized novel amphiphiles resulting in a library of gelator molecules. In further detailed investigations of sugar-based amphiphiles on phase-selective gelation, mannitol dioctanoate (M8) displayed effective oil phase-selective gelation in diesel/crude oils (Prudhoe Bay, Arabian light and South Louisiana). Selective gelation of diesel or crude oil from bulk diesel-water/crude oil-water mixture and simultaneous recovery of diesel/crude oil, with more than 80% efficiency was achieved with M8 (Figure 1). Our current research focuses on understanding the assembly process and elucidating the structure and morphology of the crude oil gel. We continue our search for sustainable technologies for oil remediation and spill clean-up using new gelators and dispersants derived from biomass.

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Session: 004 - 4

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Monday, January 21 2:45 PM  
Type: Oral Presentation

## Properties of New Coagulants of Crude Oil

**Presenter:** Richard Weiss – Georgetown University

**Authors:** Richard G. Weiss, Georgetown University; V. Ajay Mallia, Georgetown University; Tao Yu, Georgetown University; Yong He, Georgetown University

### Abstract:

Amino-substituted polysiloxanes have been crosslinked ionically and covalently by treatment with CO<sub>2</sub>, CS<sub>2</sub> and carboxylic acids. The ability of the ammonium dithiocarbamates and thioureas, obtained by addition of CS<sub>2</sub> and subsequent heating of the salt, respectively, as well as the siloxane polymers crosslinked with carboxylic acids, to swell crude oil and other organic liquids have been examined in the presence and the absence of a water sublayer. The efficiency of uptake of the polysiloxanes depends on the ionic or covalent nature of the crosslinks and the degree of amino substitution (among other factors). In addition, dispersions in methanol of a series of derivatives of the naturally-occurring molecule, (R)-12-hydroxyoctadecanoic acid, extractable from the castor bean, have been shown to coagulate crude oil and other organic liquids in the presence of a water subphase. Preparation, swelling capacities as a function of structural modifications, reusability, and experimental data to determine the velocity of the uptake and release of the organic liquids will be presented.

Session: 004 - 5

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Monday, January 21 3:00 PM  
Type: Oral Presentation

## Penetration Profile of Louisiana Crude Oil through Red Mangrove Roots in the Presence and Absence of Dispersants

**Presenter:** Berrin Tansel – Florida International University

**Authors:** Berrin Tansel, Florida International University; Urpiana Koklonis, Florida International University; Jillian Berbakov, Florida International University; Mengshan Lee, Florida International University; Derya Tansel, Florida International University

### Abstract:

Crude oil is a complex hydrocarbon. When oil spills are present in aquatic communities, the results can be devastating. Red mangroves (*Rhizophora mangle*) which grow on shorelines are vulnerable to oil spills. Laboratory experiments were conducted to evaluate the mass transfer profile of oil fractions through the roots of mangrove plants in the presence and absence of dispersants. Mass transfer characteristics of Louisiana crude oil was evaluated through the root tissues of red mangroves were evaluated in the presence and absence of Corexit 9500A. Four treatments were applied, the first without any dispersant, and the other three with increasing amounts of dispersant. The penetration profile of oil fractions were evaluated by microscopic examination of roots both externally and through cross section analyses. Theoretical analyses were performed to estimate the mass transfer coefficients of oil fractions through the root tissues.

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Session: 004 - 6

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Monday, January 21 3:15 PM  
Type: Oral Presentation

## Microscale interfaces as a tool for characterizing complex interfacial systems

**Presenter:** Shelley Anna – Carnegie Mellon University

**Authors:** Shelley L. Anna, Carnegie Mellon University; Matthew D. Reichert, Carnegie Mellon University; Nicolas J Alvarez, DTU; Lynn M. Walker, Carnegie Mellon University

### Abstract:

In an oil spill scenario, surfactants are used to emulsify oil in the ocean, which in turn reduces a spill's impact on coastlines. Designing effective dispersants for these applications includes understanding the molecular transport of the surfactant to the oil-aqueous interface, as well as the



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interfacial mechanical properties that play a role in emulsion stability. Additionally, the oil-aqueous interface responds to temperature gradients, rapid changes in dispersant concentration, and convective fluxes. We use a recently developed microtensiometer to demonstrate new techniques that can help to characterize the transport and interfacial rheology for these systems. Our device consists of a microscale droplet pinned at the end of a capillary, viewed under a microscope. Rapid image analysis in conjunction with a pressure transducer in-line with the capillary yields the instantaneous interfacial tension. The effects of convection, temperature changes, and bulk concentration changes can be decoupled using the microtensiometer for a model dispersant-oil-aqueous system. We also measure interfacial rheological properties of this model system, as well as the coalescence rates of two droplets brought into contact with one another.

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## Session: 004 - 7

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Monday, January 21 3:30 PM  
Type: Oral Presentation

### **Molecular dynamic simulations of commercial dispersant Corexit composed of Tween 80 and Aerosol OT in oil/water mixtures**

**Presenter:** Ronald Larson – University of Michigan

**Authors:** Ronald G. Larson, University of Michigan; Xueming Tang, University of Michigan

#### **Abstract:**

Corexit has been used widely as a dispersant, especially in the Deepwater Horizon oil spill in the Gulf of Mexico in 2010. The main active ingredients of Corexit are Tween-80 and Aerosol OT (AOT). Tween 80 is a nonionic long chain surfactant, while AOT is an anionic surfactant with two tails. We carried out atomistic molecular dynamic simulations on systems composed of Tween-80, AOT, squalane (a model of oil), and water or brine. Partial charges of Tween 80 and AOT were adopted from force field parameters or estimated using Gaussian density function methods. We studied micelles of Tween 80 micelles and of AOT, and of mixtures of these. We observed micelles of Tween 80 diffuse from the water phase into squalane phase within 20 ns. Initially randomly distributed Tween 80 and oil in water formed suspended aggregates coated with hydrophilic head groups of Tween 80. We also will report the system's surface tension by applying anisotropic pressure coupling at different Tween 80 and AOT ratios.

## Session: 004 - 8

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Monday, January 21 3:45 PM  
Type: Oral Presentation

### **Measurement of the Capillary Force on a Particle at a Fluid Interface**

**Presenter:** Anthony Dinsmore – University of Massachusetts Amherst

**Authors:** We He, University of Massachusetts Amherst; Anthony Dinsmore, University of Massachusetts Amherst

#### **Abstract:**

We measure capillary forces on particles at fluid interfaces in order to assess what properties determine the stability of particle-coated oil droplets in ocean water. In our experiments, a particle is attached to a cantilever, which is used to pull the particle perpendicular to the interface. Simultaneously, we image from the side to measure the cantilever's deflection and thus the pulling force, as well as the height of the particle and the shape of the interface. We focus on the effects of the contact angle, particle size and roughness, the composition of the particles and fluids, and the concentration of surfactants or other particles at the interface. We find that, in the short term, spherical particles are subject to contact-line pinning and hysteresis, in contrast to the common assumption of constant contact angle. We also find that free-floating particles at the interface reduce the work required to remove a particle, suggesting that the surrounding particles reduce the effective interfacial tension, similar to surfactants. The results should be helpful in formulating oil dispersants. This work is supported by the Gulf of Mexico Research Initiative through the C-MEDS consortium.

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Session: 004 - 9

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Monday, January 21 4:00 PM  
Type: Oral Presentation

## Using Adipogenic Differentiation of Stem Cells to Determine Potential Adverse Effects of Petroleum/Dispersant Exposure

**Presenter:** Demetri Spyropoulos – MUSC

**Authors:** Demetri D. Spyropoulos, Medical University of South Carolina and Hollings Marine Laboratory; Emily M. Allen, MBES; Satomi Kohno, MBES and Hollings Marine Laboratory; John E. Baatz, MBES and Hollings Marine Laboratory; Louis J. Guillette, MBES and Hollings Marine Laboratory

### Abstract:

Far behind acute toxicity tests, but crucial to design safe chemical dispersants, is testing adverse effects on long-term health. Barriers include the lack of rapid/reliable/inexpensive/sensitive biological systems representing long-term impacts, especially with regard to sensitive fetal growth. We developed pig and phylogenetically-linked pygmy sperm whale (PSW) induced pluripotent stem cells (iPSCs), mouse embryonic stem cells (ESCs) and are developing human/alligator iPSCs to bypass the inaccessibility of aquatic/estuarine organisms and slow rate/high cost of conventional human/animal studies. Preliminary results indicate that PSW and pig preadipocytes behave distinctly in standard adipogenic differentiation assays. Dispersant/oil mixtures are being applied to these cells to determine LD<sub>50</sub> and exposure levels that alter adipogenesis and epigenetic reprogramming. The ultimate goal is to develop high-throughput sentinel systems for identifying deleterious oil/dispersant fractions that provide frameworks to guide design of safer non-mechanical methods for oil breakdown/recycling.

Session: 004 - 10

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Monday, January 21 4:15 PM  
Type: Oral Presentation

## EFFECTS OF OIL DISPERSANTS ON SEDIMENT RETENTION AND WEATHERING OF POLYCYCLIC AROMATIC HYDROCARBONS IN THE GULF COAST ECOSYSTEMS

**Presenter:** Dongye Zhao – Auburn University

**Authors:** Dongye Zhao, Auburn University; Yanyan Gong, Auburn University; Xiao Zhao, Auburn University; S. E. O'Reilly, Bureau of Ocean Energy Management

### Abstract:

We investigated effects of a model dispersant Corexit EC9500A on sorption, desorption, physical availability and weathering of three model PAHs (polycyclic aromatic hydrocarbons) under simulated Gulf Coast conditions. Batch sorption kinetic tests showed that increasing dispersant concentration from 0 to 1360 mg/L progressively increased the sorption of PAHs, and the presence of the dispersant resulted in profound sorption hysteresis of the PAHs. The presence of the dispersant at 18 mg/L inhibited ozone-oxidation of phenanthrene and pyrene by 21% and 15%, respectively, and retarded the PAHs photolytic degradation by up to 5%. Our research revealed: 1) the dispersant can significantly increase sediment uptake of PAHs, 2) the dispersant inhibited desorption of the PAHs and increased the sorption hysteresis, 3) SOM increased PAHs sorption capacity and leveraged the effects of the dispersant on PAHs uptake, and 4) the presence of the dispersant inhibited weathering rates of PAHs. The information is important for understanding roles of oil dispersants on the distribution, transport, and fate of petroleum PAHs in the environment.

Session: 004 - 11

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Tuesday, January 22 8:30 AM  
Type: Oral Presentation

## Review of SMART Data For Aerial Dispersant Operations

**Presenter:** Ed Levine – NOAA / ORR

**Authors:** Ed Levine, NOAA; Alan Mearns, NOAA; Gary Shigenaka, NOAA; Scott Miles, LSU; Adriana Bejarano, RPI; Bret Magdasy, Genwest; Ken Bond, USCG

### Abstract:

This report is an overview of the monitoring protocols used during the Deepwater Horizon aerial dispersant applications, and describes the type of data collected, the attempt to correlate certain data, and an interpretation of what can be concluded from the empirical information with respect to possible environmental effects of the surface applications. The review includes data from aerial and vessel-based dispersant use, and does not consider the subsea injection at the wellhead.

The SMART monitoring was able to determine the effectiveness of dispersant operations. It was not sufficient to determine the effects of the dispersant and oil on marine life in the water column. Due to the enormous amount of oil in the water column and sea surface the variability of "background" sample concentrations, both from fluorometry and chemical analysis, varied greatly. It was further concluded there is



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little or no correlation between the in-situ fluorometry and laboratory chemical testing data results.

Due to the nature of sampling from a vessel not all sites were sample to the exact specifications of the protocols. From reviewing the data, a sample bias can be found. There is no data available for times when the sea state was too great for the vessels to go out.

Lessons learned from the activities as they were carried out and suggestions for future consideration are also presented.

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**Session: 004 - 12**

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Tuesday, January 22 8:45 AM  
Type: Oral Presentation

## Grafted Nanoparticle Based Interfacial Agents

**Presenter:** Ramanan Krishnamoorti – Univ of Houston

**Authors:** Ramanan Krishnamoorti, University of Houston; Daehak Kim, University of Houston

### Abstract:

Nanoparticles have attracted interest as potential interfacial agents and hence as effective dispersants of oil. We have prepared amphiphilic nanoparticles by grafting polymers onto spherical silica nanoparticles using atom transfer radical polymerization. Specifically, we have prepared block copolymers of poly(oligo ethylene oxide mono methyl ether methacrylate) and poly(styrene) at different grafting densities on silica nanoparticles with nominal particle diameters of 15 and 50 nm. We have examined their effect on the reduction of the interfacial tension of hexane and water and understand these on the basis of their thermodynamic driving force to segregate to the interface.

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**Session: 004 - 13**

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Tuesday, January 22 9:00 AM  
Type: Oral Presentation

## Mechanisms of micro-droplet generation in a liquid-liquid system

**Presenter:** Bahni Ray – Johns Hopkins University

**Authors:** Bahni Ray, Johns Hopkins University; Andrea Prosperetti, Johns Hopkins University; Joe Katz, Johns Hopkins University; Kathleen J. Stebe, University of Pennsylvania

### Abstract:

The standard scenario for the break-up of a liquid drop in a turbulent field postulates the tearing apart of the drop by a turbulent eddy with comparable dimensions. As a consequence, the original drop breaks into fragments of roughly comparable size, possibly with a few smaller satellite drops. Available experimental evidence, however, suggests that a considerable number of very small drops can also be generated. The likely mechanism is the break-up of filaments (akin to “tip streaming”) or “skirts” developed by the drop because of its motion relative to the surrounding liquid. These processes are strongly influenced by surfactants. This work describes preliminary results of a numerical simulation of these phenomena with and without insoluble surfactants.

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**Session: 004 - 14**

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Tuesday, January 22 9:15 AM  
Type: Oral Presentation

## Oil Emulsification by Surface-Tunable Carbon Black Particles

**Presenter:** Arijit Bose – University of Rhode Island

**Authors:** Amitesh Saha, University of Rhode Island; Ani Nikova, Cabot Corporation; Pradeep Venkataraman, Tulane University; Vijay John, Tulane University; Arijit Bose, University of Rhode Island

### Abstract:

We examine particle-stabilized octane-in-water emulsions prepared by modifying the pH or varying the salt concentration of an amino-benzoic acid terminated carbon black (CB) suspension in water, adding octane to this suspension and mixing. The CB particles position themselves at the oil-water interfaces, and stabilize the emulsion for several months. When naphthalene, a model polycyclic aromatic hydrocarbon, is added to the octane, its partitioning into the aqueous phase is reduced significantly from a control case with no carbon black. The fractal nature of these particles provides a large specific surface area that promotes adsorption of naphthalene, a model low molecular weight polycyclic aromatic hydrocarbon from the octane. Emulsion formation using these particles coupled with the capability to reduce PAH partitioning into a surrounding aqueous phase implies several potential applications of these surface modified carbon black particles, including their use as an alternative to conventional dispersants for emulsifying crude oil subsequent to an oil spill.

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Session: 004 - 15

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Tuesday, January 22 9:30 AM  
Type: Oral Presentation

## Near field oil droplet behavior with application to sub-surface dispersant effectiveness

**Presenter:** E. Adams – Massachusetts Institute of Technology

**Authors:** Eric Adams, MIT; Godine Chan, MIT; Aaron Chow, Gnarus Advisors; Scott Socolofsky, Texas A&M University

### Abstract:

We revisit the roles that ambient stratification and currents play in causing gas bubbles and large oil droplets to separate from smaller oil droplets and seawater in a rising plume. We distinguish stratification-dominated versus cross flow-dominated plumes based on current speed, bubble/droplet rise velocity and characteristic plume velocity. Laboratory experiments in quiescent stratification show that small droplets detrain from the plume and get transported horizontally from the source by a subsurface intrusion. Somewhat larger droplets will detrain but not enter the intrusion, resulting in less horizontal spreading, while still larger droplets will rise directly to the surface, exhibiting the least spreading. For intruding droplets, the distance over which droplets are transported was found to agree with analytical models. Because chemical dispersants are used to break oil into smaller, more slowly rising droplets that can be transported farther from the source prior to surfacing, these results provide one measure of sub-surface dispersant effectiveness.

Session: 004 - 16

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Tuesday, January 22 9:45 AM  
Type: Oral Presentation

## Salt Effects on Sodium Dodecyl Sulfate Adsorption onto Clathrate Hydrates

**Presenter:** Oluwaseun Salako – City College of New York

**Authors:** Oluwaseun Salako, City College of New York; Chi Lo, Columbia University; Junshe Zhang, The City College of New York; Alexander Couzis, The City College of New York; Ponisseril Somasundaran, Columbia University; Jae Lee, The City College of New York

### Abstract:

Gas Hydrates are one group of clathrates consisting of host and guest molecules. Gas hydrates have excellent gas storage capacity. In order to

explore gas hydrate technology for energy storage, kinetics of gas hydrate formation has to be well understood. The process of gas hydrate formation is slow due to the formation of a thin film (diffusion barrier) of ice at the gas-liquid interface. Adding small amount of surfactants can subdue the diffusion barrier. Sodium dodecyl sulfate (SDS) is one of the surfactants that has been shown to improve the hydrate formation kinetics of low molecular weight hydrocarbon like methane but the mechanism by which SDS accelerates the formation kinetics of gas hydrates is not well understood. Although study have shown that the increased hydrate formation could be due to the adsorption of SDS at the hydrate water interface, the effect of salt on SDS adsorption is not clearly understood. In this presentation, we will attempt to explain the adsorption behavior of SDS at Cyclopentane (CP) hydrate-water interface in the presence of different NaCl solutions.

Session: 004 - 17

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Tuesday, January 22 10:00 AM  
Type: Oral Presentation

## Chemical Dispersant Effectiveness as a Function of Oil-Brine Interfacial Tension Reduction and Mixing Energy

**Presenter:** Ali Khelifa – Emergencies Science and Technology Section / Environment Canada

**Authors:** Ali Khelifa, Environment Canada; Jerry Wu, Carleton University; Tsz-Shan Tong, University of Waterloo; Nigel Roshan Singh, University of Waterloo

### Abstract:

Very little research was conducted to address chemical dispersant effectiveness by measuring the independent effects of mixing energy and reduction of the oil-brine interfacial tension (IFT). This paper presents new results to establish quantitative understanding of the variations of IFT with dispersant-to-oil-ratio (DOR) and the resulting modifications to the size distribution of oil droplets under various mixing intensities. High values of IFT were measured using the pendant drop technique and low values of IFT were measured using the spinning drop method. Undisturbed oil droplets were measured using a high-resolution imaging method. Alaska North Slope (ANS) oil and Corexit9500 were used. Results showed remarkable reduction of IFT with DOR. The highest reductions of about 107, 106 and 105 % were measured with 0, 10 and 22% oil weathering, respectively. Under moderate mixing energy, maximum size of oil droplets decreased from about 600um to 150um, 1100um to 170um, and 1800um to 260um for 0, 10 and 22% oil

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weathering, respectively, when the DOR was increased from 1:500 to 1:20.

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Session: 004 - 18

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Tuesday, January 22 10:15 AM  
Type: Oral Presentation

## Oil Emulsification by Particles and Amphiphilic Polymers

**Presenter:** Ashley Guerrette – University at Buffalo, SUNY

**Authors:** Ashley Guerrette, Eric Dudek, Andrew Bodratti, Paschalis Alexandridis, Marina Tsianou, University at Buffalo - The State University of New York (SUNY)

### Abstract:

Marine oil spills cause detrimental effects on ecosystems due to the spreading of oil on the ocean surface. One way to combat oil spills is by utilizing dispersants, which reduce the oil-water interfacial tension, allowing for oil droplet formation and dilution through the water column, thus accelerating the degradation process by bacteria. Even though current dispersants are relatively non-toxic, they still add solvents and contaminants to the environment due to the large amounts used. In this work we explore the use of mineral particles in dispersants in order to reduce the amounts of surfactants utilized and to develop formulations that have low impact on the environment. We investigate the effects of solid or mesoporous silica particles (with nano- or micro- dimensions) or clay particles and/or amphiphilic polymers on the stability of oil-in-water emulsions. Hexadecane and toluene have been selected as the oil phase to model the aliphatic and aromatic components of crude oil, respectively. The aqueous phase used is deionized water where particles and/or polymers have been added. The charge on the particles can be varied by pH modification and addition of simple electrolytes. The emulsification behavior of these systems and the stability of the resulting emulsions to creaming and/or coalescence were assessed by turbidity measurements and oil droplet size distributions. The nature of both the surfactants and the particles and their concentrations affect the droplet size and polydispersity as well as the stability of the emulsions. Under certain conditions the particles have shown synergistic effects with surfactants, resulting in stable emulsions. Our data provide a better understanding of the mechanisms and interactions between surfactants and particles at the oil-water interface, allowing for the design of more effective dispersant systems.

Session: 004 - 19

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Tuesday, January 22 11:00 AM  
Type: Oral Presentation

## Accounting for Oil Dispersion in Nearshore Scales in Large Scale Oceanic Flows

**Presenter:** Juan Restrepo – University of Arizona

**Authors:** Juan M. Restrepo, University of Arizona; Shankar Venkataramani, University of Arizona; Clint Dawson, University of Texas at Austin; Arthur Mariano, University of Miami

### Abstract:

Shelf-scale models for oceanic flows and oil are challenged when required to resolve very nearshore flows. However, doing so is critical to describe shoaling oil. We propose a subscale parametrization that diffuses the oil in a manner consistent with experiments.

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Session: 004 - 20

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Tuesday, January 22 11:15 AM  
Type: Oral Presentation

## Surfactant Transport Dynamics and Interfacial Rheology of a Model Oil/Dispersant/Aqueous System using Mixtures of Tween 80 and AOT

**Presenter:** Matthew Reichart – Carnegie Mellon University

**Authors:** Matthew D. Reichert, Carnegie Mellon University; Lynn M. Walker, Carnegie Mellon University

### Abstract:

Understanding the transport mechanisms of surfactant dispersants to and from microscale interfaces is important for designing dispersants and promoting their efficient use. In this study, we create a model oil-aqueous-dispersant system of squalane, simulated sea water, Tween 80 and AOT (both are important components in Corexit®), and characterize this system using a recently developed microtensiometer. Control of transport near the interface and step changes in the bulk concentration provide us with insight into the nature of adsorption of these surfactants at oil/water interfaces. We observe a critical interfacial tension in the Tween-80 system. The mechanics and reversibility of the adsorbed interfacial layer above and below this critical value differ considerably. We also characterize the competitive adsorption of AOT and irreversibly adsorbed Tween-80 layers, and show the impact on both the interfacial tension and dilatational rheology. The ramifications of these results on dispersant design and application are discussed.

# Science Abstracts

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Session: 004 - 21

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Tuesday, January 22 11:30 AM  
Type: Oral Presentation

## Effect of Dispersants on Photochemical Transformation of Crude Oil

**Presenter:** Matthew Tarr – University of New Orleans

**Authors:** Matthew A. Tarr, University of New Orleans; Sarah M. King, University of New Orleans; Marguerite C. O'Quinn, University of New Orleans; Phoebe Z. Ray, University of New Orleans

### Abstract:

Photochemistry plays an important role in the transformation of oil on the surface of seawater. Molecules that are not readily biodegraded can be transformed into biodegradable compounds by the action of sunlight. However, some photoproducts can also be toxic. The presence of additional compounds in the oil can alter the rates, mechanisms, and products of oil photochemistry. We have observed substantial changes in oil degradation rates with added dispersant. The extent of polycyclic aromatic hydrocarbon photodegradation was inhibited in the presence of dispersants. Irradiation of dispersant in water with no oil did not affect toxicity, but irradiation of oil/dispersant mixtures did result in increased toxicity of the water layer.

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Session: 004 - 22

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Tuesday, January 22 11:45 AM  
Type: Oral Presentation

## Industry Sponsored Subsea Dispersant Injection Research

**Presenter:** Tim Nedwed – ExxonMobil Upstream Research Company

**Authors:** Tim Nedwed, ExxonMobil Upstream Research Company

### Abstract:

Subsea dispersant injection was a key response tool initiated during the Macondo incident. The API believes it played an important role protecting both the environment and the health and safety of workers in vessels attempting to contain the well. Industry plans to incorporate this tool in response strategies for future offshore drilling operations where appropriate.

The novelty of the concept did not allow it to be fully evaluated prior to the spill. For this reason, API initiated the subsea dispersant injection program to conduct studies and controlled experiments on

- The effectiveness of subsea injection over a range of conditions;
- The effects of dispersed oil on deepwater marine environments;
- Numerical modeling upgrade needs to better predict the fate of oil dispersed oil in deepwater; and
- Monitoring tools that could be used to determine the effectiveness of subsea injection.

The presentation will provide an overview of the API subsea dispersants research program and some of the preliminary research findings.

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Session: 004 - 23

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Tuesday, January 22 12:00 PM  
Type: Oral Presentation

## Distribution of Dispersant-Related Surfactants in the Gulf of Mexico Following the Deepwater Horizon Oil Spill

**Presenter:** James Gray – US Geological Survey

**Authors:** James L. Gray, U.S. Geological Survey; Additional authors from U.S. Geological Survey, Leslie Kanagy, lkanagy@usgs.gov, Jeff McCoy, jefmccoy@usgs.gov, Ed Furlong, efurlong@usgs.gov, Chris Kanagy, ckanagy@usgs.gov

### Abstract:

Dispersants are complex mixtures of surfactants and other chemicals that solubilize oil in water as small droplets. They have been used historically to reduce the plume size and increase hydrocarbon biodegradation rates after surface oil spills. Evidence suggests that dispersant components and their breakdown products may have high toxicity to marine organisms. In the wake of the Deepwater Horizon oil spill in the Gulf of Mexico, dispersants were applied to surface oil plumes as well as to subsurface plumes at the source of the leak.

Here, we present results for surfactant analysis of samples collected before and after landfall of the weathered crude oil and dispersant plume. A sensitive LC/MS/MS method (MDL=0.25 µg/L) was developed to analyze dioctylsulfosuccinate (DOSS), a component of Corexit dispersants used here. In 91 prelandfall water samples DOSS was only rarely detected and it was not detected in postlandfall samples. DOSS was detected in several samples near application at both the surface and in deep water (1500 m) near the spill site. In only one surface sample did the concentration exceed the EPA aquatic life benchmark of 40 mg/L.

# Science Abstracts

Session: 004 - 24

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Tuesday, January 22 12:15 PM  
Type: Oral Presentation

## Performance of submersible optical sensors exposed to chemically-dispersed crude oil: wave tank simulations for improved oil spill monitoring and evaluation

**Presenter:** Robyn Conmy – US EPA

**Authors:** Robyn Conmy, US EPA; Paula Coble, USF; Jim Farr, NOAA; A. Michelle Wood, NOAA; Kenneth Lee, DFO Canada; Corey Koch, WET Labs Inc.; Rost Parsons, NOAA; Mary Abercrombie, USF; W. Scott Pegau, OSRI; Marlon Lewis, Dalhousie University; Ian Walsh, WET Labs Inc.; M. Scott Miles, LSU

### Abstract:

During the DWH Spill, in situ fluorometers provided critical measurements for tracking the subsea oil plume. In the wake of the spill questions persist regarding sensor capability, applicability of laboratory calibrations (at high concentrations and insufficient mixing energies) to field conditions, and sensor reliability to detect oil. To address uncertainties, performance of sensors deployed during the spill was evaluated using a wave tank facility at the Bedford Institute of Oceanography, which simulates in field mixing energies and dispersant effectiveness. Presented are the results of the sensors exposed to chemically-dispersed MC252 crude oil using Corexit 9500, DOR=1:20. Stepwise additions of dispersed oil (0.3 – 12 ppm) to the tank were used to establish linearity. Model 1 regressions were calculated and applied to fluorescence data during validation experiments to simulate dilution of an oil plume. Findings will assist in the evaluation of DWH spill measurements and in understanding fate and transport of chemically-dispersed plumes in potentially-impacted ecosystems.

Session: 004 - 25

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Tuesday, January 22 2:00 PM  
Type: Oral Presentation

## Silica Nanoparticle Oil-in-Water Pickering Emulsions in Deionized Water and Artificial Seawater

**Presenter:** Geoffrey Bothun – University of Rhode Island

**Authors:** Geoffrey Bothun, University of Rhode Island; Anju Gupta, Texas A&M International University; Hongyin Zhang, University of Rhode Island; Vinka Oyanedel-Craver, University of Rhode Island

### Abstract:

Microbial degradation of dispersed oil is dependent in part upon the physicochemical properties and stability of the emulsified oil droplets. Oil-in-water Pickering Emulsions (PEs) formed using non-amphiphilic nanoparticles (NPs) represent an alternative approach to oil dispersion. Physicochemical properties of PEs formed using silica NPs can be tuned with surface silanol (Si-OH) density, which controls surface hydrophobicity. Silica-based PEs are well documented, but the ability to form PEs in seawater has not been examined. We report the formation and characterization of oil-in-water PEs stabilized by commercially available non-porous and mesoporous 15 nm silica NPs in deionized water and artificial seawater as a function of NP concentration, oil composition, and silanol density. Our results demonstrate the ability control droplet size, stability, and concentration based on silanol density and NP porosity, and confirm NP biocompatibility.

Session: 004 - 26

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Tuesday, January 22 2:15 PM  
Type: Oral Presentation

## Nopal Cactus Extracts for Organic Compounds Water Remediation

**Presenter:** Jorge Lara – University of South Florida

**Authors:** Jorge Lara, University of South Florida; Daniela Stebbins, University of South Florida; Rosa Devesa, Universidad de Vigo; Norma Alcantar, University of South Florida

### Abstract:

Exxon-Valdez oil spill and the dispersive chemicals used during the March 1989 catastrophe has recently escalated collective reactions from environmental independent groups and scientific sectors about ailing and adding number of ceased cleanup personnel that helped during the event. Furthermore, during the Gulf of Mexico oil spill in 2010 the known dispersants were applied again amid the ecological calamity, sensitively alerting awareness on human health effects. In this line, previous research has been made where phyto-extracts of *Opuntia ficus-indica* (OFI) has shown flocculating activity when assessed in turbid waters contaminated with suspended particles and dissolved toxic metals. Results of OFI studies in petroleum derivatives contaminated water samples are to be presented, as this Nopal Cactaceae extracts are proposed as an environmental friendly water cleaning substance.

**Keywords:** oil spill, *Opuntia ficus-indica* (OFI), phyto-extracts, water remediation



# Science Abstracts

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## Session: 004 - 27

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Tuesday, January 22 2:30 PM  
Type: Oral Presentation

### A Smart Oil Spill Dispersant Formulation for Reduced Environmental Impact and Consumption

**Presenter:** Courtney Ober – Auburn University

**Authors:** Courtney A. Ober, Auburn University; Matthew J. DeCuir, Auburn University; Ram B. Gupta, Auburn University

#### Abstract:

Targeted delivery of an oil dispersing agent directly to an oil spill could significantly reduce the amount of dispersing agent needed. To this end, a “smart” dispersant formulation that microencapsulates the active ingredient of chemical dispersants, a surfactant, in a water-insoluble shell has been developed. In this formulation the surfactant payload is only released when in contact with oil, at which time the shell dissolves in the aromatic compounds present in the oil. The components used in this study were the surfactant, dioctyl sodium sulfosuccinate, and aromatic-soluble polymer, polystyrene. The particles were created by ultrasonically spray drying surfactant and polymer solutions and the kinetics of surfactant release from the coated microparticles studied using representative oil components and simulated sea water. This study demonstrates that novel core-shell surfactant-polymer microparticles, prepared by simplistic and scalable technologies such as spray drying, have significant potential for improving oil spill dispersion.

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## Session: 004 - 28

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Tuesday, January 22 2:45 PM  
Type: Oral Presentation

### Hydrophobic animals encounter hydrophobic droplets in the feeding current: the role of dispersants

**Presenter:** Kara Kunz – University of Wisconsin-Milwaukee

**Authors:** Kara Kunz, University of Wisconsin Milwaukee; Jeff Motschman, University of Wisconsin Milwaukee; Woo-Jin Chang, University of Wisconsin Milwaukee; J. Rudi Strickler, University of Wisconsin Milwaukee

#### Abstract:

Mixture of dispersant and crude oils in aquatic environments result in micro sized oil droplets. Dispersant coating the oil droplets result in an

assemblage that is both hydrophobic and hydrophilic. Filter feeders, like Daphnia, filter through these droplets because of their natural feeding currents. Carapaces of most macro- and micro zooplankters are made from chitin, which can have characteristics of a hydrophobic form. Using microfluidic devices to mimic oil droplets found in aquatic environments, we can visually observe the encounters between Daphnia magna and droplets. Droplets consist of different sizes and compositions from mineral oil and hydrocarbons (hexane, heptanes, and octane). Interaction between Daphnia and droplets will be observed with the change in dispersant ratio to water creating different hydrophilic coatings. Results from this experiment will be shown through video presentation.

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## Session: 004 - 29

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Tuesday, January 22 3:00 PM  
Type: Oral Presentation

### The fate of Corexit surfactants in coastal seawater: use of LC-time-of-flight-MS to characterize biodegradation and sorption

**Presenter:** Bruce Brownawell – Stony Brook University

**Authors:** Bruce Brownawell, Stony Brook University; Joseph Ruggieri, Stony Brook University

#### Abstract:

The persistence of intrinsically biodegradable 1,4-bis(2-ethyl-hexyl) sodium sulfosuccinate (DOSS) in the deep Gulf of Mexico (GOM) highlights the need to better understand the factors controlling the fate of dispersant components in marine ecosystems to allow better assessments of potential risks of dispersant use. Short-term incubations using Long Island Sound seawater were conducted to characterize the biodegradation and sorption of surfactant ingredients in Corexit 9500 and 9527 (DOSS, SPAN 80, Tween 80 and 85). DOSS was completely degraded over 2 days in a seawater sample collected in June from a harbor receiving treated wastewater, and a more persistent mono-ester product(s) was formed. However, DOSS was persistent in more pristine water from a saltwater marsh or in a harbor sample collected in winter. In contrast, SPAN 80 and Tween surfactants were substantially lost in each of the waters tested, suggesting that these nonionic surfactants may be biodegradable under a wider range of conditions. Ester hydrolysis products of Tween surfactants were observed along with relatively small polyethylene glycol oligomers that have been identified as degradation products of other polyethoxylated surfactants. The concentrations of surfactants used in these experiments were relatively low (low nM) compared to levels often used in standardized biodegradation testing, but much higher than that encountered in the deep GOM during the Deep

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Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Tuesday, January 22 3:30 PM  
Type: Oral Presentation

## Impact Of The Deepwater Horizon Oil Spill And Dispersant Application On Marine Bacterial Populations

**Presenter:** Suja Rajan – University of Alabama

**Authors:** Suja Rajan, University of Alabama Tuscaloosa; Nikaela Flournoy, University of Alabama Tuscaloosa; Melanie J Beazley, University of Alabama Tuscaloosa; Robert J Martinez, University of Alabama Tuscaloosa; Terry C Hazen, University Of Tennessee; Jizhong Zhou, University of Oklahoma; Patricia A Sobecky, University of Alabama Tuscaloosa

### Abstract:

The Deepwater Horizon (DWH) oil spill in April 2010 released more than 200 million gallons of crude oil into the Gulf of Mexico (GoM). In order to mitigate the impacts of the spill, approximately 2 million gallons of dispersants were applied at the ocean surface (1.06 million gallon, of COREXIT 9500A and 9527) and subsurface (0.78 million gallons COREXIT 9500A). The primary objective of our study is to determine coastal microbial community responses to hydrocarbon and dispersant impact as a result of this unprecedented oil spill event. The objectives of this research include (1) identifying the composition and genomic potential of the indigenous microbial communities to promote hydrocarbon degradation and; 2) To determine the impact of the dispersants used on coastal microbial communities. Relatively little is known about the impact that dispersants have on marine microbial communities and more specifically on the activity of marine hydrocarbon degraders. Water column and salt marsh sediments have been collected from our coastal study site, Point Aux Pines, Alabama. Total nucleic acids were extracted from samples collected prior to and during visible oiling of the coastal AL study site. Molecular-based analyses of microbial communities were conducted on the samples using the high-throughput microarrays for profiling of microbial populations and determining functional gene abundances. Marine bacteria isolated from (Point Aux Pines, AL) water column and salt marsh sediments samples were assayed for their tolerance to increasing concentrations of dispersants alone, and in combination with hydrocarbons. Preliminary cultivation-based analyses of bacterial tolerance to increasing concentrations of Corexit 9500A suggest that some marine bacteria were negatively affected even at the lowest concentrations tested. The toxicity of the dispersant appears to be attenuated when bacterial cells were exposed to a combination of dispersant and oil mixtures.

Water Horizon spill. At these concentrations sorption of the anionic DOSS was not significant, but nonionic SPAN and Tween surfactants were appreciably sorbed to suspended particles and glass fiber filters, with sorption of the polyethoxylated sorbitan oleates increasing with the number of hydrophobic oleate functional groups. Future work will characterize sorption isotherms of oil dispersant surfactants with GOM sediments to help inform whether sorption is likely to an important process affecting their fate and bioavailability.

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Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Tuesday, January 22 3:15 PM  
Type: Oral Presentation

## Sub-sea oil spill dispersant effectiveness. A new evaluation methodology

**Presenter:** Nicolas Passade-Boupat – Total

**Authors:** Nicolas Passade-Boupat, Total; Marianna Rondon Gonzalez, Total; Maurice Bourrel, Total; Anne Courbot, Total; Yannick Autret, Total

### Abstract:

During the Macondo accident, dispersants were injected sub-sea. This new type of injection seemed very efficient, but showed a knowledge gap: it was not known how effective dispersants formulated for surface would be for sub-sea injection or if the formulation rules and phenomena in sub-sea were the same as for surface. Additionally, no standard test existed to qualify additives for these injections.

This paper presents our results on these points, with the description of new experimental tests and protocols to simulate conditions closer to sub-sea injection. They allow screening several additives in limited time. The analysis of mechanisms at play, based on oil/water/surfactant formulation rules, allows understanding sub-sea dispersion phenomenology.

Using this approach and performing water/oil/additive screenings have allowed us to make a link between the physical chemistry behavior and the quality of dispersion.

This methodology allows not only screening additives for a given physical chemistry environment (type of oil, water chemistry) but also optimizing dispersants for sub-sea.



# Science Abstracts

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Session: 004 - 32

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Tuesday, January 22 3:45 PM  
Type: Oral Presentation

## Exploring the effect of macromolecular architecture on the self-assembly and stability of micelles prepared from polymer amphiphiles

**Presenter:** Scott Grayson – Tulane

**Authors:** Scott Grayson, Tulane University; Boyu Zhang, Tulane University; Yi Wang, Tulane University; Dawanne Poree, Tulane University

### Abstract:

The use of dispersants to break up hydrocarbon contaminants in aqueous environments remains the most attractive technique for reducing the negative ecological impact of oil spills. However, traditional small molecule surfactants (e.g. COREXIT 9500 and 9527) assemble into micelles via a concentration-dependent equilibrium process, which leads to disaggregation under the inevitable dilution that is achieved in a large open body of water. By making use of larger polymeric amphiphiles, the critical micelle concentration (the concentration at which disaggregation is favored) can be reduced, yielding more stable, effective micelles. Furthermore, by incorporating a high degree of branching within the macromolecular architecture, polymers can be obtained that are true “unimolecular micelles,” those that exhibit a micelle-like conformation as single, isolated molecules, and therefore can act as micelles even under infinite dilution.

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Session: 004 -

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Monday, January 21 16:30 - 18:30  
Type: Poster

## Aerosolization of Oil Spill Matter via Bursting Bubbles

**Presenter:** Paria Avij – Louisiana State University

**Authors:** Paria Avij, Louisiana State University; Franz S. Ehrenhauser, Louisiana State University; Kalliat T. Valsaraj, Louisiana State University

### Abstract:

The Deepwater Horizon Oil Spill released 4.9 million barrels of crude oil into the Gulf of Mexico. The fate of the oil is only partly known, with approximately one-quarter of the oil spill matter being unaccounted for.

Except for the evaporation of the low molecular compounds (up to C<sub>10</sub>), transfer of oil spill matter into the atmosphere has been largely neglected. This is in so far surprising as the production of aerosol and consequently particulate matter via bursting bubbles in whitecaps of breaking waves is well-known to be the dominant source for marine aerosols.

In order to investigate this pathway, we evaluate the ejection rates of particulate matter and its alkane content in the laboratory, allowing us to conclusively demonstrate the aerosolization of compounds with up to 40 carbon atoms. As this transport process is predominantly surface-driven, the effect of dispersants on the ejection rates of particles and oil spill matter is of particular interest and investigated in our studies.

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Session: 004 -

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Monday, January 21 16:30 - 18:30  
Type: Poster

## Oil-Dispersant Interactions at Different Hydraulic Pressures for Underwater Applications

**Presenter:** Jillian Berbakov – Florida International University

**Authors:** Jillian Berbakov, Florida International University; Urpiana Koklonis, Florida International University; Berrin Tansel, Florida International University; Mengshan Lee, Florida International University

### Abstract:

Oftentimes, oil pipelines must be placed thousands of feet underwater. The Deepwater Horizon was approximately 35,000 feet deep, and operated in over 4,000 feet of water. Unfortunately, sometimes, the pipes carrying crude oil may leak or break. In such events, application of oil dispersants at the point of leakage could be more effective before the oil reaches water surface. However, interaction of dispersants with oil as well as dispersion characteristics of oil can be significantly different from those observed with surface or near surface dispersant applications. For every 33 feet of depth in water, hydraulic pressure increases 1 atmosphere. The effects of increased hydraulic pressures on the oil-dispersants interactions were evaluated in laboratory conditions using Louisiana crude oil and Corexit 9500A. Mathematical analyses were performed based on laboratory data for effects of increased pressure as well as temperature on oil solubility and dispersion characteristics both in the presence and absence of dispersants.

# Science Abstracts

Session: 004 -

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Monday, January 21 16:30 - 18:30

Type: Poster

## Measurement techniques for ultrafast surfactant dynamics at oil/water interfaces

**Presenter:** Christopher V. H-H. Chen – Princeton

**Authors:** Christopher V. H-H. Chen, Princeton University; Bryan R. Benson, Princeton University; Howard A. Stone, Princeton University; Robert K. Prud'homme, Princeton University

### Abstract:

Our interest is in ultrafast (i.e. millisecond) measurements of surfactant processes at oil/water interfaces with application to dispersion processes. Microfluidics provides a tool for investigating interfaces at these time scales. Förster resonance energy transfer (FRET) is a biological tool used to image protein interactions with high spatial and temporal resolution. This makes FRET a prime candidate for visualizing the transport of surfactant to and along a drop interphase. We have synthesized a surfactant-dye as a FRET acceptor for this purpose, by oxidizing monomethoxy PEG to form a PEG aldehyde and then reductively aminating with Nile blue (NB) to form NB-PEG. Nile red and/or DiI will act as the FRET donors. We will visualize the movement of surfactants to drop interfaces with this FRET pair. Drops formed in the microfluidics channel can be imaged during breakup and transit down the channel until full coverage is attained. Imaging surfactant attachment to interfaces at these time scales will allow for the development of improved dispersants systems and improved understanding of mixing required for the attainment of low surface tensions required for oil dispersion.

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Date: Monday, January 21 16:30 - 18:30

Type: Poster

## Multifunctional Microgels for Release of Rheology Modifiers

**Presenter:** Haobo Chen – Arizona State University

**Authors:** Haobo Chen, Arizona State University; Lenore Dai, Arizona State University

### Abstract:

Solid particles serve as potential alternative dispersants in oil drilling, cleaning, and recovery. This poster presentation focuses on synthesis and characterization of microgel particles that are responsive to environmental stimuli such as pH and temperature. More importantly,

we have elucidated the effective encapsulation and release of rheology modifiers of these microgel particles. Such approach may offer a new way to engineer the viscoelasticity of oil-water interfaces.

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Date: Monday, January 21 16:30 - 18:30

Type: Poster

## Impacts of particle-based dispersants on benzene bioavailability and on viability of *Artemia franciscana* as a model organism

**Presenter:** Megan Creighton – Brown University

**Authors:** Megan Creighton, Brown University; April Rodd, Brown University; Charles Vaslet, Brown University; Agnes Kane, Brown University; Robert Hurt, Brown University

### Abstract:

Fine particles have been proposed as an alternative to the chemical dispersants typically deployed after an oil spill. This study examines carbon black as a model fine particle system that can stabilize oil droplets in the water column and also reduce the bioavailability of toxic aromatic petroleum fractions by adsorption. We study how functionalized carbon blacks of varying hydrophilicity interact with benzene as a model aromatic compound and with *Artemia franciscana* (brine shrimp) larvae as a model marine microcrustacean. Toxicity endpoints for the larvae include activation of stress responses, oxidative damage, reduced motility and death. The brine shrimp model will also build a foundation for future studies to assess bioaccumulation and trophic transfer using killifish. This model will provide important information on potential adverse environmental effects of particle-based dispersants deployed in the aftermath of an oil spill. This research is supported by BP/The Gulf of Mexico Research Initiative and NIEHS Training Grant T32 ES07272.

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Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Monday, January 21 16:30 - 18:30

Type: Poster

## Surface Grafting of Nanoparticles by divergent method, towards Amphiphilic Micelle-like Nanoparticles

**Presenter:** Muhammed Ejaz – Tulane University

**Authors:** Muhammad Ejaz, Tulane University; Scott M Grayson, Tulane University

# Science Abstracts

## Abstract:

Use of dispersants provides a benefit to affected ecosystem by breaking up oil into microdrops. Small molecule surfactants suffer from low stability and exhibit a critical micelle concentration (CMC). An attractive approach for improving the effectiveness of dispersants involves unimolecular micelles (UM). Because UM are covalently bond and cannot disaggregate, exhibit no CMC. Herein we explore synthesis of amphiphilic grafted nanoparticles (AGN) as CMC-independent UM dispersants. The synthesis of AGN will be achieved by grafting (divergent) amphiphilic block polymers onto silica cores by ring opening polymerization. Poly( $\epsilon$ -caprolactone) (PCL), is attractive for inner block as it can absorb non-polar compounds. The PCL inner block will be coupled with polyethylene glycol monomethyl ether to provide a highly water soluble corona. An alternative method for grafting amphiphilic block polymers is living radical polymerization. These approaches of divergent grafting lead to AGN that should effectively absorb oil particles as well as improve their colloidal stabilization in aqueous media.

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Date: Monday, January 21 16:30 - 18:30  
Type: Poster

## Trace Analysis of Anionic and Nonionic Surfactants from Oil Dispersants in Gulf of Mexico Seawater Using Large Volume Injection Liquid Chromatography

**Presenter:** Jennifer Field – Oregon State University

**Authors:** Jennifer Field, Oregon State University; Benjamin Place, Oregon State University; Ewan Sinclair, ALS Global

## Abstract:

In response to the Deepwater Horizon oil spill, 7 million liters of Corexit oil dispersants were applied in order to mitigate the environmental impact of the oil. In order to determine the environmental impact of the Corexit dispersant, an analytical method was developed using large volume (1800  $\mu$ L) direct injection liquid chromatography with tandem mass spectrometry (LVI-LC-MS/MS). The method included the detection of the surfactant components in the Corexit formulations: bis-(2-ethylhexyl) sulfosuccinate (DOSS), sorbitan monooleate (Span 80), sorbitan monooleate polyethoxylate (Tween 80), and sorbitan trioleate polyethoxylate (Tween 85), as well as the hydrolysis transformation products of DOSS ( $\alpha/\beta$ -2-ethylhexyl sulfosuccinate). The analytical method was applied to the analysis of Gulf of Mexico seawater from June 2010, including both surface and sub-surface samples. Concentrations of DOSS in the seawater samples ranged from 71 – 13,000 ng/L, while Span

80, Tween 80, Tween 85 were infrequently detected. The DOSS hydrolysis products were detected in seawater and Corexit formulations.

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Date: Monday, January 21 16:30 - 18:30  
Type: Poster

## Magnetite Nanoparticles Stabilized by p-Amino Benzoic Acid Terminated Carbon Black Particles for Oil Spill Remediation

**Presenter:** Etham Frenkel – Tulane University Department of Chemical & Biomolecular Engineering

**Authors:** Etham Frenkel, Tulane University; Pradeep Venkataraman, Tulane University; Olasehinde Owoseni, Tulane University; Arijit Bose, University of Rhode Island; Vijay T. John, Tulane University

## Abstract:

Particle-stabilized emulsions have recently gained attention as potential alternatives to dispersant based oil spill remediation methods. Para-amino benzoic acid (PABA) functionalized carbon black (CB) particles are interfacially active and can stabilize oil-in-water emulsions at high dilutions. In addition to their ability to absorb environmentally toxic polycyclic aromatics, the interfacial properties of these particles can be tuned by varying environmental factors such as ionic strength and pH. We propose an innovative cost-effective, environmentally benign technology for oil spill remediation using magnetite nanoparticles stabilized by PABA functionalized CB particles. We hypothesize that the carboxyl groups of the PABA attached to CB particles can conjugate with iron salts and can be reduced to synthesize magnetite nanoparticles. We employ powder X-Ray Diffraction, FTIR spectroscopy and transmission electron microscopy to characterize the surface chemistry and morphology of these composite particles. We investigate the ability of the composite particles to form oil-in-water emulsions of these particles under varying conditions of pH and ionic strength of the continuous phase. We propose that the magnetic properties imparted by magnetite and tunable surface properties due to PABA functionalized CB particles make these composite particles attractive agents for oil emulsification and enhanced surface oil removal.

# Science Abstracts

Session: 004 -

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Monday, January 21 16:30 - 18:30  
Type: Poster

## Simulations-based Design of a Hydrophobically-modified Chitosan Dispersant

**Presenter:** Carol Hall – North Carolina State University

**Authors:** Carol K. Hall; North Carolina State University; Steven Benner, North Carolina State University; Jan Genzer, North Carolina State University; Vijay T. John, Tulane University

### Abstract:

The goal of this research is to develop a biocompatible oil dispersant that effectively stabilizes the oil/water interface, with minimal negative effects upon aquatic life. The backbone of these dispersants is chitosan, a naturally-occurring polysaccharide found in the exoskeletons of ocean crustaceans, with hydrocarbon groups attached at selective locations on the backbone to achieve amphiphilic behavior. The aim of this work is to learn how to attach hydrocarbon chains along the chitosan sequence such that the resulting hydrophobically-modified chitosan tends to adopt conformations that wrap around oil molecules. A novel approach is being examined in which the hydrophobic modifications (aldehyde molecules with a reactive hydroxide group) are first assembled into micelles and then exposed to chitosan molecules which react with hydroxide molecules on the micellar periphery. The results of proof-of-concept molecular dynamics simulations of systems of containing model aldehyde, chitosan, water and oil molecules, all modeled on a coarse-grained level, are described.

Session: 004 -

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Monday, January 21 16:30 - 18:30  
Type: Poster

## Molecular dynamics simulations of oil hydrocarbons and surfactants at atmospheric air/salt water interfaces

**Presenter:** Francisco Hung – Louisiana State University

**Authors:** Thilanga P. Liyana-Arachchi, Louisiana State University; Kalliat T. Valsaraj, Louisiana State University; Francisco R. Hung, Louisiana State University

### Abstract:

A significant fraction of the oil released during the 2010 DWH accident accumulated at the sea surface. According to recent studies, the volatile

organic compounds (VOCs), as well as some intermediate volatiles (IVOCs) evaporated into the atmosphere and formed aerosols. However, the fate of other organics, such as heavier IVOCs (C17-C18) and semi-volatiles (SVOCs, C19-C31) has not been addressed so far. We hypothesize that these compounds didn't evaporate but remained in the sea surface, and phenomena such as bubble-bursting and white caps carried these compounds, as well as part of the dispersants released to combat the spill, into the atmosphere. We report molecular dynamics (MD) simulations of chain alkanes, e.g., pentadecane (C15) and icosane (C20), at atmospheric air/salt water interfaces. The effects of varying concentrations of these alkanes, as well as varying amounts of a standard surfactant, sodium dodecyl sulfate (SDS), on the interfacial properties of these systems is investigated.

Session: 004 -

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Monday, January 21 16:30 - 18:30  
Type: Poster

## Modified Polysaccharides as Synergistic Dispersants

**Presenter:** Vijay John – Tulane University

**Authors:** Pradeep Venkataraman, Vijay John, Jingjian Tang, Tulane University;

Srinivasa Raghavan, University of Maryland,

### Abstract:

A key challenge in the treatment of oil spill with dispersant is to break oil slicks into stable small droplets which remain suspended in the water column and are biodegraded. The objective of this research is to enhance effectiveness of dispersant through the application of environmentally benign biopolymers that greatly improve the colloidal stability. We focus on hydrophobically modified polysaccharides where alkyl groups are attached to the polymer backbone. These hydrophobic side chains anchor in the oil phase resulting in the formation of a protective polymer layer around the droplet. Cryogenic Scanning Electron Microscopy images of the colloidal dispersion of oil in saline water created by the use of dispersant and the biopolymer prove the presence of a polymer layer around oil droplets. Turbidimetric and zeta potential measurements of the dispersions confirm an significantly enhanced colloidal stability. The systems imply a significantly lower usage of chemical dispersants.

# Science Abstracts

Session: 004 -

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Monday, January 21 16:30 - 18:30

Type: Poster

## Interfacial Activity of Homopolymer Grafted Nanoparticle

**Presenter:** Daehak Kim – Univ of Houston

**Authors:** Daehak Kim, Ramanan Krishnamoorti, University of Houston

### Abstract:

The oil-water interfacial tension is reduced when nanoparticles segregate to the oil-water interface and this segregation is governed by the inter-particle interactions of the nanoparticles. The inter-particle interaction can be tuned by grafting hydrophilic polymers such as poly-(oligo(ethylene oxide) monomethyl ether methacrylate) on the nanoparticles using a living radical atom transfer polymerization technique. We have studied the nature of inter-particle interactions of such nanoparticles using interfacial tension, and their structure at the interface using grazing incidence small angle X-ray scattering (GISAXS).

Session: 004 -

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Monday, January 21 16:30 - 18:30

Type: Poster

## Photo-induced Degradation of COREXIT Constituents

**Presenter:** Stephanie Kover – University of Colorado Boulder

**Authors:** Stephanie Kover, Fernando Rosario-Ortiz, Karl Linden, University of Colorado Boulder

### Abstract:

In 2010, an estimated 7.9 million L of the chemical dispersants COREXIT 9500 and 9527 were applied to open ocean waters in Gulf of Mexico as part of the response to the Deepwater Horizon blowout. This research focuses on elucidating the contribution of sunlight-driven processes to the degradation of solvent constituents of these dispersant mixtures to aid in optimizing oil spill responses through efficient dispersant application. Specifically, the compounds 2-butoxyethanol and 1,2-propylene glycol were examined. As solvents, these constituents allow the active ingredients within dispersant mixtures to penetrate oil films and interact at the oil-water interface; small changes made to solvent concentration based on spill location and solar flux may prevent unnecessary dispersant over-application. Irradiation experiments in laboratory water determined the rates of direct photolysis of 2-butoxyethanol and 1,2-propylene glycol.

To determine the rates of indirect photolysis, irradiation experiments were conducted in Gulf of Mexico seawater and Macondo crude oil matrices.

Session: 004 -

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Monday, January 21 16:30 - 18:30

Type: Poster

## Elucidating Mechanisms of Chemical Oil Dispersant Action

**Presenter:** Alon McCormick – University of Minnesota

**Authors:** Alon McCormick, David Riehm, University of Minnesota

### Abstract:

Although variations in oil dispersant effectiveness (as a function of dispersant composition, seawater temperature and salinity, ambient mixing energy, etc.) are well-documented in the literature, clear explanations of these trends have yet to be developed. We seek explanations in terms of the molecular-level interactions between a) the mix of surfactants and solvents found in dispersants, b) crude oil, and c) seawater. We are beginning to use measurements of the crude oil dispersion effectiveness of mixtures of Tween 80, Span 80, and Aerosol OT in a paraffinic solvent as a function of dispersant composition and of dispersion temperature. We intend to correlate these with measurements of "molecular-level" properties, including surface tension, molecular displacement kinetics, and packing parameters.

Session: 004 -

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Monday, January 21 16:30 - 18:30

Type: Poster

## Effect of Pressure on the Aggregation of Surfactant Micelles

**Presenter:** Bin Meng – Tulane University

**Authors:** Bin Meng, Hank Ashbaugh, Tulane University

### Abstract:

In deep sea application of dispersants pressure can have a significant effect on their self-assembly and solubilization power. We have undertaken a molecular simulation study to piece apart the molecular-level contributions to pressure induced disaggregation of micelles. Three different surfactant molecules including anionic surfactant sodium decyl sulfate (SDeS), cationic surfactant decyl trimethyl ammonium bromide



# Science Abstracts

(DTAB) and non-ionic surfactant penta ethylene glycol monodecyl ether (C<sub>10</sub>E<sub>5</sub>) are studied through all-atom molecular dynamics simulation on GROMACS software using generalized amber force field in NPT ensemble with periodic boundary conditions. Above the critical micelle concentration (CMC), the surfactant molecules can aggregate to form micelle in water that causes the partial molar volume (PMV) to transform from single surfactant molecule dissolving in water to micelle dissolving in water. The difference of PMV is calculated by subtracting the simulation result of one surfactant molecule in water from one micelle with 40 surfactant molecules in water for pressure increasing from 1 bar to 2500 bar. The fact that the CMC changes from increasing to decreasing when pressure increases indicates that the difference of PMV changes from a positive value to a negative value, which is consistent with the simulation result. In addition, Kirkwood-Buff theory is used to investigate the tail and head group contribution of surfactant molecule to PMV through proximal correlation functions.

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Session: 004 -

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Monday, January 21 16:30 - 18:30  
Type: Poster

## Analysis of DOSS and its degradates by LVI-LC/ESI-MS/MS

**Presenter:** Matt Perkins – Oregon State University

**Authors:** Matt Perkins, Jennifer Field, Oregon State University

### Abstract:

Approximately 200 million gallons of Corexit was applied in the Gulf of Mexico in response to the Macondo oil spill of 2010. Corexit, a surfactant, is capable of reducing the interfacial tension between aqueous and oil phases, reducing oil droplet size and potentially mitigating some environmental impacts of the spill. The scale of such environmental dispersion of surfactants is unprecedented and little knowledge of the ultimate fate of Corexit in the marine environment has been reported. The environmental presence of the major constituents of Corexit, Span 80, Tween 80, Tween 85, as well as, DOSS and its suspected degradation products, is reported for depth specific water column samples collected from priority sites in the Gulf of Mexico in 2012. These values are compared to those for samples collected from similar sites in 2010 and 2011. Additionally, a preliminary method for the extraction and quantification of DOSS and its degradates from marine sediment, using large volume LC/ESI-MS/MS, is presented.

Session: 004 -

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Monday, January 21 16:30 - 18:30  
Type: Poster

## Fabrication of a Standard Leaf Mimic to study Interactions of Oil droplets with Marshland Grasses

**Presenter:** Noshir Pesika – Tulane University

**Authors:** Noshir Pesika, David Cutting, Joseph Cremaldi, Tulane University

### Abstract:

Oil, in the form of a sheen or droplets, has been found to spontaneously spread onto marshland grass leaves, which contributes to wetland loss. In an effort to understand the interaction of oil with marshland grass, we have developed a standard leaf mimic with similar physical and chemical properties as natural marshland grass. The standard leaf mimic minimizes experimental variations due to plant species, age and history in studies involving the interaction of oil with surfaces. Data on the physical and chemical properties of the leaf mimic will be presented. Initial experimental data on the interaction of oil droplets with the leaf mimic under salt water will also be shown.

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Session: 004 -

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Monday, January 21 16:30 - 18:30  
Type: Poster

## Surfactant Effect on the dynamics of BP crude oil droplet in a water column

**Presenter:** Abhijit Rao – Louisiana State University

**Authors:** Abhijit Rao, Louisiana State University, Rupesh K Reddy, Louisiana State University; Krishnaswamy Nandakumar, Louisiana State University; Kalliat T Valsaraj, Louisiana State University; Franz S Ehrenhauser, Louisiana State

### Abstract:

The present study tries to analyze the effect of surfactant addition on the dynamics of crude oil droplet. Experiments were conducted in a tank with a capacity of about 100 liters. A single oil droplet was released into the quiescent water column through a nozzle (2 cm in diameter) and the droplet rise time, the time taken by droplet to reach the water-air interface, was noted. The shape adopted by the emanating droplets was observed to vary from spherical to oblate. However, when the surfactant was added to water column the reduction of interfacial tension caused the droplet to flatten. This caused the drag coefficients to increase and

# Science Abstracts

consequently the rise time was observed to increase nearly by two folds. In addition to the effect of surfactant, we also studied the effect of bulk convection on the fate of the crude oil droplet.

A numerical model based on Volume of Fluid method was used to emulate the above experimental observations. The mass transfer of surfactant from continuous to dispersed phase was accounted for, by including species transport equation in the model.

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## Session: 004 -

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Monday, January 21 16:30 - 18:30  
Type: Poster

### Structural Changes in BP Crude Oil During Degradation

**Presenter:** Amitava Roy – Louisiana State University

**Authors:** Amitava Roy, Louisiana State University, Baton Rouge, LA; Henning, Lichtenberg, Karlsruhe Institute of Technology, Germany, Edward, Overton, Louisiana State University, Baton Rouge, LA, ebovert@lsu.edu

#### Abstract:

Crude oil samples from BP's Macondo well were analyzed by small and wide angle X-ray scattering (SAXS and WAXS). The samples were: a) fresh crude oil from the riser pipe; b) oil subjected to controlled burn; c) oil from near Venice, Louisiana; d) emulsified oil and e) tar balls. In addition, samples included fresh crude oil treated with two dispersants.

Petroleum or crude oil is a mixture of four hydrocarbon fractions: saturates, aromatics, resins and asphaltenes. A slight change in the equilibrium condition can lead to aggregation of the asphaltene fractions. This process is known to create problems during production and transportation of crude oil.

Both SAXS and WAXS show distinct changes in oil properties during emulsification, burning and treatment with dispersant.

## Session: 004 -

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Monday, January 21 16:30 - 18:30  
Type: Poster

### Characterization of a Natural Surfactant

**Presenter:** Paul Russo – Louisiana State University

**Authors:** Wayne Huberty, Louisiana State University; Paul Russo/Louisiana State; Brad Blalock/Louisiana State; Michael Pham/Louisiana State

#### Abstract:

Hydrophobins, a family of proteins produced by fungi, are among nature's most surface-active materials. As such, they offer potential for green chemistry initiatives, environmental remediation, and perhaps novel materials science. Cerato ulmin is one member of the hydrophobin family. An unusual feature of CU is its propensity to form and stabilize air bubbles and oil blobs of unusual shape. These entities sometimes fall into the range of sizes that can be characterized by standard methods of polymer and colloid science. The conditions of pressure, temperature, salt and pH which support the formation of these unusual structures will be discussed, along with scattering and microscopic investigations of their remarkable stability. Acknowledgment is made to Dr. Wayne C. Richards of the Canadian Forest Service for the gift of Cerato ulmin. Supported by Gulf of Mexico Research Initiative.

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## Session: 004 -

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Monday, January 21 16:30 - 18:30  
Type: Poster

### Analysis of Gulf Seafood Samples for Diocylsulfosuccinate (DOSS)

**Presenter:** Darrell Sparks – Miss State Chem Lab

**Authors:** Darrell Sparks, MSCL, Jack Atkins, Cindy Foster, Ashley Meredith, Ashli Brown, Kevin Armbrust - MSCL

#### Abstract:

As part of the cleanup efforts of the Deepwater Horizon oil spill, chemical dispersants were used to protect the Gulf of Mexico ecosystem. Ultimately, about 1.84 million gallons of Corexit® dispersants were used during the aftermath of the oil spill. The active ingredient in Corexit® dispersants is dioctylsulfosuccinate (DOSS). As part of a long-term monitoring program, the Mississippi State Chemical Laboratory receives Gulf samples monthly for DOSS analysis via an Agilent 1290 Infinity Liquid Chromatograph coupled to an Agilent 6430 Triple-Quadrupole Mass Spectrometer. Although no samples received have shown the



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presence of DOSS, there is concern that DOSS metabolites may be present but are not monitored. In this poster, the analytical procedure for DOSS will be outlined and a plan of work for monitoring DOSS metabolites as part of the Phase II Gulf of Mexico Research Initiative will be provided.

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Session: 004 -

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Monday, January 21 16:30 - 18:30  
Type: Poster

## Investigating the Effects of Nanoparticle Size on Pickering Emulsion Formation and Stability

**Presenter:** Pranav Vengsarkar – Auburn University

**Authors:** Pranav, Vengsarkar, Department of Chemical Engineering, Auburn University; Christopher B., Roberts, Department of Chemical Engineering, Auburn University

### Abstract:

Nanoparticle (NP)-stabilized Pickering emulsions offer opportunities to create oil-in-water emulsions applicable to oil spill cleanup. The objective of this project is to improve our understanding of the influence that NP size and size distribution have on the formation of Pickering emulsions and their stability. In this work, fatty acid capped iron oxide NPs have been synthesized and dispersed in various organic solvents and subsequently size-selectively fractionated into distinct particle size distributions for these Pickering emulsion formation and stability investigations. Specifically, this work utilizes a novel CO<sub>2</sub>-expanded liquid nanoparticle fractionation technique to establish the impact that precise size adjustment of iron oxide NPs has on the principal emulsion properties. These iron oxide NPs have been characterized using various techniques such as XRD, FTIR and TEM in order to understand the effect of ligand structure on the fractionation process as well as the NP-dispersion stability.

Session: 004 -

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Monday, January 21 16:30 - 18:30  
Type: Poster

## Modified Polysaccharides as Synergistic Dispersants

**Presenter:** Pradeep Venkataraman – Tulane University

**Authors:** Pradeep Venkataraman, Tulane University, Vijay John, Tulane University; Gary McPherson, Tulane University; Etham Frenkel, Tulane University; Jingjian Tang, Tulane University; Srinivasa Raghavan, University of Maryland

### Abstract:

A key challenge in the treatment of oil spill with dispersant is to break oil slicks into stable small droplets which remain suspended in the water column and are biodegraded. The objective of this research is to enhance effectiveness of dispersant through the application of environmentally benign biopolymers that greatly improve the colloidal stability. We focus on hydrophobically modified polysaccharides where alkyl groups are attached to the polymer backbone. These hydrophobic side chains anchor in the oil phase resulting in the formation of a protective polymer layer around the droplet. Cryogenic Scanning Electron Microscopy images of the colloidal dispersion of oil in saline water created by the use of dispersant and the biopolymer prove the presence of a polymer layer around oil droplets. Turbidimetric and zeta potential measurements of the dispersions confirm an significantly enhanced colloidal stability. The systems imply a significantly lower usage of chemical dispersants.

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Session: 004 -

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Monday, January 21 16:30 - 18:30  
Type: Poster

## Enhanced removal of surface oil spill using magnetic carbon microspheres and hydrophobically modified biopolymer

**Presenter:** Pradeep Venkataraman – Tulane University

**Authors:** Pradeep Venkataraman, Tulane University; Vijay John, Tulane University; Gary McPherson, Tulane University; Bhanukiran Sunkara, Tulane University; Sukshma Fating, Tulane University; Srinivasa Raghavan, University of Maryland

### Abstract:

The removal and recovery of surface oil from a spill is one of major methods employed in oil spill remediation. Magnetic nanocomposites have gained a lot of attention as agents in oil removal applications. We describe a novel technology for enhancing removal of surface oil by

# Science Abstracts

successive addition of magnetic carbon microspheres and hydrophobically modified chitosan (HMC). The magnetic carbon microspheres are synthesized using an aerosol based process using inexpensive precursors such as sucrose and iron sulfate. The iron oxide particles embedded in carbon matrix have affinity to crude oil and remain in the oil phase. The alkyl chains attached to chitosan polymer backbone anchor at the oil water interface allowing the polymer to wrap around the oil droplets and tether them together. The cryogenic scanning electron microscope images of show that the oil droplets containing carbon particles are bound together by HMC is a gel-like matrix. The measurement of dynamic modulus of the oil phase shows shear thinning gel-like characteristics. This gel-like phase of crude oil droplets containing magnetic carbon spheres can be removed as an aggregate using a strong magnet resulting in enhanced recovery of crude oil.

have found that silica particles alone were unable to stabilize toluene-water or n-hexadecane-water emulsions, whereas Pluronic F127®, can stabilize these emulsions more effectively. We were however, able to successfully achieve an increase in emulsion stability by adding silica particles to samples with low surfactant concentrations (where the surfactant alone does not provide stable emulsions), thus demonstrating that particles and surfactants can act synergistically to stabilize emulsions.

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## Session: 004 -

Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases

Date: Monday, January 21 16:30 - 18:30

Type: Poster

## Emulsion Stabilization by Silica Particles and Non-ionic Block Copolymers

**Presenter:** Lee Joan Villafuerte – University at Buffalo, SUNY

**Authors:** Lee Joan Villafuerte, Worcester Polytechnic Institute; Alecia Bernard, SUNY Buffalo; Ashley Guerrette, SUNY Buffalo; Ankitkumar I. Fajalia, SUNY Buffalo; Marina Tsianou, SUNY Buffalo

### Abstract:

About 2 million gallons of chemical dispersants were used in the clean-up efforts of the worst oil spill in the US history resulting from the April 20, 2010 BP/Deepwater Horizon accident. Such large amounts of dispersants cause concerns for the wildlife and humans exposed to them. In this work we evaluate the emulsification behavior of oil components with addition of particles and surfactants in order to facilitate the reformulation of dispersants so as to render them more effective for deep-water applications as well as safer toward the environment. We have employed silica particles (LUDOX TM50™, with average diameter of 26 nm and surface area of ~140 m<sup>2</sup>/g) and a non-ionic block copolymer (Pluronic F127®, PEO100-PPO70-PEO100) and we have investigated their effectiveness in stabilizing oil-in-water emulsions. Emulsions were prepared using toluene as an aromatic hydrocarbon component and n-hexadecane as an aliphatic hydrocarbon. Emulsion stability was evaluated by means of phase behavior. Emulsified samples were visually inspected to determine the volume fractions of emulsion, aqueous, and oil phases and their changes over time. Optical microscopy images of emulsion droplets were used for the droplet size distribution characterization. We

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## Session: 005 Ecosystems of the Open Ocean: Microbes Mammals and Models—Lower Trophic Level Studies

Session: 005 - 1  
Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Lower Trophic Level Studies

Date: Wednesday, January 23 10:30 AM  
Type: Oral Presentation

### Plankton Dynamics Following the BP Oil Spill

**Presenter:** Kendra Daly – University of South Florida

**Authors:** Kendra Daly, University of South Florida; L. Schwierke-Wade, University of South Florida; K. Dreger, University of South Florida; S. Murasko, Florida Fish and Wildlife Research Institute; D. Outram, University of South Florida; A. Remsen, University of South Florida

#### Abstract:

Here we report the results of 15 cruises to investigate plankton dynamics during and after the Deep Water Horizon oil spill. Maximum chlorophyll ( $2 \mu\text{g L}^{-1}$ ) and detritus concentrations ( $62,470 \text{ per m}^3$ ) occurred during August 2010, less than one month after capping the wellhead and concomitant with a surface low salinity layer in the NE GOM. Oiled detritus likely contributed to the flux of oil to the seafloor. Phytoplankton also showed a reduced photosynthetic capacity in near-surface waters compared to following months. In addition, total zooplankton abundance was about 2x lower during August 2010 compared to abundances during September 2011. Zooplankton abundance and diversity are generally highest nearshore and decrease offshore. Copepods are the dominant component (55 -90%) of the zooplankton community, followed by ostracods, chaetognaths, larvaceans, and decapods. A change in copepod species composition occurred during summer 2011. The historically dominant nearshore copepod, *Centropages velificatus* (2010 maximum abundance:  $1,284 \text{ ind m}^3$ ), had very low densities and was replaced by *Temora turbinata* (2011 maximum abundance:  $643 \text{ ind m}^3$ ) as the dominant species.

Session: 005 - 2

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Lower Trophic Level Studies

Date: Wednesday, January 23 10:45 AM  
Type: Oral Presentation

### Response of zooplankton assemblages from the Alabama inner shelf to the Deepwater Horizon oil spill : fisheries implications

**Presenter:** Frank Hernandez – University of Southern Mississippi

**Authors:** Frank Hernandez, University of Southern Mississippi; Laure Carassou, Rhodes University; William Graham, University of Southern Mississippi

#### Abstract:

Variability in the recruitment of marine fishes to adult populations is largely related to the variability encountered in vital rates during the larval stages. Therefore Deepwater Horizon (DWH) related impacts on ichthyoplankton may have profound effects on future recruitment and fishery yields. A long-term plankton survey (Fisheries Oceanography of Coastal Alabama, Dauphin Island Sea Lab) provided baseline (2005-2009) and impact (2010) samples to examine zooplankton and ichthyoplankton abundances, distribution and assemblage dynamics in relation to the DWH event. Correspondence Analysis for May-August zooplankton data indicated that 2010 assemblages fell outside the historic 2005-2009 distribution for the months of May and June. Results of ANOSIM confirmed statistical differences in zooplankton community structure between pre-spill years and 2010 during these months. Principal Component Analysis of environmental conditions (water temperature, atmospheric pressure, NAO index, wind speed, Mobile Bay discharge, SO index, cross-shore wind, along-shore wind) observed between May and August on the Alabama shelf indicated that 2010 conditions fell within the range of historic values, which suggested the shift in zooplankton community structure may be related to the DWH event. This documented change in zooplankton community composition may have implications for larval fish survival (e.g., "match-mismatch" dynamics), therefore species-specific information on the phenologies, abundances, and distributions of larval fishes, their zooplankton prey, and the factors that affect the variability in these parameters is needed to quantify and predict changes in planktonic food webs due to the DWH event that may ultimately affect the success of future fish populations.

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Session: 005 - 3

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Lower Trophic Level Studies

Date: Wednesday, January 23 11:00 AM  
Type: Oral Presentation

## Effects of crude oil exposure on survival and PAH bioaccumulation of adult and larval stages of gelatinous zooplankton (Scyphozoans and Ctenophores)

**Presenter:** Rodrigo Almeda – University of Texas at Austin

**Authors:** Rodrigo Almeda, The University of Texas at Austin; Zucheng Wang, East China Normal University; Zoe Wambaugh, Humboldt State University; Cammie Hyatt, The University of Texas at Austin; Zhanfei Liu, The University of Texas at Austin; Edward Buskey, The University of Texas at Austin

### Abstract:

Gelatinous plankton, including scyphozoans and ctenophores, play an important role in marine food webs both as major consumers of metazooplankton and as prey of apex predators, but little is known about the effects of crude oil on gelatinous plankton. In this study we determined the effects of suspended crude oil on survival and bioaccumulation of polycyclic aromatic hydrocarbons (PAHs) in scyphozoans and ctenophores. Adult and larval stages of scyphozoans (*Pelagia noctiluca*, *Aurelia aurita*) and ctenophores (*Mnemiopsis leidyi*) were exposed to crude oil concentrations ranging from 0.1 to 25  $\mu$ L L<sup>-1</sup> (equivalent to PAH concentrations of ca. 0.21 to 53 ppb, respectively) during incubations of 1-6 days. Pelagic scyphozoan, *Pelagia noctiluca*, and larval developmental stages of gelatinous plankton (scyphozoan ephyra larvae and *M. leidyi* cydippid larva) were highly sensitive to exposure to crude oil with mortality ranging from 50% to 100% depending on crude oil concentration and exposure time. Data on the bioaccumulation of PAH by gelatinous plankton will also be presented.

Session: 005 - 4

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Lower Trophic Level Studies

Date: Wednesday, January 23 11:15 AM  
Type: Oral Presentation

## Potential Food Web Impacts Following the Deep Water Horizon Oil Spill: Toxicity Effects on Phytoplankton and Zooplankton

**Presenter:** Amber Garr – Harbor Branch Oceanographic @ FAU

**Authors:** Amber Garr, Harbor Branch Oceanographic Institute at Florida Atlantic University; Susan Laramore, Harbor Branch Oceanographic Institute at Florida Atlantic University; Will Krebs, Harbor Branch Oceanographic Institute at Florida Atlantic University

### Abstract:

To better understand the potential impacts of the DWH oil spill on lower trophic level food sources, a series of experiments were conducted with rotifers and two microalgae species. The acute toxicity of oil, dispersant, and dispersed oil on *Brachionus plicatilis* survival (LC<sub>50</sub>), and growth inhibition (IC<sub>50</sub>) of *Isochrysis galbana* (clone T-iso) and *Chaetoceros* sp. were determined. There was no impact on cell division (growth) for either phytoplankton exposed to oil and mean motility of *Isochrysis* sp. never dropped below 79%. However, the addition of dispersant inhibited cell division and motility within 24 hrs. IC<sub>50</sub> levels ranged from 44 to 638 mg/L for dispersed oil solutions. Initial rotifer mortality was greatest in those exposed to the dispersant, but within 48 hrs the impact of exposure to dispersed tar mat oil was equally detrimental. LC<sub>50</sub> values ranged from 7 to 707 mg/L for oil exposure and 1 to 140 mg/L for dispersed oil over the 96 hr period. Results from these studies indicate that phytoplankton motility and rotifer survival can be negatively impacted by oil spills.

Session: 005 - 5

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Lower Trophic Level Studies

Date: Wednesday, January 23 11:30 AM  
Type: Oral Presentation

## Toxicity of Waters Contaminated by the Deepwater Horizon Oil Spill: Then and Now

**Presenter:** John Paul – University of South Florida

**Authors:** John Paul, University of South Florida; Jennifer Delaney, Harvard University; Jonelle Basso, University of South Florida

### Abstract:

The Deepwater Horizon Oil spill is unparalleled amongst environmental hydrocarbon releases, because of the tremendous volume of oil, the additional contamination by dispersant, and the oceanic depth at which this occurred. Here, we present evidence of acute and chronic impacts on marine plankton resulting from oil and dispersant from the Deepwater Horizon oil spill based upon sampling that occurred in July and August 2010. Three of 14 stations were toxic to bacteria based on the Microtox assay, four of thirteen were toxic to phytoplankton via the QwikLite assay, and six of 14 (43%) showed DNA damaging activity using the  $\square$ -Microscreen Prophage induction assay. The Microtox and Microscreen assays indicated that the degree of toxicity was correlated to total petroleum hydrocarbon concentration. Subsequent to that we have returned to the environs of the DWH disaster for seven cruises (179 stations) and to the West Florida shelf for four cruises (45 stations) over the past two years. The highest Microtox values occurred in August 2010 in the environs of the DWH while the WFS Southern Transect had maximal Microtox values in August 2012. The Northern Transect of the

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WFS had detectable water column toxicities in June of 2011. Whether this toxicity is from the slow movement of recalcitrant hydrocarbons from the DWH spill onto the WFS or other phenomena is not known. Over the past two years QwikLite toxicity has been more frequently encountered than the Microtox toxicity as well as a migration of the former to subsurface waters.

Session: 005 - 6

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Lower Trophic Level Studies

Date: Wednesday, January 23 11:45 AM  
Type: Oral Presentation

## Petroleum Metabolism by Northern Gulf of Mexico Vibrios

**Presenter:** D. Grimes – The University of Southern Mississippi

**Authors:** D. Jay Grimes, University of Southern Mississippi; Samantha L. Allen, William Carey University; Hang Nguyen, Mississippi Gulf Coast Community College; Adrienne R. Flowers, The University of Southern Mississippi; Kimberly J. Griffitt, The University of Southern Mississippi; Marcia L. Pendleton, The University of Southern Mississippi

### Abstract:

Vibrios were reported to metabolize hydrocarbons by Zobell's group in 1943. This metabolic capability was later established conclusively by Walker and Colwell in the 1970s, including demonstration that Vibrios have the ability to utilize polycyclic aromatic hydrocarbons (PAHs). Recently, Grimes showed that three strains of genomically sequenced *Vibrio* spp. contained aromatic ring cleavage genes necessary for PAH utilization. In this presentation it will be shown that a variety of *Vibrio* spp. including *V. cholerae*, *V. harveyi*, *V. parahaemolyticus* and *V. vulnificus*, can utilize Macondo Canyon 252 oil, naphthalene and phenanthrene as their sole source of carbon and energy. Specifically, out of 48 strains of bacteria examined (40 of which were Vibrios), 28 strains of *Vibrio* grew on naphthalene and 28 strains grew on phenanthrene. All 48 strains of bacteria will be examined for dioxygenase genes using a universal dioxygenase PCR primer (the 78-bp Rieske iron-sulfur center common to all PAH dioxygenases) and this work is now underway. The work on MC252 oil, using oil collected from the top hat by Hazen's group, has not yet begun but will be completed later this year; based on preliminary testing with *V. cholerae*, *V. parahaemolyticus* and *V. vulnificus* it is anticipated that most of the Vibrios will grow on this crude oil.

Session: 005 - 7

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Lower Trophic Level Studies

Date: Wednesday, January 23 12:00 PM  
Type: Oral Presentation

## FUNCTION OF RHODOLITHS AS SEEDBANKS IN POST-SPILL NW GULF OF MEXICO DEEP BANKS: A NOVEL AND UNEXPLORED CONCEPT

**Presenter:** Suzanne Fredericq – University of Louisiana at Lafayette

**Authors:** Suzanne Fredericq, University of Louisiana at Lafayette; Thomas Sauvage, University of Louisiana at Lafayette; Joseph Richards, University of Louisiana at Lafayette; Olga Camacho, University of Louisiana at Lafayette; William Gardiner, University of Louisiana at Lafayette; Dagoberto Venera Ponton, University of Louisiana at Lafayette; William Schmidt, University of Louisiana at Lafayette

### Abstract:

We will illustrate and discuss how the 2010 Deepwater Horizon oil spill that caused a dramatic die-off of mature seaweeds in hard bank habitats (45-90m) at two sites offshore Louisiana was an epiphany about the apparent vital role of rhodoliths/rubble as seedbanks for community regeneration (albeit one that is still currently suppressed in the hard bank ecosystem). Dredged algal-denuded rubble maintained in 20-gallon salt-water tanks in our laboratory gradually became covered by a suite of red, green and brown seaweed germlings that to this day continue to grow to adult size, reproduce, go through a series of temporal biomass decline and subsequent regrowth reflecting pre-spill species composition at each site. The rate of algal succession is being documented by weekly digital photography and taxonomic identity is confirmed by ongoing molecular barcoding and morphological evidence. Furthermore, in order to assess how offshore benthic seaweeds respond to and recover from differential exposure to hydrocarbon insult, we will present preliminary transcriptome analysis data from species selected on the basis of their ecological importance, common presence throughout the NW Gulf, and divergent evolutionary histories.



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Session: 005 - 8

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Lower Trophic Level Studies

Date: Wednesday, January 23 12:15 PM  
Type: Oral Presentation

## Deepwater Horizon Oil Spill: Assessment of Potential Impacts to the Offshore Benthos Along the Northeastern Gulf of Mexico Shelf

**Presenter:** Jeffrey Hyland – NOAA

**Authors:** Jeff Hyland, NOAA; Cynthia Cooksey, NOAA; Mike Fulton, NOAA; Ed Wirth, NOAA; Terry Wade, TAMU-GERG

### Abstract:

A field survey was conducted in August 2010 on the NOAA Ship Nancy Foster to assess potential impacts of the Deepwater Horizon oil spill and other possible stressors throughout offshore waters of the northeastern Gulf of Mexico shelf, from the Mississippi Delta to Tampa, at depths of 10-100 meters. Samples were collected at each of 50 stations for multiple types of analyses including condition of benthic infaunal communities, sediment toxicity, concentrations of oil and other contaminants in sediments and fish tissues, and basic habitat characteristics (e.g., salinity, temperature, DO, pH, turbidity, nutrients, chlorophyll). Incorporation of a probabilistic sampling design also provided a basis for making unbiased statistical estimates of the spatial extent of degraded versus non-degraded condition with respect to these various measured indicators and corresponding evaluation thresholds. The resulting information provides an account of the current status of ecological condition throughout these offshore habitats and a valuable baseline for quantifying future trends.

Session: 005 - 9

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Lower Trophic Level Studies

Date: Wednesday, January 23 2:00 PM  
Type: Oral Presentation

## Analysis of continental shelf meiofauna in the northern Gulf of Mexico following the Deepwater Horizon Oil Spill

**Presenter:** Stephen Landers – Troy University

**Authors:** Stephen C. Landers, Troy University; Frank A. Romano III, Jacksonville State University; Craig A. Schimmer, Troy University; Al Nichols, Jacksonville State University; David A. Steffy, Jacksonville State University; P. Michael Stewart, Troy University; Steve Ramroop, Troy University

### Abstract:

Our research focuses on meiofauna from the continental shelf/slope area across the northern Gulf of Mexico. Collections from 2010-2011 along the

entire US Gulf Coast demonstrated the patchiness of meiofauna densities and found positive statistical correlations among abundances in these major animal groups: nematodes, benthic copepods, polychaetes, kinorhynchans, priapulids, nauplii, and mites. Analysis of trace metals from sediment samples revealed negative correlations among abundances of many of the animal groups and nickel, lead, and vanadium concentrations, though when the data were subsampled to only include the Central Gulf from TX/LA border to Apalachicola these negative correlations were not significant. Future sampling for 2013-2015 will focus on the north central Gulf and will include species identifications of the invertebrates along with PAH, trace metals, and granulometry analysis.

Session: 005 - 10

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Lower Trophic Level Studies

Date: Wednesday, January 23 2:15 PM  
Type: Oral Presentation

## Effects of BP Deepwater Horizon Oil Spill on Benthic Macrofauna Communities

**Presenter:** Joseph Lemanski – TAMUG NSF-REU Intern

**Authors:** Joseph Lemanski, Siena Heights University; Fangyuan Qu, Texas A&M University at Galveston

### Abstract:

Following the destruction of the British Petroleum owned Deepwater Horizon platform, approximately 200 million gallons of crude oil entered the deep Gulf of Mexico. Nine box core samples were taken near the spill site to evaluate the possible damage caused to deep-sea macrofauna communities. Three sites were sampled; N, NE, and SW in relation to the destroyed Macondo wellhead, between six and ten kilometers away from the wellhead. The animals present were identified to the class level, recorded, and compared to the 2000-2002 Deep Gulf of Mexico Benthos (DGoMB) study. Several classes of animals showed significant changes in relative abundance within the total population. Crustaceans in particular decreased in relative abundance. Polychaetes were identified to the species level and have shown significant changes in abundance and certain community measures.



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Session: 005 - 11

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Lower Trophic Level Studies

Date: Wednesday, January 23 2:30 PM  
Type: Oral Presentation

## Sensitivity and resilience of the deep-sea gorgonian coral *Paramuricea* spp to oil and dispersant exposure

**Presenter:** Erik Cordes – Temple University

**Authors:** Erik Cordes, Temple University; Cheryl Doughty, Temple University; Andrea Quattrini, Temple University

### Abstract:

Species in the genus *Paramuricea* are common in deep waters (>200 m) of the Gulf of Mexico, and the most common species at the deep-water sites where direct impacts of the spill have been documented. Using remotely operated vehicles, the abundances and size frequencies of *Paramuricea* were recorded across 22 sites at depths of 250-2500 m and samples obtained for genetic identification and oil exposure experiments. Seven mitochondrial haplotypes are present and appear to be segregating into different depths zones at approximately 300, 450, and 600 m. Abundances ranged from a single colony (GC246, 894 m) to 523 colonies (AT357, 1050 m) at different sites. Recruitment was variable, and the lack of small colonies (<10cm) at many of the sites suggests limited recent recruitment. Oil and dispersant exposure experiments reveal sensitivity to low concentrations, similar to the concentrations measured in the subsurface plume. Together, these data illustrate that *Paramuricea* species are rare and exhibit low recruitment rates, making them highly susceptible to anthropogenic threats.

Session: 005 - 12

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Lower Trophic Level Studies

Date: Wednesday, January 23 2:45 PM  
Type: Oral Presentation

## Growth rate and age distribution of deep-sea coral *Paramuricea* sp. in the Gulf of Mexico

**Presenter:** Nancy Prouty – USGS

**Authors:** Nancy Prouty, U.S. Geological Survey; Ellen Druffel, University of California Irvine; Shelia Griffin, University of California Irvine; Charles Fisher, Penn State; Amanda Demopoulos, U.S. Geological Survey

### Abstract:

Information on growth-rates and life-spans of deep-sea corals is important for understanding the vulnerability of these organisms to both natural and anthropogenic perturbations, as well as the likely duration of

any observed adverse impacts. Demonstrated slow growth-rates suggest that it may take centuries for certain deep-sea coral species to recover from negative impacts. Results from this work represent the first comprehensive investigation of growth-rates and age distributions of proteinaceous corals from the area of potential Deepwater Horizon (DWH) impact. Recently published results indicate that deep-sea black corals, approximately 40-55 km northeast of the DWH oil spill, have been growing continuously for at least the last two millennia. However, there are no published values for growth rates or ages for *Paramuricea* sp. from the Gulf of Mexico, which is the dominant coral species at the study site, 1 km to the southwest of the Macondo Well. Preliminary results suggest a *Paramuricea* specimen from this site is at least 560 years old with a radial growth rate of 6  $\mu\text{m yr}^{-1}$ .

Session: 005 - 13

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Lower Trophic Level Studies

Date: Wednesday, January 23 3:00 PM  
Type: Oral Presentation

## The impact of the Deepwater Horizon oil spill on deep-water coral adjacent macrofauna benthos

**Presenter:** Amanda Demopoulos – US Geological Survey

**Authors:** Amanda Demopoulos, U.S. Geological Survey; Jill Bourque, U.S. Geological Survey

### Abstract:

Deep-sea coral habitats are known to support significant levels of biodiversity, yet due to their slow growth rates are highly susceptible to anthropogenic disturbance. Sediment cores were collected in situ in 2011 to quantitatively assess biological and environmental conditions near deep-coral ecosystems in the Gulf of Mexico after the DWH oil spill. Ten sites encompassing three coral types were compared using macrofauna family diversity, composition, numerical abundance, sediment particle size, and hydrocarbon concentrations. The site closest to the wellhead, MC294, exhibited the highest levels of surface hydrocarbons combined with depressed macrofaunal abundance, diversity, and high familial dominance. Within individual sites near the wellhead, the extent of hydrocarbon cover was patchy, resulting in high variability between replicates. Overall increased hydrocarbon concentrations were associated with decreased macrofaunal abundance. These data provide a baseline for natural and potentially exposed communities and will enhance future monitoring and restoration activities.

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Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Lower Trophic Level Studies

Date: Wednesday, January 23 3:15 PM  
Type: Oral Presentation

## ASSESSMENT OF DEEPWATER HORIZON SPILL IMPACTS ON SHELF AND SLOPE DECAPOD CRUSTACEANS

**Presenter:** Darryl Felder – University of Louisiana - Lafayette

**Authors:** Darryl Felder, University of Louisiana at Lafayette; Suzanne Fredericq, University of Louisiana at Lafayette; Brent Thoma, University of Louisiana at Lafayette; Emma Palacios-Theil, University of Louisiana at Lafayette; Heather Bracken, Florida International University Biscayne; Keith Crandall, George Washington University

### Abstract:

Pre-spill assessments of decapod diversity on deep banks and adjacent sediments continued on post-spill cruises. Rubble banks (60-90m) were sampled with 1m box dredges and sediments (150-2000m) with 3m epibenthic skimmers. Post-spill sampling was limited to four cruises, two matching pre-spill seasons. Diversity and abundance on banks decreased in post-spill periods. Assemblage composition shifted dramatically on banks, including near extinction of some previously dominant decapods. Gene-expression studies are underway to characterize responses of selected populations to oil stress. Post-spill epibenthic decapods often bear coatings of dark residues, especially on branchiae and appendages contacting sediments. Frequency of coatings and some lesions increased in post-spill samples, though patterns were heterogeneous across lineages. Lesions could involve microbial attenuation of shell defenses by lipoclastic and chitinoclastic processes. We hypothesize infection pathways linked to weathering of dispersed hydrocarbons, enhancing recruitment of natural shell disease pathogens.

Session: 005 - 15

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Lower Trophic Level Studies

Date: Wednesday, January 23 3:30 PM  
Type: Oral Presentation

## Biodiversity discoveries and gene expression studies applied to assess the stress response of decapod crustaceans affected by the Gulf of Mexico Deepw

**Presenter:** Heather Bracken-Grissom – Florida International University

**Authors:** Heather Bracken-Grissom, Florida International University; Darryl L. Felder, University of Louisiana at Lafayette; Brent Thoma,

University of Louisiana at Lafayette; Patricia Cabezas, Brigham Young University; Keith Crandall, George Washington University

### Abstract:

The ocean represents a mysterious realm ripe with novel life forms and undiscovered biodiversity. Originally described as a “monstrous and misshapen animal,” the bizarre planktonic larva, *Cerataspis monstrosa*, has remained unassigned to an adult counterpart despite nearly two centuries of marine research. Larval-adult linkages have unquestionably contributed to the understanding of ecology, taxonomy, systematics and marine biology. Our study definitively links the decapod larva, *Cerataspis monstrosa*, with the deep-sea shrimp, *Plesiopenaeus armatus*, on the basis of molecular evidence. This case study demonstrates the need for increased research on the communities that may have been altered by the deepwater horizon oil spill. Gene expression studies are underway to characterize the affects of the oil spill on decapod communities in the Gulf of Mexico. Specimens were collected from unaffected sites and exposed to DWH oil under laboratory conditions. Next generation transcriptome research is ongoing to identify the genes and associated stress response of selected decapod populations.

Session: 005 - 16

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Lower Trophic Level Studies

Date: Wednesday, January 23 3:45 PM  
Type: Oral Presentation

## Settlement of Blue Crab Megalopae Before, During and After the Deepwater Horizon Oil Spill

**Presenter:** Erin Grey-Avis – University of Notre Dame

**Authors:** Erin K. Grey, University of Notre Dame; Susan Chiasson, Tulane University; Caz Taylor, Tulane University

### Abstract:

The blue crab, *Callinectes sapidus*, supports a large fishery and plays an important role in estuarine food webs in the Gulf of Mexico. Blue crab spawning occurs offshore and peaks during the late spring and summer, indicating that gravid females, eggs and larvae were likely exposed to contaminants from the Deepwater Horizon spill. To assess the spill's effect on spawning success, we monitored blue crab megalopal (post-larval) settlement to sites both inside and outside of the spill in 2010 (during) and 2011 (one year after). To determine the spill's effect we compared our data with published baseline data from 1990-1992. As expected, we found that settlement was highly variable both among sites and within sites over time. Settlement in all years fell within the range of normal variation, although there was a trend for lower settlement in 2011 at a few sites. In summary, we found no evidence for immediate

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catastrophic effect on settlement, but we also found high natural variability that could mask even large impacts and so further monitoring is necessary.

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Session: 005 - 17

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Lower Trophic Level Studies

Date: Wednesday, January 23 4:00 PM  
Type: Oral Presentation

## Estimating Blue crab population connectivity in the northern Gulf of Mexico with graph theory and Lagrangian particle-tracking

**Presenter:** Benjamin Jones – Woods Hole Oceanographic Institution

**Authors:** Benjamin Jones, Woods Hole Oceanographic Institution; Caz Taylor, Tulane University; Erin Grey, University of Notre Dame

### Abstract:

The Blue crab, *Callinectes sapidus*, is an economically valuable species that inhabits estuaries during its adult stage and spawns planktonic larvae in nearshore areas.

We simulated dispersal using a Lagrangian particle-tracking model in order to estimate potential connectivity across the northern Gulf of Mexico. Our study included waters from the Florida panhandle to western Louisiana from April to November of 2010, including during the Deepwater Horizon oil spill. We found that local retention was high, the Mississippi River is a barrier to dispersal, and that particles that were potentially exposed to oil at the time of spawning were most likely to settle on the eastern side of the delta. Using graph theoretic metrics to assess variation in connectivity, we found that average vertex degree declined during the year, and that estuaries adjacent to the Mississippi River were most important for maintaining connectivity. The direction of particle movement became more westerly later in the season, indicating that seasonal variation in currents may drive trends in larval transport.

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Session: 005 - 18

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Lower Trophic Level Studies

Date: Wednesday, January 23 4:15 PM  
Type: Oral Presentation

## Surprising patterns of regional genetic differentiation in blue crabs, *Callinectes sapidus*, in the Gulf of Mexico

**Presenter:** Bree Yednock – University of Louisiana

**Authors:** Bree K. Yednock, University of Louisiana at Lafayette; Joseph E. Neigel, University of Louisiana at Lafayette

### Abstract:

The planktonic larval stage of the blue crab suggests the potential for widespread dispersal across its range. Indeed, several genetic studies have found high gene flow between locations along the Atlantic Coast and the Gulf of Mexico. However, it is now widely recognized that planktonic larvae do not always reach their dispersal potential. Larval behavior coupled with spatial and temporal heterogeneity in oceanographic conditions can result in much shorter dispersal distances than would be expected. In fact, one early allozyme study of blue crabs along the Texas Coast uncovered surprisingly high levels of genetic differentiation over relatively short distances that could easily be traversed by dispersing larvae. Our present research shows similar patterns exist in Louisiana and further suggests connectivity between blue crab populations in the Gulf of Mexico may be more limited than previously thought. We review these findings and address the potential impacts of limited population connectivity on the recovery of local populations following an environmental disturbance.

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Session: 005 -

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Lower Trophic Level Studies

Date: Wednesday, January 23 8:30 - 10:30  
Type: Poster

## BATHYAL ASSEMBLAGES OF LIVE, BENTHIC FORAMINIFERA NEAR THE DEEPWATER HORIZON OIL SPILL, NORTHERN GULF OF MEXICO.

**Presenter:** Valerie Cruz – University of Southern Mississippi

**Authors:** Valerie Cruz, University of Southern Mississippi; Charlotte Brunner, University of Southern Mississippi; Kevin M. Yeager, University of Kentucky; Kevin B. Briggs, U.S. Naval Research Laboratory; Patrick Louchouart, Texas A&M University

### Abstract:

Live, benthic foraminiferal assemblages were compared at oiled and un-oiled bathyal sites around the Macondo wellhead to test for pollution effects. Samples were taken from un-oiled (U1, U2 and U3), moderately oiled (O1 and O2) and heavily oiled (O3) sites, in which PAHs ranged from 73-7553 ng/g. Samples were sliced at 1-cm intervals, stained and wet sieved at 45-  $\mu$ m. Stained specimens were tallied and identified at successive depth intervals until 95% of the living assemblage was accumulated (= depth of habitation [DOH]).

Surface densities at all sites range from 390-2221 tests/10cm<sup>3</sup> and weakly correlate with increasing [PAH]. The surface density of O2 is less than that of O1 and U1-3, but density at the most polluted site is 3-6x greater than that of all other sites.

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The distributions of live specimens with depth in U3 and O3 are distinctly different and mirrored by the macrofauna. The DOH is 2x deeper at U3, but the standing stock is 1.5x greater at O3. Diversity is greater throughout U3's DOH compared to O3. The DOH and species diversity appear linked to pollution effects.

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Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Lower Trophic Level Studies

Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

## **Petroleum Hydrocarbon-Degrading Bacteria Enriched from Deep-Sea Sediments Associated with the Deepwater Horizon Gulf of Mexico Spill**

**Presenter:** Bryan Davis – University of West Florida

**Authors:** Bryan Davis, University of West Florida; Joe Eugene Lepo, University of West Florida; Zongjun Li, Hunan Agricultural University; Wade H. Jeffrey, University of West Florida

### **Abstract:**

Recent studies of microbial response to oil spills rely upfront on molecular biological tools, e.g., T-RFLP, metagenomics. In contrast, we enriched and isolated bacteria that utilize petroleum hydrocarbons as their sole C-source. Deep-sea sediments collected along a transect crossing the well-head of the Gulf of Mexico BP oil spill as part of the Consortium for the Integrated Modeling and Analysis of the Gulf Ecosystem (C-IMAGE) were stored at -20°C. Homogenized sediments were inocula to Bushnell-Haas broth containing n-hexadecane, or a PAH mix, or artificially weathered crude oil. Enrichments were shaken at 25°C until visibly turbid, then streaked to trypticase-soy agar. Unique colonies inoculated to sole C-source (various PAHs or hexadecane) media ensured ability to grow on those substrates. Approx. 90 strains have been preserved at -80°C. We will PCR-amplify 16S rRNA genes, to be sequenced for phylogenetic information; PAH-, n-alkane- and biosurfactant-encoding genes will be analyzed for biodegradation guild capabilities; strains of interest will be characterized physiologically.

Session: 005 -

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Lower Trophic Level Studies

Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

## **ASSESSMENT OF DEEPWATER HORIZON SPILL IMPACTS ON OFFSHORE SEAWEED DIVERSITY IN THE NW GULF OF MEXICO**

**Presenter:** Suzanne Fredericq – University of Louisiana at Lafayette

**Authors:** Suzanne Fredericq, University of Louisiana at Lafayette; Darryl L. Felder, University of Louisiana at Lafayette; Thomas Sauvage, University of Louisiana at Lafayette; Joseph Richards, University of Louisiana at Lafayette; Olga Camacho, University of Louisiana at Lafayette; William Gardiner, University of Louisiana at Lafayette; Dagoberto Venera Ponton, University of Louisiana at Lafayette; William Schmidt, University of Louisiana at Lafayette

### **Abstract:**

Pre-spill rubble habitats associated with unique deep banks (45-90m) were prominent features harboring the highest known seaweed diversity in the N Gulf, but this diversity was severely depressed/absent in four post-spill collecting cruises. Post-spill “bare” or partly algal-denuded rubble brought back as “live rocks” and maintained in 20-gallon tanks gradually became covered by seaweed germlings that to this day continue to grow to adult size, revealing biodiversity repressed in the Gulf at the time of sampling. Many of these species currently growing and reproducing in our tanks had not been observed in the field during pre-spill sampling. The rate of algal succession is being documented by photography, and taxonomic identity is confirmed by ongoing molecular and morphological evidence. The implications of these exciting results that undetected propagules, spores and endolithic filaments collected along with the “bare” substrata and in situ seawater have been triggered to germinate, grow, and reproduce under laboratory conditions are far-reaching. We hypothesize the function of rhodoliths and rubble as marine seedbanks for biological diversity and explore the role of cryptic young stages in overall community resilience following a major anthropogenic disaster.

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Session: 005 -

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Lower Trophic Level Studies

Date: Wednesday, January 23 8:30 - 10:30  
Type: Poster

## Photochemical Degradation and Bacterial Growth Response to Crude Oil

**Presenter:** Wade Jeffrey – University of West Florida

**Authors:** Wade H. Jeffrey, University of West Florida; Noel Harris, University of West Florida; Gabrielle Daniel, University of West Florida; Ryan Pichulo, University of West Florida; Dane Brankle, University of West Florida; Rose Atkinson, University of West Florida; Jamie Trindell, University of West Florida; Pamela P. Vaughan, University of West Florida

### Abstract:

Crude oil from Jay, FL was used to develop Water Accommodated Fractions (WAF) over 2 weeks under different solar conditions (full sun, no UVR, darkness) and their subsequent effects on bacterioplankton growth. Polycyclic aromatic hydrocarbon (PAH) and alkane concentrations were determined by GC/MS. Phenanthrenes were highest in the full sun treatment. Chrysenes peaked at day 6 under full sun but at day 11 in the dark. Naphthalenes were constant over time and independent of light. The effect of the different WAFs on bacterial production was determined by <sup>3</sup>H-leucine incorporation. WAFs developed in the dark inhibited growth at approximately 40% that did not change over time. Inhibition from the full sun WAF peaked after one week then leveled off. The NO UVR WAF had the highest level of inhibition to bacterial growth, increasing from 40% inhibition at day 1 to 60% at one week, followed by a return to approximately 40% by the end of the second week. Results have implications for how photochemical weathering may alter the impact of spilled oil on microbial communities in surface waters.

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Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Lower Trophic Level Studies

Date: Wednesday, January 23 8:30 - 10:30  
Type: Poster

## Synergy of oil, nutrients, and microbial predators in short-term oxygen dynamics in the Gulf of Mexico water column.

**Presenter:** Andrew Juhl – Columbia University, Lamont Doherty Earth Observatory

**Authors:** Andrew Juhl, Columbia University; Nigel A. D'Souza, Columbia University; Ajit Subramaniam, Columbia University; Beizan Yan, Columbia University

### Abstract:

Experimental additions of oil and nutrients (inorganic N, P, and trace metals) were combined with dilution experiments that minimize predation on bacteria to assess the influence of these variables on the activity of heterotrophic water column bacteria from offshore waters of the Gulf of Mexico. Oxygen measurements during experiments showed that oil additions (10 ppm) and experimental reduction of bacterivory by dilution increased biological oxygen demand (BOD), and nutrient additions increased BOD in surface waters, though not in deep water. Combinations of the treatments generally increased the effects on BOD. Thus, predation and nutrient availability are important factors controlling oxygen demand when oil is present at low concentration.

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Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Lower Trophic Level Studies

Date: Wednesday, January 23 8:30 - 10:30  
Type: Poster

## The influence of dispersants on pelagic microbial oil degradation in the Gulf of Mexico

**Presenter:** Sara Kleindienst – University of Georgia

**Authors:** Sara Kleindienst, University of Georgia; Michael Seidel, University of Georgia; Matt Perkins, Oregon State University; Jennifer Field, Oregon State University; Hilary G. Morrison, Josephine Bay Paul Center -MBL; Mitchell Sogin, Josephine Bay Paul Center - MBL; Thorsten Dittmar, Carl von Ossietzky University; Patricia Medeiros, University of Georgia; Samantha B. Joye, University of Georgia

### Abstract:

Dispersants are used after oil spills to break up oil slicks, dissolve oil into the water, and enhance the rate of microbial oil biodegradation. However, the impact of dispersant chemicals on pelagic microbial communities remains largely unknown. In this study, microbial communities from deep seawater at a natural hydrocarbon seep (Mississippi Canyon 118) in the northern Gulf of Mexico were exposed to Macondo oil, dispersed oil, or dispersants (COREXIT 9500) in laboratory experiments. Successive changes within the microbial community were monitored over several weeks using paired-end Illumina sequencing. In a combined multi-tracer approach, hydrocarbon biodegradation, dispersants and dissolved organic matter were analyzed using radiotracers, large volume injection high performance liquid chromatography tandem mass spectrometry (LVI-LC/MS/MS), gas chromatography coupled to mass spectrometry (GC-MS), and Fourier transform ion cyclotron resonance mass spectrometry (FTICR-MS), respectively. The environmental impacts of dispersants were estimated by correlating the obtained molecular microbiological and geochemical data.



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Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Lower Trophic Level Studies

Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

## ASSESSING LONG-TERM DAMAGE AND RECOVERY OF BENTHIC FORAMINIFERA FOLLOWING THE DEEPWATER HORIZON OIL SPILL, ORANGE BEACH, ALABAMA

**Presenter:** Ronald Lewis – Auburn University

**Authors:** Isabel A. Leon y Leon, Auburn University; Ronald D. Lewis, Auburn University

### Abstract:

Long after the Deepwater Horizon explosion in April of 2010, fragments of submerged tar mats washed ashore in the area of Orange Beach, Alabama, following Tropical Storm Lee (April 2011) and Hurricane Isaac (August 2012). Recently a submerged tar mat has been found in the same area. The impact of the BP oil spill on the Gulf's marine life and the rate of recovery since the event are subjects of ongoing research. Our group is using benthic foraminifera, a group of shell-bearing protists, as a proxy for the health of benthic marine communities.

Sampling was done along a north-south transect south of Orange Beach and from sites further west at ~3-month intervals from July 2011 to January 2012. The best data is from a back-barrier-island site (Ono Island) dominated by *Ammonia*. Test abnormalities are mild, but include extra chambers and chambers that are oddly shaped or are unusually large or small. In the June 2011 recovery, 9.5% of dead *Ammonia* and 30.0% of live specimens were abnormal. By January 2012, live specimens with abnormal tests had dropped to 20.9%. Data analysis is ongoing.

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Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

## Phytoplankton associations in the vicinity of DeSoto Canyon, northwestern Gulf of Mexico: Preliminary results

**Presenter:** James Nienow – Valdosta State University

**Authors:** James A. Nienow, Valdosta State University; Anna Shultz, Valdosta State University

### Abstract:

We are conducting a multi-year study of the phytoplankton in the vicinity of DeSoto Canyon with the primary goal of characterizing the structure of the association in space and time. This will improve our understanding of base-line conditions and allow for better assessments the impact of environmental disasters. The data will also help validate models of oil transport being developed by other researchers. So far, 12 cruises have been conducted along three transects extending from the panhandle of Florida, with additional cruises planned at 3-month intervals. At each station 1-liter samples are collected at 20-25-m intervals to depths of up to 200 m. These are filtered onto 0.45  $\mu\text{m}$  filters and examined with SEM to quantify the most abundant species. Net-plankton samples are collected at odd-numbered stations for analysis of larger forms. At this point we have documented the presence of 29 genera of haptophytes, 50 genera of diatoms and 6 genera of dinoflagellates. Of interest is the seasonal abundance of the diatom *Nanoneis haslea*, a species not previously reported from the Gulf.

Session: 005 -

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Lower Trophic Level Studies

Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

## The Lethal and Sublethal Effects of Chemical Dispersant on the Ctenophore *Mnemiopsis leidyi*

**Presenter:** Ryan Peiffer – University of Delaware

**Authors:** Ryan Peiffer, University of Delaware; Jonathan H. Cohen, University of Delaware

### Abstract:

The effects of chemical dispersants on the physiology of coastal and offshore zooplankton are poorly understood. This study examined lethal and sublethal effects of COREXIT 9500A solutions on the ctenophore *Mnemiopsis leidyi* at 23° C. 24-hour LC<sub>50</sub> levels were determined from dispersant exposures (0, 2.5, 5, 10, and 20 mg/L), and bioluminescence and respiration rates were measured in individuals surviving the exposure period. The 24 hr LC<sub>50</sub> was 5.15 mg/L (95% C.I.: 3.09-8.57 mg/L). Dispersant concentrations above 10 mg/L led to a significant decrease in bioluminescent emissions in response to standardized mechanical stimulation (Control: 6.68  $\times 10^{11}$ ; 10 mg/L: 5.91  $\times 10^{10}$ ; 20 mg/L: 1.36  $\times 10^{10}$  photons/cm). Additionally, ANCOVA revealed a significant decrease in mass specific respiration rates between the 5 and 10 mg/L treatments. These data suggest that chemical dispersants can affect physiology at sublethal levels of exposure, and the effects may have



# Science Abstracts

consequences for the complex trophic interactions of coastal ecosystems in which *M. leidyi* plays an important role.

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**Session: 005 -**

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Lower Trophic Level Studies

Date: Wednesday, January 23 8:30 - 10:30  
Type: Poster

## Deep-Sea Benthic Community Structure Following the Deepwater Horizon Blowout

**Presenter:** Adelaide Rhodes – Texas A&M University Corpus Christi

**Authors:** Adelaide Rhodes, Harte Research Institute Gulf of Mexico Studies; Travis Washburn, Harte Research Institute Gulf of Mexico Studies; Paul Montagna, Harte Research Institute Gulf of Mexico Studies

### Abstract:

In April 2010, the Deepwater Horizon blowout resulted in the largest oil release in American history. The release was two incidents: the common surface slick, and a subsurface deep water plume depositing oil to sediments. In fall 2010, benthic cores were collected in the deep sea at depths from 76 m to 2767 m. Stations ranged from < 1 km to approximately 200 km from the DWH wellhead. Annelid and crustacean assemblages were analyzed and compared. These taxa were chosen because of their differing feeding strategies (deposit vs. suspension feeders), habits (burrowing vs. crawling) and different sensitivity to pollution (generally greater for crustaceans). Abundance, family diversity and annelid:crustacean ratios were examined as possible bioindicators of spill effects. Community composition was analyzed at various distances from the spill using multivariate statistical analyses. This study presents results for over two years of work performed to assess potential impacts of the blowout to deep sea benthos.

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**Session: 005 -**

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Lower Trophic Level Studies

Date: Wednesday, January 23 8:30 - 10:30  
Type: Poster

## Microbial reactivity to water masses in the northeastern Gulf of Mexico

**Presenter:** Christian Riesenfeld – University of West Florida

**Authors:** Christian Riesenfeld, University of West Florida; Joseph Moss, UWF; Sarah Tominack, UWF; Katie Houghton, UWF; Bryan Davis, UWF; Josette Hutcheson, UWF; Joe Lepo, UWF; Wade Jeffrey, UWF; Richard Snyder, UWF

### Abstract:

The Gulf of Mexico oil spill in 2010 highlighted a lack of understanding of even basic processes of the northern Gulf of Mexico ecosystem. Eubacteria, archaea, and microzooplankton are key elements of productivity in the Florida Panhandle Bight Shelf and head of DeSoto Canyon, and they are the targets for UWF research in Deep-C and C-IMAGE GRI consortia. We are monitoring these microorganisms in a study aimed at addressing spatial and temporal stability and change in the water column and benthos. Data collection includes primary productivity, hydrographic and water nutrient chemistry data. DNA sequences assigned to taxonomic groups based on similarity to gene sequence data in public databases (e.g., R.D.P and SILVA) are being analyzed to characterize vertical bacterioplankton distribution and conduct nearshore, offshore comparisons relative to seasonal water mass dynamics. Findings from this study augment what is known about Gulf of Mexico microbial loop structure and function.

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**Session: 005 -**

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Lower Trophic Level Studies

Date: Wednesday, January 23 8:30 - 10:30  
Type: Poster

## RNA-BOSS: a new approach to studying in situ microbial gene expression

**Presenter:** John Skutnik – Harvard University

**Authors:** John Skutnik, Harvard University; Charles Vidoudez, Harvard University; Peter Girguis, Harvard University

### Abstract:

Marine microbes play a major role in planetary biogeochemical cycles, yet we know surprisingly little about their physiological capacities. Microbial gene expression provides a snapshot of an organism's physiological poise, and is a means of identifying which microbes participate in particular processes. Sampling systems exist that appropriately sample and preserve microbes, but are often complex and costly. To further our understanding of the role that microbes play in biogeochemical cycles, in particular the degradation of methane and other alkanes in the waters above the seafloor, we present a new method for sampling and preserving marine bacteria for gene expression studies. Here we characterized the performance of various preservatives and tested their efficacy during simulated in situ deployments. These samplers provide high spatial and temporal resolution, require no electricity, are low in cost, and easy to use. Such samplers now allow us to conduct detailed studies in the deep sea, and facilitate our understanding of how microbes influence biogeochemical processes.

# Science Abstracts

Session: 005 -

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Lower Trophic Level Studies

Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

## **A time series hydrographic dataset for the northeastern Gulf of Mexico**

**Presenter:** Sarah Tominack – University of West Florida

**Authors:** Sarah Tominack, University of West Florida; Marie Gaona, UWF; Jesse Rosanbalm, UWF; Chelsea Hester, UWF; Joseph Moss, UWF; Wade Jeffrey, UWF; Richard Snyder, UWF

### **Abstract:**

Oil spill response at the University of West Florida included the initiation of time series datasets for the Northwest Florida Bight Shoreline and Shelf. Data has been collected along three transects of 9 stations each covering the shelf south of Pensacola, Destin, and Panama City and the head of DeSoto Canyon. Sampling was at near monthly resolution from January 2011 to May 2012, and will continue quarterly within the Deep-C GRI consortium. Data includes CTD hydrographic data (salinity, temperature, dissolved oxygen, Chl and CDOM fluorescence, turbidity) Light attenuation (PAR, UVa, UVb), nutrient and chlorophyll a concentrations, Phytoplankton and bacterial production measures. Historical hydrographic data will be organized and added to the datasets. Sediment samples have been collected and analyzed for PAHs, chlorophyll a, and C:N composition.. The datasets will be available on the UWF Center for Environmental Diagnostics and Bioremediation webpages (<http://uwf.edu/cedb>) and through the DEEP-C Research consortium.

however, no quantitative studies have been published on their abundance and seasonal variability in this region. Thus, the effects of the BP Macondo Oil Spill on these skeletal-bearing phytoplankton can only be determined by after-the-fact measurements and comparisons with unpublished data. We report here preliminary results of a study in progress, the first step in the reconstruction of nannoplankton populations at the time of the spill. We began monthly sampling in January, 2011, along three transects across the shelf of the Florida Panhandle. We have taken over 1000 samples through the photic zone via Niskin-bottle rosettes, from which quantitative nannoplankton census data are being taken via scanning electron microscopy. Our goal is to use these data to predict the effects of any future oil spills in the GOM on calcareous nannoplankton.

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Session: 005 -

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Lower Trophic Level Studies

Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

## **Reconstruction of calcareous nannoplankton assemblages present along the Florida continental margin during the 2010 Macondo Oil Spill in the Gulf of M**

**Presenter:** Sherwood Wise – Florida State University

**Authors:** Aisha Agbali, Florida State University; Susan Foley, Florida State University; Nicholas Myers, Florida State University; Sherwood Wise, Florida State University

### **Abstract:**

Calcareous nannoplankton are important protist constituents of the base of the food chain along the continental margin off the Florida panhandle,

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## Session: 006 Ecosystems of the Open Ocean: Microbes Mammals and Models—Higher Trophic Level Studies

Session: 006 - 1

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Higher Trophic Level Studies

Date: Monday, January 21 2:00 PM  
Type: Oral Presentation

### An Overview of Fish Health Indicators in Offshore Waters of the Gulf of Mexico

**Presenter:** Steven Murawski – University of South Florida

**Authors:** FIO: W. Hogarth; USF: S. Murawski, E. Peebles, A. Wallace, E. Herdter; Florida Fish and Wildlife Research Institute: T. Cody, J. Landsberg; NMFS: G. Ylitalo, J. Stein, W. Dickhoff; Mote Marine Lab: D. Wetzell, J. Reynolds

#### Abstract:

Persistent reports of fishes exhibiting skin lesions and other symptoms began following the Deepwater Horizon (DWH) blowout. The DWH region is chronically exposed to oil from natural seeps and chronic releases from the oil industry. We undertook comprehensive demersal longline (baited hook) surveys intended to sample primarily bottom-dwelling fishes in the Northern Gulf of Mexico (NGM), near the well site, and in a comparable negative control – the non-affected region on the West Florida Shelf (WFS). Our results document the spatial and species-specific differences in the prevalence of various fish diseases, which were elevated in some cases in the NGM during 2011, as compared to the WFS. Subsequent monitoring in 2012 has documented changes in the rates of occurrence of fish diseases and their severity. Assessments of the frequency of lesions, PAH concentrations, and PAH metabolite levels are complemented by results of biomarker assays to compare critical sublethal effects on immune function, reproductive capacity, and genotoxicity in fish from affected and unaffected areas.

Session: 006 - 2

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Higher Trophic Level Studies

Date: Monday, January 21 2:15 PM  
Type: Oral Presentation

### Shifts in Reef Fish Community and Trophic Structure Following the Deepwater Horizon Oil Spill

**Presenter:** Will Patterson – University of South Alabama and Dauphin Island Sea Lab

**Authors:** Will Patterson, University of South Alabama and Dauphin Island Sea Lab; Joseph Tarnecki, University of South Alabama and Dauphin Island Sea Lab; Charles Jagoe, Florida A&M University; Isabel Romero, University of South Florida; David Hollander, University of South Florida; Andrew Kane, University of Florida; Margaret James, University of Florida

#### Abstract:

Northern Gulf of Mexico (86.6W to 88.4W) natural reefs (n=16) were studied between May 2009 and Aug 2012. Fish communities were sampled with an ROV and fish were collected to examine growth and trophic ecology. Liver and bile were sampled following the Deepwater Horizon Oil Spill (DHOS) to assess exposure to polycyclic aromatic hydrocarbons (PAHs). Fish community shifts occurred as early as summer 2010, with the greatest effect occurring in small demersal planktivores, many of which declined by 100% following the DHOS. Large fishes (e.g., snappers, jacks, and triggerfish) also declined. Trophic shifts within communities included declines in demersal planktivores and piscivores but increases in pelagic planktivores. Muscle stable isotope ratios indicated a shift toward more benthic versus pelagic prey sources in several species. High liver PAH concentrations were rich in alkyl homologs, thus indicating a petrogenic source. Presence of PAHs and induction of enzymes that catabolize PAHs indicate community structure and trophic shifts were most likely due to toxicological effects of the DHOS.

Session: 006 - 3

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Higher Trophic Level Studies

Date: Monday, January 21 2:30 PM  
Type: Oral Presentation

### SPATIO-TEMPORAL CONCENTRATIONS AND COMPOSITION OF POLYCYCLIC AROMATIC HYDROCARBONS IN FISH: EVIDENCE FOR DWH OIL SPILL IMPACT ON MESOPELGIC AND OUTER

**Presenter:** Isabel Romero – University of South Florida

**Authors:** Isabel C. Romero, University South Florida; David J. Hollander, University South Florida; William Patterson, University of South Alabama; Steve W. Ross, University of North Carolina; Andrew S. Kane, University of Florida; Steven Murawski, University South Florida; Ester Quintana-Rizzo, University South Florida; Ernst B. Peebles, University South Florida; Ethan A. Goddard, University South Florida; Joseph J. Torres, University South Florida

#### Abstract:

Spatial and temporal variability in polycyclic aromatic hydrocarbons (PAHs) in fishes from the outer continental shelf, slope waters, and mesopelagic depths of the northern Gulf of Mexico were used to assess

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biological uptake and impacts of the Deepwater Horizon blowout (DwH). Elevated PAHs concentrations were observed in all of the 4 outer-shelf and 7 mesopelagic species. Mesopelagic fishes showed temporal variability in PAH composition where 2-3 ring PAHs were more common in pre-DwH fish (2007), whereas 2-6 ring PAHs were more common in post-DwH fish (2011). Total PAHs in mesopelagics also changed over time, with a 10-fold increase from 2007-2011 with up to 40% retained in muscle samples relative to gut samples. Results suggest that both fish populations are still being exposed to oil even after the DwH. Mechanisms explaining elevated PAH concentrations and composition, PAH biomass partitioning, and their relationship to trophic food-webs, population dynamics, gross- and histopathology, and disease indicators will be discussed.

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Session: 006 - 4

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Higher Trophic Level Studies

Date: Monday, January 21 2:45 PM  
Type: Oral Presentation

## Community Structure of Deep Demersal Fishes from Desoto Canyon and Adjacent Habitats of the Eastern Gulf Of Mexico After Deepwater Horizon

**Presenter:** R. Dean Grubbs – Florida State University Coastal and Marine Lab

**Authors:** R. Dean Grubbs, Florida State University; Felicia Coleman, Florida State University; Chris Koenig, Florida State University; James Gelsleichter, University of North Florida; Charles Cotton, Savannah State University; Michael Heithaus, Florida International University

### Abstract:

Edge habitats often have high biodiversity and biomass regardless of ecosystem, but such deep-sea habitats (e.g. continental shelf and slope edges, submarine canyons, seamounts) have received little research focus. DeSoto Canyon and adjacent habitats of the eastern Gulf of Mexico were the first affected by the Deepwater Horizon oil spill (DwH). Unfortunately, little was known about the structure of these communities prior to DwH, particularly for the assemblages of larger deep-water fishes that are not susceptible to capture by trawls. We used fishery-independent longline and trap surveys to describe the assemblages and relative abundances of demersal fishes from 75-2000 m deep as functions of depth, temperature, habitat, and proximity to the DwH site. More than 65 species of teleosts, elasmobranchs and hagfishes contribute to these assemblages including taxa ranging from 10 cm to 500 cm in length. For selected taxa, we also examined exposure to petroleum-derived toxins,

trophic structure (stable isotopes), and reproductive status as functions of depth and proximity to DwH.

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Session: 006 - 5

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Higher Trophic Level Studies

Date: Monday, January 21 3:00 PM  
Type: Oral Presentation

## Effects of the Deepwater Horizon Oil Spill on deepwater fish populations from the northeast Gulf of Mexico.

**Presenter:** Jim Gelsleichter – University of North Florida

**Authors:** James Gelsleichter, University of North Florida; Arianne Leary, University of North Florida; R. Dean Grubbs, Florida State University; Michael Heithaus, Florida International University

### Abstract:

As the largest oil spill in history in U.S.-controlled waters, the Deepwater Horizon Oil Spill resulted in extensive contamination of Gulf of Mexico waters. This poses significant health risks to numerous marine wildlife populations, especially deepwater species residing in offshore waters within and/or adjacent to the primary contamination zone. Given the population-level impacts that have occurred in some wildlife species as a result of chronic exposure to oil constituents from prior oil spills (e.g., Exxon Valdez oil spill), it is critical to monitor the health of the Gulf's deepwater fauna to assess the full impacts of the Deepwater Horizon Oil Spill on these animals. However, little is known about demersal animal populations that reside within deepwater habitats of the northeast Gulf of Mexico. Therefore, to partially address this problem, the goals of this study were to characterize deepwater fish assemblages in the northeast Gulf of Mexico and examine if they are being exposed to and are experiencing effects of exposure to polycyclic aromatic hydrocarbons (PAHs), the most toxic constituents of oil. To accomplish this, we examined multiple biomarkers of PAH exposure and effects in several deepwater elasmobranch and teleost species collected from areas impacted by the Deepwater Horizon Oil Spill. PAH biomarkers were compared with those measured in deepwater fish collected from reference locations on the west Florida shelf to determine if northeast Gulf fish populations are experiencing physiological effects of oil exposure.

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Session: 006 - 6

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Higher Trophic Level Studies

Date: Monday, January 21 3:15 PM  
Type: Oral Presentation

## Status of Mesophotic Shelf-Edge Reef Fish Communities, Before and After 2010

**Presenter:** Kenneth Sulak – USGS

**Authors:** Kenneth J. Sulak, U.S. Geological Survey

### Abstract:

Over the time period of 1997-2003, the USGS scientists undertook a series of Remotely Operated Vehicle (ROV) research missions to investigate fish community structure on northern Gulf of Mexico (NGOM: LA to FL) deep shelf-edge mesophotic reefs. Quantitative video transects conducted on four target reefs during that time period provide a baseline of historic conditions in that community across the NGOM. Following the 2010 oil spill, USGS conducted two ROV missions in 2010 and 2011 to re-visit the same primary reefs, two within the potential zone of oil spill effects, two reference reefs outside that zone. Quantitative ROV video analysis results from 2010-2011 are compared with those from 1997-2003. Comparisons are drawn in terms of fish species diversity, rank order dominance, and population density. Substantial differences in community structure have been documented. Observations on the comparative conditions of reef fish habitat are also presented.

Session: 006 - 7

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Higher Trophic Level Studies

Date: Monday, January 21 3:30 PM  
Type: Oral Presentation

## Biomarker enzymatic activities in livers of Gulf of Mexico fishes

**Presenter:** Margaret James – University of Florida

**Authors:** Margaret James, University of Florida; Andrew Kane, University of Florida; Laura Rowland-Faux, University of Florida; Guo Zhong, University of Florida; Quentin Mievre, University of Florida; Alan Beers, University of Florida; Andre Espaillet, University of Florida; William Patterson, University of South Alabama and Dauphin Island Sea Lab

### Abstract:

This study examined potential hepatic CYP1A induction and evidence of oxidative stress in Gulf of Mexico fishes harvested from north-central sampling sites in 2011 and 2012. Ethoxyresorufin O-deethylase (EROD), benzo(a)pyrene hydroxylase (AHH), glutathione transferase (GST) and glutathione peroxidase (GPx) activities were measured from post-

mitochondrial supernatant fractions (S9) of liver tissues that were carefully removed and frozen at the time of capture. A total of 149 fish were evaluated including red snapper, grey triggerfish, red porgy, bank seabass, sand perch and vermillion snapper. Considering all tested fish, EROD activities ranged from 0.29 to 29.5, AHH activities from 0.68 to 24.5 pmol/min/mg S9 protein. GST activities ranged from 0.17 to 1.1  $\mu$ mol/min/mg S9 protein and GPx from 45 to 700 nmol/min/mg S9 protein. These values fall within the normal ranges reported for uninduced fish, suggesting that there was inappreciable exposure near the time of capture, or that potential exposure did not target CYP1A or glutathione-dependent pathways.

Session: 006 - 8

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Higher Trophic Level Studies

Date: Monday, January 21 3:45 PM  
Type: Oral Presentation

## Hydrocarbon-Induced Biomarker Responses in Gulf Killifish, *Fundulus grandis*, as an Aquatic Gulf of Mexico Sentinel

**Presenter:** Kristi Crowe – University of Alabama

**Authors:** Kristi Crowe, University of Alabama; Calvin Johnson, Auburn University; Joe Newton, Auburn University; Stephen Bullard, Auburn University

### Abstract:

*Fundulus grandis*, an emerging model sentinel in Gulf of Mexico research, was exposed to hydrocarbon solutions in lab studies to identify biomarker responses for assessing acute exposure impacts on this ubiquitous species. Fish were exposed to total soluble hydrocarbon solutions (16mg/L C6-C28) in aquaria over 8hr periods during which time the aqueous solution was slowly diluted to 0 mg/L C6-C28 with 15ppt aerated artificial sea water. Following washout, fish remained in the aerated aquaria for 12, 24, or 48hr before euthanasia and sample collection. Results of serum antioxidant capacity testing indicate a transient, yet significant increase ( $p < 0.05$ ) in antioxidant defenses at 12 and 24hr post-exposure (30.2 and 25%, respectively) with a return to baseline by 48hr. Preliminary results of liver samples analyzed for CYP1A DNA and mRNA copy numbers per cell suggest CYP1A is transiently induced upon exposure, peaking at 24hr with a baseline return by 48hr. Collectively, these hydrocarbon-induced biomarker responses suggest *F. grandis* may serve as an indicator of acute toxicant exposure.



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Session: 006 - 9

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Higher Trophic Level Studies

Date: Monday, January 21 4:00 PM  
Type: Oral Presentation

## Deep-diving Cetacean Monitoring and Temporal Patterns During and After the Deepwater Horizon Oil Spill

**Presenter:** John Hildebrand – Scripps Institution of Oceanography

**Authors:** John A. Hildebrand, Scripps Institution of Oceanography; Karlina P. B. Merckens, UCSD; Kaitlin E. Frasier, UCSD; Mark A. McDonald, Whaleacoustics; Simone Baumann-Pickering, UCSD; Sean M. Wiggins, UCSD; Tiago Marques, St Andrews University; Danielle Harris, St Andrews University; Len Thomas, St Andrews University

### Abstract:

The region impacted by the Deepwater Horizon oil spill includes the habitat of seven species of deep-diving cetaceans. We used High-frequency Acoustic Recording Packages (HARPs) to monitor for cetacean sounds at a site 8 nm from the Macondo wellhead and at two deep-water sites that were not exposed to surface oil. The acoustic data from these sites include recordings of sperm whales, *Kogia* spp., and four species of beaked whales. Deep-diving cetaceans were present at all sites during the oil spill and for the duration of the recording period (16 May 2010 – 17 Feb 2012), but acoustic detections varied across all sites. Exposure to surface oil as well as other longer-term effects of the oil spill and associated human activities, such as increased low-frequency noise and vessel activity, may affect the animals in the area. By identifying long- and short-term changes in the acoustic presence of different species, and relating these to anthropogenic and natural forces through environmental modeling, we aim to understand the potential impact of the oil spill on cetaceans in the region.

Session: 006 - 10

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Higher Trophic Level Studies

Date: Monday, January 21 4:15 PM  
Type: Oral Presentation

## Brown Pelican Foraging and Nesting in Relation to the Deepwater Horizon Oil Spill

**Presenter:** Scott Walter – Tulane University

**Authors:** Scott T. Walter, Tulane University; Jordan Karubian, Tulane University; John J. Dindo, Dauphin Island Sea Lab; Paul L. Leberg, University of Louisiana at Lafayette

### Abstract:

Rapid habitat degradation and threats of environmental contamination heighten the importance to understand Brown Pelican (*Pelecanus occidentalis*) use of their surroundings to develop conservation plans. To assess nesting and foraging ecology we deployed 32 Global Positioning System tags on pelicans in Louisiana and Alabama in 2012. Capture locations represented a gradient from none to heavy oiling during the 2010 Deepwater Horizon oil spill. Location and acceleration data allowed identification of nesting and foraging patterns over three months. Pelicans foraged up to 150 km away from their nest and either prospected for mates or nested up to 375 km away from their capture site. These long-distance movements suggest that pelicans from uncontaminated areas during the Deepwater Horizon event may have come in contact with contaminants. Our identification of foraging hotspots could help direct future oil spill response to diminish contamination of foraging adults and their brood during nesting.

Session: 006 -

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Higher Trophic Level Studies

Date: Monday, January 21 16:30 - 18:30  
Type: Poster

## Improving deepwater horizon risk assessment for large benthopelagic rays: integration of aerial observation and satellite telemetry

**Presenter:** Matthew Ajemian – Harte Research Institute / TAMU-CC

**Authors:** Matthew J. Ajemian, Harte Research Institute for Gulf of Mexico Studies; Sean P. Powers, University of South Alabama

### Abstract:

Despite their highly mobile nature, large benthopelagic rays (cownose, eagle, and manta rays) were likely exposed to crude oil and chemical dispersants from the Deepwater Horizon (DWH) incident. Historically, coarse-scale aerial observations indicate the particular time frame (i.e., spring-summer season) of the DWH incident supports considerable ray densities in this region. However, these surveys were limited to a single species and conducted several decades ago. Utilizing a robust recent aerial data set from the north-central Gulf of Mexico, we examined the potential impact of DWH on the distribution and densities of multiple benthopelagic ray species. Additionally, we used towed-float satellite telemetry to examine fine-scale surface habitat use and migratory behavior of rays over a large spatial scale. Though data analyses are ongoing, our preliminary work suggests taxon-specific differences in benthopelagic ray ecology may have played a critical role in the relative exposure rates of individual species to DWH.



# Science Abstracts

Session: 006 -

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Higher Trophic Level Studies

Date: Monday, January 21 16:30 - 18:30  
Type: Poster

## Biomarkers of PAH exposure in livers and bile of reef fish from the northern Gulf of Mexico after the Deepwater Horizon Oil Spill

**Presenter:** LaTrisha Allen – FAMU-School of the Environment

**Authors:** LaTrisha Allen, Florida A&M University; Diana Johnson, Florida A&M University; Kali Farris, Florida A&M University; Will Patterson, University of South Alabama; Joe Tarnecki, University of South Alabama; Charles Jagoe, Florida A&M University

### Abstract:

In 2010, the Deepwater Horizon Oil spill released almost 5 million barrels of crude oil into the Gulf of Mexico. Crude oil contains toxic components including polycyclic aromatic hydrocarbons (PAHs) that may harm aquatic organisms. Fish metabolize PAHs and excrete the metabolites via bile. PAH metabolism involves Cytochrome p450 induction, which can be measured as 7-ethoxyresorufin o-deethylase (EROD) activity in liver. We collected over 500 fish during and after the oil spill, including *Lutjanus campechanus* (red snapper), *Balistes caprisacus* (grey triggerfish), *Pagrus pagrus* (red porgy), and *Seriola dumerili* (greater amberjack) from multiple offshore locations in the Gulf of Mexico off Alabama and Florida in 2010-2011. Bile fluorescence was measured at excitation/emission wavelengths of 290/335, 341/383 and 380/430 nm to detect metabolites of 2, 4 and 5 ring PAHs, respectively, and standardized to billiverdin and protein concentrations. Most fish had bile fluorescence signals consistent with naphthol, indicative of oil exposure. Bile fluorescence decreased over the sampling period, suggesting that PAH exposure declined after the oil release ended. EROD was measured using a fluorescence microplate method. Activities were generally highest in fish collected near the well site soon after the spill, and differed among species and locations. EROD activities generally decreased over time after the spill. Additional enzyme assays (for glutathione-S-transferase, a phase 2 detoxification enzyme, and superoxide dismutase, involved in antioxidant defenses) are underway to further characterize oil exposure and biochemical responses in these fish.

Session: 006 -

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Higher Trophic Level Studies

Date: Monday, January 21 16:30 - 18:30  
Type: Poster

## Long-term monitoring of dolphins in the Gulf of Mexico

**Presenter:** Kaitlin Frasier – Scripps Institution of Oceanography

**Authors:** Kaitlin Frasier, Scripps Institution of Oceanography; Karlina P. Merkens, Scripps Institution of Oceanography; Mark A. McDonald, WhaleAcoustics; Sean M. Wiggins, Scripps Institution of Oceanography; Simone Baumann-Pickering, Scripps Institution of Oceanography; Marie A. Roch, Scripps Institution of Oceanography; John A. Hildebrand, Scripps Institution of Oceanography

### Abstract:

Delphinids were continuously monitored during and after the Deepwater Horizon oil spill at five sites in the northeastern Gulf of Mexico, using High-frequency Acoustic Recording Packages (HARPs). These sites are within the known habitat ranges of 11 species of delphinids. Surface oil reached two sites, while three unexposed sites functioned as “controls”. Presence of dolphin vocalizations (clicks and whistles) was documented at each site over two years following the oil spill. Towed array recordings with concurrent visual identifications were used to determine species-specific vocalization characteristics. These were compared with the long-term autonomously recorded vocalizations. Acoustic propagation models were used to estimate delphinid detection ranges at each site. The data provide a comparative view of delphinid presence relative to oil coverage, as well as preliminary information needed for studying long-term responses of delphinids to the oil spill.

Session: 006 -

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Higher Trophic Level Studies

Date: Monday, January 21 16:30 - 18:30  
Type: Poster

## Development of a Towed Camera System Indexing Reef Fish Density: Applications to MPA Assessment

**Presenter:** Sarah Grasty – The University of South Florida

**Authors:** Sarah Grasty, University of South Florida; Chad Lembke, University of South Florida; Gino Gonzalez, University of South Florida; Alex Silverman, University of South Florida; Steven Butcher, University of South Florida; Steve Murawski, University of South Florida

### Abstract:

The development of rapid assessment methods to determine spatial abundance and biomass of Gulf of Mexico reef fishes is of great priority as

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these data are integral for the evaluation of current marine protected areas (MPAs) and proposals to limit fishing in other habitats. Here, we describe the development of a towed camera system (C-BASS or Camera-Based Assessment System) that will have the capability to facilitate large-scale quantitative assessments of economically important reef fish stocks, as well as their habitat, both within and outside MPAs. There are three sites off the West Florida Shelf which are a part of this study: Steamboat Lumps, Madison Swanson, and the Florida Middle Grounds, all of which are reserves with varying degrees of fishing regulations. This camera system could be utilized by virtually any research vessel possessing a conventional CTD rosette system, and thus has the potential to enhance both the quantity and quality of available data on habitat associations and density distributions of fishes in the Gulf of Mexico and elsewhere.

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**Session: 006 -**

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Higher Trophic Level Studies

Date: Monday, January 21 16:30 - 18:30  
Type: Poster

## Effects of the Deepwater Horizon Oil Spill on Epipelagic fish populations in the northeast Gulf of Mexico

**Presenter:** Matthew Long – UNF

**Authors:** Chase Long, University of North Florida; Arianne Leary, University of North Florida; Robert E. Hueter, David Kerstetter, Mote Marine Laboratory; NSU Oceanographic Center; Jim Gelsleichter, University of North Florida

### Abstract:

The Deepwater Horizon Oil Spill contaminated large areas of the waters of the Gulf of Mexico. Contamination from the spill poses serious health risks to many of the epipelagic populations of marine wildlife that reside within or around the primary contamination zone. Prior oil spills, such as the Exxon Valdez Oil Spill, have resulted in population-level impacts on some wildlife species. It is for this reason that monitoring the health of epipelagic fish species that were potentially impacted by the spill must be undertaken. The goals of this study were to assess whether epipelagic fish species in the northeast Gulf of Mexico were exposed to and affected by oil-related contaminants, particularly polycyclic aromatic hydrocarbons (PAHs). PAHs are the most toxic constituents of oil, and therefore have the greatest potential impact on the species examined. Multiple biomarkers of PAH exposure and effects were examined in epipelagic species, such as swordfish, oilfish, tunas, and a number of shark species collected from contaminated sites in order to determine the impacts of the spill. These biomarkers were compared to samples taken from the

southwest Atlantic in order to determine whether the fish residing in the Gulf of Mexico are experiencing the effects of oil exposure.

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**Session: 006 -**

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Higher Trophic Level Studies

Date: Monday, January 21 16:30 - 18:30  
Type: Poster

## Trophic Dynamics and Feeding Ecology within the Southeast Florida Coastal Pelagic Fish Complex

**Presenter:** Travis A. Moore – Nova Southeastern University  
Oceanographic Center, Fisheries Research Laboratory

**Authors:** Travis A. Moore, Nova Southeastern University; David W. Kerstetter, Nova Southeastern University

### Abstract:

The trophic interactions and feeding ecology of coastal pelagic fishes remains poorly known. To elucidate these ecological relationships, this study focused on six species: king mackerel, blackfin tuna, skipjack tuna, little tunny, wahoo, and dolphinfish. From March 2010 to March 2012, samples from over 500 fishes were collected opportunistically from recreational anglers in southeast Florida. The stomach, gonads, muscle tissue, and liver tissue were collected from each specimen, as well as length data. Stable isotope analysis of carbon  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  in the muscle tissue was conducted along with descriptions of stomach contents. The combined analyses provide a more complete evaluation of the trophic interactions and positions among the coastal pelagic community.

The preliminary analysis of stomach contents and  $\delta^{13}\text{C}$  data for blackfin tuna, king mackerel, and little tunny (-16.5 to 20.5) shows a diverse diet of fish, squid, and crustaceans. The  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  data together indicates differences in trophic position and diet among the species in the coastal pelagic complex.

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Session: 006 -

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Higher Trophic Level Studies

Date: Monday, January 21 16:30 - 18:30  
Type: Poster

## **Spatiotemporal Effects of the Deep Water Horizon Oil Spill on Productivity of Important Recreational and Commercial Fisheries of the Gulf of Mexico**

**Presenter:** Debra Murie – University of Florida

**Authors:** Debra J. Murie, University of Florida; Daryl C. Parkyn, University of Florida; Robert Ahrens, University of Florida

### **Abstract:**

Changes in the productivity of recreational and commercial fisheries can have profound ecological and economic consequences. The primary goal of our study is to determine the extent that the Deep Water Horizon (DWH) oil spill impacted the growth and productivity of important recreational and commercial fisheries in the Gulf of Mexico. To address this concern, our study will compare the growth of representative fish species before and after the DWH oil spill event, and with additional comparison to a control area that was not physically impacted. Age-specific growth of fish prior to the DWH oil spill will be estimated using their otoliths or “ear stones.” Otoliths show annual patterns of concentric growth rings similar to a cross-section of a tree trunk, and they record the entire growth history of the fish from birth to capture. Fish species chosen for this study are representative of different habitats (inshore estuarine areas, reefs, sand/mud, offshore waters) and trophic levels (detritivore, demersal carnivore, piscivore, pelagic carnivore), and include spotted seatrout, red drum, striped mullet, sheepshead, southern flounder, red snapper, gag, gray snapper, greater amberjack, and king mackerel. Spatial and temporal changes in growth of these fishes will be estimated through the growth increments in their otoliths and then incorporated into age-based stock production assessments to estimate changes in productivity. At a fisheries ecosystem level, the historical growth of these fishes will be explored using otolith sclerochronology, where the widths of the growth increments (rings) are matched to known environmental variables. Sclerochronology will be used in combination with Autoregressive Integrated Moving Average (ARIMA) models and intervention (impact) analysis to statistically evaluate the impact of the DWH oil spill on their growth patterns. This study will develop the framework to provide a better understanding of the relative impacts of environmental catastrophic events on growth and productivity of coastal fish stocks in the Gulf of Mexico.

Session: 006 -

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Higher Trophic Level Studies

Date: Monday, January 21 16:30 - 18:30  
Type: Poster

## **Impacts of the Deepwater Horizon blowout on burrow-forming finfishes: An interdisciplinary approach**

**Presenter:** Susan Snyder – The University of South Florida

**Authors:** Susan Snyder, University of South Florida; Haley Ramirez, Eckerd College; Isabel Romero, University of South Florida; Dana Wetzel, Mote Marine Laboratory; David Hollander, University of South Florida; Steve Murawski, University of South Florida

### **Abstract:**

Following the Deepwater Horizon blowout, oil settled on the northern Gulf of Mexico seafloor. The interactions between chemicals in oil, sediments, and the health of infaunal fishes, at present, is poorly understood. This study aims to understand the effects of contamination on two putative burrow-forming species, the golden tilefish (*Lopholatilus chamaeleonticeps*) and king snake eel (*Ophichthus rex*), using biomarkers of exposure to organic pollutants, particularly polycyclic aromatic hydrocarbons (PAHs).

Biometric data, fish tissue and sediment samples were obtained from longline and coring surveys conducted at potentially exposed and reference sites in the northern Gulf in 2011 and 2012. Ongoing analyses are aimed at correlating sediment PAH levels and depositional histories with indices of exposure. The potential exposure vectors are also being evaluated.

The health of these fish populations is being assessed via condition factors, liver histopathology, compromises of immune functions, DNA integrity, reproductive impairment and PAH concentrations in the bile, liver and muscle. This interdisciplinary approach will provide insights into the pathways of exposure and toxicity between potentially oil-contaminated sediments and these infaunal fishes.

# Science Abstracts

Session: 006 -

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Higher Trophic Level Studies

Date: Monday, January 21 16:30 - 18:30  
Type: Poster

## Detection of Genes of Oil Spill Microbe Genes in Digestive Tract of Fish After the BP Oil Spill

**Presenter:** Illya Tietzel – Southern University at New Orleans

**Authors:** Illya Tietzel, Southern University at New Orleans; Gawain Kiffin, Southern University at New Orleans

### Abstract:

The ecological consequences of major oil spills such as the Deepwater Horizon in the Gulf of Mexico remain to be studied. More specifically, no reports exist whether the oil spill associated microbes cause changes of the microbial communities inside the digestive tract of fish or shrimp. Currently, it is only known that the oil spill increased the numbers of oil degrading microbes in the Gulf and beaches. However, based on the reported presence of oil degrading microbes in the Gulf of Mexico and the findings that externally applied microbes impact the microbial community of the intestine of fish and shrimp, it is hypothesized that oil degrading microbes such as of the genus *Alcanivorax* will be present in the digestive tract of fish and potentially cause changes of the microbiota. To test this hypothesis, fish captured from oil spill sites near Chauvin, LA in September, October and November of 2010 were analyzed with Polymerase Chain Reaction (PCR) specific for *Alcanivorax borkumensis*. DNA was isolated from fecal matter of fish. Primers for *alkB1* and *alkB2* genes were used. A lab strain of *Alcanivorax borkumensis* served as positive control. Preliminary data showed presence *Alcanivorax borkumensis* in the digestive tract of fish from oil spill sites. Longitudinal studies will study the long term effects of the oil spill. The research was funded by NSF MCB-1051237 and LEQSF-EPS(2012)-SURE-63.

Session: 006 -

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Higher Trophic Level Studies

Date: Monday, January 21 16:30 - 18:30  
Type: Poster

## Is Exposure to Genotoxic Metals Part of the Toxic Legacy of the Deepwater Horizon Oil Crisis?

**Presenter:** John Wise – University of Southern Maine

**Authors:** John Pierce Wise, Sr., University of Southern Maine; John Pierce Wise, Jr., University of Southern Maine and Ocean Alliance; James Wise, University of Southern Maine and Ocean Alliance; Christopher Perkins, University of Connecticut; W. Douglas Thompson, University of Southern Maine

### Abstract:

In the wake of the Deepwater Horizon oil disaster of 2010, we collected tissue samples from sperm whales in order to determine the effects of the oil and chemical dispersants on their population. We focused on whales because they are at the top of the food chain and they are biologically similar to humans. Sperm whales live and feed at the same depth as the Deepwater Horizon well head, placing them at high risk to this disaster. Concern has largely focused on oil and dispersants while the potential threat of genotoxic metals in the oil has gone largely overlooked. Genotoxic metals, such as chromium and nickel, damage DNA and bioaccumulate in organisms resulting in longer exposures. Analysis of sperm whale skin samples showed mean levels of Ni and Cr at significantly higher levels than those found in whales collected around the world prior to the spill. We found Cr and Ni levels ranged from 0.4-94.63 ppm in tissue collected from Gulf of Mexico whales in the wake of the crisis, with mean Ni and Cr levels of 14.9 and 12.0 ppm, respectively. In addition, we found Cr and Ni levels ranged from 0.24-8.46 ppm in crude oil from the riser, oil slicks from surface waters and tar balls from Gulf beaches. Maps of where we collected our samples showed the highest metal levels in whales closest to the epicenter. Given the capacity of these metals to break DNA, their presence in the oil and their elevated levels in whales, we believe metal exposure is an important overlooked concern for the Deepwater Horizon oil disaster. Further analysis is underway to determine the impact of this disaster on the genetic health of the whales and the long term impact in years following.

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## Session: 007 Ecosystems of the Open Ocean: Microbes Mammals and Models—Analysis and Modeling

Session: 007 - 1  
Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Analysis and Modeling

Date: Monday, January 21 10:30 AM  
Type: Oral Presentation

### Development of an Atlantis ecosystem model to study food web impacts of DWHOS

**Presenter:** Cameron Ainsworth – University of South Florida

**Authors:** Cameron Ainsworth, USF; Michael Drexler, USF; Michelle Masi, USF; Holly Perryman, RSMAS; Matt Nutall, RSMAS; David Die, RSMAS; Beth Babcock, RSMAS; Michael Schirripa, SEFSC-NOAA

#### Abstract:

We describe development of a biogeochemical marine ecosystem and fisheries model, Atlantis, for the Gulf of Mexico. Atlantis is spatially explicit in three dimensions; it describes bioregional features using irregular polygon geometry. Key features include habitat dependency (for physical and biogenic substrates), hydrodynamics (for nutrient and larval advection), and a highly articulated fisheries module (including bycatch, economics and habitat impacts). The model will take advantage of lab and field research emerging from the C-IMAGE and DEEP-C consortia. From this, we will develop spatial mortality and recruitment forcing patterns representing cumulative exposure to oil and dispersants in order to study long-term impacts of the DWHOS on the upper food web. Analysis will focus on recovery time for species and changes in ecosystem structure and function. We will highlight ongoing research projects including use of a generalized additive model (GAM) to allocate biomass spatially, and a fish gut content study with statistical analysis to parameterize the diet matrix.

Session: 007 - 2

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Analysis and Modeling

Date: Monday, January 21 10:45 AM  
Type: Oral Presentation

### Atlantic bluefin tuna (*Thunnus thynnus*) spawning and larval habitats in the northern Gulf of Mexico: overlap between the habitats and oiled surface waters during May 2010

**Presenter:** James Franks – Gulf Coast Research Laboratory

**Authors:** Jim Franks, University of Southern Mississippi; Donald Johnson, University of Southern Mississippi; Dong S. Ko, Naval Research Laboratory; Jason Tilley, University of Southern Mississippi; Dyan Gibson, University of Southern Mississippi; Bruce Comyns; Eric Hoffmayer, NOAA Fisheries; Mitch Roffer, Roffer's Ocean Fishing Forecasting Service; Read Hendon, University of Southern Mississippi; Mae Blake, University of Southern Mississippi

#### Abstract:

Larvae of Atlantic bluefin tuna (*Thunnus thynnus*) were collected during Gulf Coast Research Laboratory ichthyoplankton cruises conducted in the Gulf of Mexico (GoM) between May 2003 - May 2010 in support of NOAA Fisheries' fishery-independent Atlantic bluefin tuna spawning stock biomass index. Larval bluefin were taken in surface neuston (947 $\mu$  mesh) tows from western and northern boundary regions of the Loop Current and associated eddies. Larvae were aged to update 30-year old larval bluefin age and growth information for the GoM, and larval ages were used to retrospectively identify discrete bluefin spawning locations and larval habitats in the GoM using the Intra-Americas Seas Nowcast/Forecast System (IASNFS, NRL) model to track (hindcast) passive transport of known-age larvae from collection dates and locations. The geographical history of 'back-tracked' larvae as related to environmental conditions encountered during passive transport contributes toward describing bluefin tuna habitat in the GoM.

The Deepwater Horizon oil spill coincided temporally and spatially with the bluefin tuna spawning season in the GoM. Considering the depressed status of the Western Atlantic bluefin tuna stock and the proximity of the spill to the spawning grounds, the potential for adverse effects from the spilled oil to bluefin tuna life stages, critical habitats, and recruitment success was (is) of paramount concern. In May 2010, collections of larval bluefin tuna (>350) were taken from waters visibly contaminated by surface oil sheens. That account is presented in the context of bluefin spawning locations and larval habitats by use of modeled larval transport pathways coupled with satellite imagery of surface oil locations.

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Session: 007 - 3

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Analysis and Modeling

Date: Monday, January 21 11:00 AM  
Type: Oral Presentation

## Biological-Physical Ocean Modeling in the Gulf of Mexico

**Presenter:** Sergio DeRada – Naval Research Laboratory

**Authors:** Sergio Derada, Naval Research Laboratory; Jason Jolliff, Naval Research Laboratory; Sherwin Ladner, Naval Research Laboratory; Robert Arnone, University of Southern Mississippi; Bradley Penta, Naval Research Laboratory; Fei Chai, University of Maine; Stephanie Anderson, Naval Research Laboratory; Patrick Hogan, Naval Research Laboratory; Eric Chassignet, Florida State University

### Abstract:

A  $1/25^\circ$  horizontal-resolution bio-physical coupled numerical ocean model for the Gulf of Mexico (GOM) has been running since 2000 and continued into near-real time. The physical formulation is based on the Naval Coastal Ocean Model (NCOM) configured with a 40 level  $\sigma$ -z vertical structure. The physical model is one-way coupled to a 13-component ecosystem model that includes nutrients, two classes of phytoplankton, two classes of zooplankton, as well as O<sub>2</sub> and CO<sub>2</sub>. The model receives (initial) boundary information from the operational  $1/8^\circ$  Global NCOM physical fields and the World Ocean Atlas 2009 and Carbon Dioxide Information Analysis Center (CDIAC) biogeochemical fields. It is forced with 3-hourly  $1/2^\circ$  momentum and heat fluxes from the Naval Operational Global Prediction System (NOGAPS) and assimilates daily surface/subsurface temperature and salinity data via the Modular Ocean Data Assimilation System (MODAS), which regresses satellite derived Sea Surface Temperature (SST) and Sea Surface Height (SSH) data to obtain T&S synthetic profiles. The model was initialized on January 1, 2000 and continuously run into the present, providing long-term fields of statistical significance for inter-annual/seasonal assessments. The long-term results are evaluated relative to physical, biological, and optical in-situ and remotely sensed observations, focusing on plankton distribution in the northern Gulf over the modeled period.

Session: 007 - 4

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Analysis and Modeling

Date: Monday, January 21 11:15 AM  
Type: Oral Presentation

## Did dissolved hydrocarbons impact the West Florida Continental Shelf?

**Presenter:** Robert Weisberg – Univ. of South Florida

**Authors:** Robert Weisberg, University of South Florida; Lianyan Zheng, University of South Florida

### Abstract:

Owing to remote forcing by Loop Current (and eddy) interactions with the shelf slope near (and north of) the Dry Tortugas, the West Florida Shelf experienced intense upwelling beginning in May 2010 and lasting through most of the year. This resulted in subsurface flows from the northern to the southern portions of the shelf with an onshore component in the bottom Ekman layer. Using a passive tracer introduced where oil was known to have existed west of Cape San Blas, we model the tracer concentration evolution in time and space. Following well established upwelling circulation routes the tracer permeated the entire West Florida Shelf and even reached land between Tampa Bay and Charlotte Harbor in concentrations too low to be seen, but perhaps high enough to have had deleterious effects on living marine resources. Whereas there are no analyses available for confirmation, the spread of the tracer is consistent with the finding of lesions in fish as purposely sampled subsequent to the spill.

Session: 007 - 5

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Analysis and Modeling

Date: Monday, January 21 11:30 AM  
Type: Oral Presentation

## Modelling Nutrient Cycling In The Gulf Of Mexico: A Real-time Decision Support for Managers and Field Work

**Presenter:** Clelia Marti – Centre for Water Research - The University of Western Australia

**Authors:** Jorg Imberger, The University of Western Australia; Anouk Dupre, The University of Western Australia; Clelia Luisa Marti, The University of Western Australia

### Abstract:

In this talk I will report on a preliminary real-time 3D model setup that simulates the formation of the low oxygen deep water mass. The set up is based on the CWR Real-time Management System Online (<http://www.rmso.com.au>). The purpose of the talk is to illustrate the



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universality of the software suite and solicit participation to validate and improve the set up. The objective is to provide the Gulf State Community with an open source facility for the collation of validation data, incorporation of new knowledge as well as the extension to the behaviour of the dispersal and fate of future oils spills. I am hoping to find a group to take over the set up and provide ongoing support for the Gulf State community.

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## Session: 007 - 6

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Analysis and Modeling

Date: Monday, January 21 11:45 AM  
Type: Oral Presentation

### **Eutrophication, hypoxia, ocean acidification, and oil spill: potential interactions of multiple environmental stressors in the northern Gulf of Mexico**

**Presenter:** Wei-Jun Cai – University of Georgia

**Authors:** Wei-Jun Cai, University of Georgia

#### **Abstract:**

As a result of surface water eutrophication, hypoxia has developed during spring and summer in subsurface waters underneath and downstream of the river plume in the northern Gulf of Mexico (nGOM). Based on dissolved inorganic carbon (DIC) parameters, we have found that net community production of the Mississippi River plume was probably the highest among all global large river plumes. Surface water pCO<sub>2</sub> was consistently below atmospheric levels (~380 uatm), and reached very low levels of 100-200 uatm at intermediate salinities along the mixing gradients from the river mouths to shelf waters. pH increased to as high as 8.6 at middle salinities.

Ocean acidification caused by fossil-fuel CO<sub>2</sub> uptake from the atmosphere has acidified seawater and threatened to change ocean ecosystems and biogeochemistry. Based on results from the Mississippi River plume, I will argue that biological production is the dominant process causing very high pH and high carbonate saturation state in freshwater plumes. High biological production rates in the plume were, however, accompanied by strong respiration of organic carbon (OC) and the development of bottom water hypoxia and acidification in summer. Interestingly, ocean acidification and eutrophication-induced hypoxia have acted in concert to lower the pH of the bottom water greatly. The effect will lead to regional under-saturation with respect to the carbonate mineral (aragonite) within this century and thus will make the system more venerable for dealing with other environmental stressors such as oil spill. Such an abnormal signal in pH and carbonate saturation was detectable in the nGOM

hypoxia zone in summer 2010 after the oil spill. While the nGOM is sink of the atmospheric CO<sub>2</sub>, the system actually respire more OC than it produces (net heterotrophic), burning plume-produced OC as well as terrestrial OC and exporting DIC to the open ocean. I will summarize the carbon budget and metabolic balance in the nGOM and discuss the potential impacts of oil and gas input on them.

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## Session: 007 - 7

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Analysis and Modeling

Date: Monday, January 21 12:00 PM  
Type: Oral Presentation

### **Oil spills and overfishing led to increments of harmful algal blooms on the West Florida shelf, with public health consequences: An isomorph?**

**Presenter:** John Walsh – University of South Florida

**Authors:** John J. Walsh, University of South Florida; Jason M. Lenes, University of South Florida; Robert H. Weisberg, University of South Florida; Chuanmin Hu, University of South Florida; Kendra Daly, University of South Florida

#### **Abstract:**

A combination of parallel overfishing of piscivores, with onset of trophic cascades, and oil spills [Torrey Canyon, Mumbai North, Deepwater Horizon] forced ten-fold reductions of herbivore grazing stresses off England, India, and Florida. Consequent increments of red tides of *Karenia brevis* and *Karenia mikimotoi* = *Gyrodinium aureolum* have emerged as HAB triggers of asthma attacks among adjacent humans of all three regions. Biophysical models of the plankton dynamics over the last half century on the West Florida shelf explore the contrasting roles of fishing harvests and petrochemical effluents as top-down control functions, effecting both altered marine trophodynamics and frequency of malign respiratory episodes.

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Session: 007 - 8

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Analysis and Modeling

Date: Monday, January 21 12:15 PM  
Type: Oral Presentation

## Can we Disentangle the Effects of a Big Oil Spill and a Big Fisheries Closure? An Analysis of Fisheries-Independent Trawl Data for Louisiana

**Presenter:** Joe Neigel – UL Lafayette

**Authors:** Joe Neigel, University of Louisiana at Lafayette; Erin K. Grey, University of Notre Dame; Caroline M. Taylor, Tulane University

### Abstract:

The 2010 oil spill coincided with the spawning of many important fish and invertebrate species that have planktonic larvae. Contact with oil and dispersant, both of which are toxic to larvae, may have reduced larval survival and settlement, and possibly the sizes of cohorts recruited in that year. However, the oil spill prompted one of the largest fishery closures in history, which likely had significant and possibly opposing effects on recruitment. The Louisiana Department of Wildlife and Fisheries has been conducting a fishery-independent monitoring program since 1986. Counts and size distributions for over 20 species are recorded from each trawl. We analyzed these data and compared catch/effort of juveniles in 2010 and 2011 with preceding years. Short term changes associated with the oil spill and fisheries closures were superimposed on long-term trends of changing abundance. These results highlight the difficulty of assessing the direct impacts of the oil spill in what was essentially an uncontrolled experiment with a single replicate and multiple interacting factors.

body growth changes. We intend to develop an end to end ecosystem model using the Atlantis framework for the Gulf of Mexico, which allows us to synthesize this C-IMAGE data to better understand the community level impacts. Atlantis will incorporate hydrodynamic modeling, toxicology, and physiological impacts of oil and dispersants throughout the food web in a 3D spatially explicit domain. Based on this data, we will develop spatial forcing functions to drive various aspects of the ecology dynamically, such as mortality due to toxins present in the water column or benthos. Model results will be validated with empirical community structure observations. Atlantis can also simulate the effects of remediation actions taken, such as fisheries closures and water releases and estimate their economic impact.

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Session: 007 -

Track: Ecosystems of the Open Ocean: Microbes Mammals and Models—Analysis and Modeling

Date: Monday, January 21 16:30 - 18:30  
Type: Poster

## End to end ecosystem modelling of DWHOS impacts

**Presenter:** Lindsey Dornberger – University of South Florida

**Authors:** Lindsey Dornberger, University of South Florida; Cameron Ainsworth, University of South Florida

### Abstract:

Quantifying impacts from the Deepwater Horizon oil spill in terms of persisting trophic cascades and ecosystem recovery time is a priority. The C-IMAGE consortium has begun to study various aspects of the spill; such as droplet dynamics, changing sediment composition, fish histology, and

# Science Abstracts

University of Delaware; A. Griffo, CNR-ISMAR; A.D. Kirwan Jr. ,  
University of Delaware

## Abstract:

Initial dispersion, residence time, and advective pathway results obtained from the nearly simultaneous deployment of some 300 surface drifters in the vicinity of the DeSoto Canyon are reported. The goal of the GLAD experiment was to characterize, with unprecedented statistical significance, multi-point and multi-scale dispersion properties of the flow in the region of the DwH spill site including demarcation of the advective pathways between the Canyon and larger-scale flow features in the Gulf. Both the absolute and relative dispersion of surface drifters was quite slow for those drifters initialized within the Mississippi River Outflow. For the initial time period considered, drifter motion was characterized by large amplitude inertial motions, overall strong topographic control, and significant indications of interior control by frontal dynamics on 1-5 km scales. Very limited exchange, either across-shelf or with nearby mesoscale features, was observed and residence times in the Canyon typically exceeded one week with many drifters remaining there for more than 21 days.

## Session: 008 Physical Oceanography of the Northern Gulf of Mexico

Session: 008 - 1

Track: Physical Oceanography of the Northern Gulf of Mexico

Date: Monday, January 21 2:00 PM  
Type: Oral Presentation

### Review of Slope Circulation between the Mississippi Delta and DeSoto Canyon from Observations

**Presenter:** Peter Hamilton – SAIC

**Authors:** Peter Hamilton, Science Applications International, Corp.

#### Abstract:

The DeSoto canyon is where the complex steep topography of the northeast continental slope meets the smooth broad slope of the Florida Terrace. Slope circulation is dominated by warm and cold eddies, with diameters ~150-20 km and rotation periods ~10-20 days, such that smaller and larger eddies tend to dominate the shelf-break and lower slope, respectively. Lower slope eddies are often quasi-stationary, remaining in similar locations for ~weeks to months. Slope eddies are influenced by peripheral cold cyclones on the northern part of an extended Loop Current (LC), both directly, and by the advection of warm LC water northwards across the slope, resulting in the spin-up of warm anticyclones through potential vorticity conservation. Eddy interactions with topography often produce oppositely directed along slope flows at the surface (usually eastward) and at 200 to 300 m depth (usually westward). Eddy and wind-driven upwelling, and narrow on- or off-slope jets that occur between small-scale eddy pairs of opposite sign, are important shelf-upper slope exchange processes.

Session: 008 - 2

Track: Physical Oceanography of the Northern Gulf of Mexico

Date: Monday, January 21 2:15 PM  
Type: Oral Presentation

### Grand Lagrangian Deployment: Drifter observations of surface currents and dispersion characteristics in the DeSoto Canyon

**Presenter:** Andrew Poje – City University of New York

**Authors:** A. Poje, City University of New York; T. Ozgokmen, University of Miami; B. Lipphardt, University of Delaware; A. Haza, University of Miami; B. Haus, University of Miami; G. Jacobs, NRL; A. Reniers, University of Miami; J. Olascoaga, University of Miami; E. Ryan, University of Miami; G. Novelli, University of Miami; Helga Huntley,

Session: 008 - 3

Track: Physical Oceanography of the Northern Gulf of Mexico

Date: Monday, January 21 2:30 PM  
Type: Oral Presentation

### Deepwater mooring deployment and oceanographic conditions on the continental shelf and slope of the north central Gulf of Mexico - July 2012

**Presenter:** Steven DiMarco – Texas A&M University

**Authors:** Steven DiMarco, Texas A&M University; Piers Chapman, Texas A&M University; Norman Guinasso, Texas A&M University; Laura Spenser, Texas A&M University; Joseph Kuehl, Texas A&M University

#### Abstract:

Six deepwater oceanographic moorings collecting current velocity, temperature and salinity were deployed in the northcentral Gulf of Mexico as part of the Gulf Integrated Spill Research Consortium (GISR). We report on the horizontal and vertical distributions of hydrographic and water column properties in the north central Gulf of Mexico during the July 2012 deployment. The observations are made from the Louisiana continental shelf seaward to the continental slope in the vicinity of the Deepwater Horizon spill site. At the time of the observations, the Mississippi River was near record low levels, however, surface winds and offshore circulation features show the freshwater plume advected south and west from the Mississippi River delta across the shelf and into the

# Science Abstracts

deep Gulf of Mexico. Hydrographic properties in deepwater apart from the very near surface influenced by the freshwater plume (temperature, salinity, nutrients, dissolved oxygen concentration) are within historical limits. No evidence of deep (1100-1500 m depth) dissolved oxygen anomalies reported in the wake of the spill are observed.

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Session: 008 - 4

Track: Physical Oceanography of the Northern Gulf of Mexico

Date: Monday, January 21 2:45 PM

Type: Oral Presentation

## Surface Oil Motion Yields New Perspectives on Circulation Processes in the Northern Gulf of Mexico

**Presenter:** Nan Walker – Louisiana State University

**Authors:** Nan Walker, Louisiana State University; Chet Pilley, Louisiana State University; Peter Brickley, Horizon Marine Inc.; Patrice Coholan, Horizon Marine Inc.; Robert Leben, University of Colorado CCAR; Hans Graber, University of Miami

### Abstract:

This study assesses the forcing mechanisms for surface oil motion during the 84-day Deepwater Horizon oil spill. Satellite data from MODIS and SAR sensors proved effective for tracking the surface oil in near real-time. De-clouded GOES sea surface temperatures and multi-sensor sea surface height data were used to track the Loop Current and deepwater eddies on a daily basis. Satellite-tracked drifters, acoustic Doppler current profilers, and anemometers were employed to identify the major forcing mechanisms. Some of the observed oil patterns fortuitously provided researchers with Lagrangian tracers of circulation. Oil motion and directional changes were found to be controlled by several main circulation processes: (1) easterly wind-driven shelf gyre systems (2) direct and in-direct wind effects (3) wind-related sea level slopes east of the Mississippi delta, and a (4) cyclonic eddy merging event along the LC that entrained oil rapidly seaward tripling oil coverage within seven days.

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Session: 008 - 5

Track: Physical Oceanography of the Northern Gulf of Mexico

Date: Monday, January 21 3:00 PM

Type: Oral Presentation

## Upwelling Response to Hurricane Isaac

**Presenter:** Lynn Shay – University of Miami

**Authors:** Benjamin Jaimes, University of Miami; Lynn K. Shay, University of Miami; Jodi Brewster, University of Miami; Ryan Schuster, University of Miami

### Abstract:

Tropical cyclone (TC) Isaac moved over the oceanic eddy field in the Gulf of Mexico. Expendable probes were deployed from NOAA WP-3D aircraft during four in-storm flights to measure oceanic variability and its impact on TC-driven upwelling and surface fluxes of heat and momentum. At the time of intensification to category 1 hurricane, Isaac's center moved over cold cyclonic features, while its right and left sides moved over warm anticyclones. Over these oceanic regimes, maximum oceanic mixed layer (OML) currents of 0.2 to 0.7 m s<sup>-1</sup> were measured, which are about 50% smaller than the expected velocity response under quiescent oceanic conditions; thermocline currents are at least twice as energetic as the OML currents. Although OML currents were measured inside the core of cyclonic wind stress curl, their orientation is not consistent with horizontally divergent flows typically found in upwelling regimes under TC centers. These results point to an important modulation of the OML current and upwelling response by background oceanic flows.

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Session: 008 - 6

Track: Physical Oceanography of the Northern Gulf of Mexico

Date: Monday, January 21 3:15 PM

Type: Oral Presentation

## Autonomous Ocean Acidification Survey Utilizing the Wave Glider

**Presenter:** Jamie Griffith – Liquid Robotics

**Authors:** Jamie, Griffith, Liquid Robotics; Stephan Howden, University of Southern Mississippi

### Abstract:

The Wave Glider (WG) is an Unmanned Surface Vehicle (USV) that harnesses mechanical energy from waves and electrical energy from solar cells to power a configurable panel of scientific instruments. In partnership with the University of Southern Mississippi, the Gulf of Mexico Coastal Ocean Observing System (GCOOS) and the Northern Gulf Institute, Liquid Robotics deployed a Wave Glider in the northern Gulf of Mexico. The system was outfitted with: CO<sub>2</sub> air-sea interface system, a CTD+dO, a pH sensor, a weather station, and a water speed sensor. The vehicle was deployed near the Central Gulf of Mexico Ocean Observing System (CenGOOS) buoy site at the 20 m isobath in the northwest corner of the Mississippi Bight in early October of 2012 and directed along a path near the Mississippi Balize Delta defined by the July 2012 GOMEC-II trials ship route. The purpose of the mission was to assess the ability to support the monitoring goals of NOAA's Ocean and Great Lakes Acidification Research Implementation Plan, the interagency North American Carbon Program (NACP), and the Integrated Ocean Observing System (IOOS) through the autonomous collection of CO<sub>2</sub> using a wave

# Science Abstracts

Glider. This study also demonstrated the ability to use the Wave Glider as an effective mobile tool for gathering a suite of in-situ observations typically collected with fixed buoys, and how the real-time data stream could effectively be integrated into GCOOS Data Portal and made readily available for coastal resource decision makers.

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Session: 008 - 7

Track: Physical Oceanography of the Northern Gulf of Mexico

Date: Monday, January 21 3:30 PM

Type: Oral Presentation

## Wind-driven Shelf Water Flow Near the DeSoto Canyon

**Presenter:** Allan Clarke – Florida State University

**Authors:** Allan J. Clarke, Florida State University; Stephen VanGorder, Florida State University

### Abstract:

How did the BP oil spill go from about a mile deep and reach the zero depth coastal beaches more than a hundred km away in 3 weeks? Particles are mainly transported by low-frequency flows, and therefore it is crucial to understand the dynamics of those flows for moving particles onto, along and across the shelf. Much of the flow on the shelf is wind-driven, and here we seek to understand the basic physics of this flow using a coastally trapped wind forced-wave model and current meter observations available to us from the Shelf to Slope Energetics and Exchange Dynamics (SEED) program, the DeSoto canyon eddy intrusion study, the Florida State University Red Tide and Northern Gulf Institute programs, and NOAA Ports. Comparison of model and observed currents will test the hypothesis that remote wind forcing along the West Florida shelf plays a major role in the wind-driven shelf flow near the DeSoto canyon. The hypothesis that narrow canyons cutting into the shelf provide a rectified transport of the low-frequency flow onto the shelf will also be discussed.

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Session: 008 - 8

Track: Physical Oceanography of the Northern Gulf of Mexico

Date: Monday, January 21 3:45 PM

Type: Oral Presentation

## Vertical Distribution of Water Trajectory Analysis Using Oil Rig-based ADCP Measurements and Optimal Interpolations in the Horizontal

**Presenter:** Chunyan Li – Louisiana State University

**Authors:** Chunyan Li, LSU; Changming Charles Dong, UCLA

### Abstract:

Oil rig-based ADCP measurements of subsurface oceanic velocity profiles along the vertical at various locations in the northern Gulf of Mexico are analyzed. The objective was to determine the water particle trajectories at various sub-surface positions and at different locations within the northern Gulf of Mexico. We are also interested in the ocean dynamics that drives the water motion in the study area. In Situ observational data will provide valuable information for the dynamics. For that purpose, the velocity profiles from multiple oil rigs are used to calculate the water particle trajectories, aimed at a good understanding of the fate of the oil spilled from the May 2010 BP Deep-Water Horizon (DWH) accident. More specifically, current velocity profiles at 22 stations surrounding the DWH site are used. The Optimal Interpolation (OI) method is employed to map the current velocity field at each vertical level. Continuous quasi-Lagrangian trajectories of water particles starting from the DWH site are calculated from the velocity field. The Lagrangian trajectories of water particles derived from the data are comparable with satellite images of the surface oil from the accident, which indicates that the advection of oceanic currents might be a dominant process at the early stage of the oil spill. In addition, subsurface data reveal vertical variation of the trajectories. The results also suggest that observations from these ADCPs on oil rigs in the northern Gulf of Mexico can be used collectively to provide a preliminary predictive assessment of an oil spill, should it occur in the future.

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Session: 008 - 9

Track: Physical Oceanography of the Northern Gulf of Mexico

Date: Monday, January 21 4:00 PM

Type: Oral Presentation

## Observations of Loop Current Circulation Processes and Eddy Separations: April 2009 to November 2011

**Presenter:** Kathleen Donohue – University of Rhode Island

**Authors:** Kathleen Donohue, University of Rhode Island; Peter Hamilton, Science Applications International Corporation; Robert R. Leben, University of Colorado; Julio Sheinbaum, Centro de Investigacion Cientifica y Educacion Superior de Ensenada (CICESE); D. R. Watts, University of Rhode Island

### Abstract:

Between April 2009 and November 2011, in a BOEM-funded study, 9 full-depth, and 6 near-bottom current meter moorings, along with 25 PIES were deployed in the eastern Gulf of Mexico along with moorings on Campeche bank and in the Yucatan Channel. Detachments and separations of three major LC eddies are observed, one occurred during the Deep Water Horizon oil spill. Detachments were initiated by growing



# Science Abstracts

large amplitude, long wavelength meanders, on the eastern side of an extended LC. A growing trough from the southwest Florida slope leads to detachment. Meanders seem to be triggered by a build up of cyclonic eddies along the LC's northern edge. These eddies form along the Campeche slope and translate northwards along the LC. Large amplitude bottom currents occur during LC eddy formation and detachment events and are nearly depth independent below 1000 m depth. A ~90 degree phase lead of the lower-layer cyclonic and anticyclonic velocities exists with surface-layer meander troughs and crests -- a signature of baroclinic instability. This is not found on the western side of the LC.

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Session: 008 - 10

Track: Physical Oceanography of the Northern Gulf of Mexico

Date: Monday, January 21 4:15 PM

Type: Oral Presentation

## Predictability potentials of the dynamic conditions in the Mississippi – Atchafalaya shelf

**Presenter:** Yuley Cardona – Georgia Institute of Technology

**Authors:** Yuley Cardona, Georgia Institute of Technology; Annalisa Bracco, Georgia Institute of Technology

### Abstract:

The predictability of the Northern Gulf of Mexico is evaluated using an ensemble of two-way nested integrations for the period 2000-2008. The model implemented is Roms-Agrif 2.1. The nested grid covers the Mississippi-Atchafalaya shelf at 1.6 km horizontal resolution with 35 vertical layers, while the parent grid covers the whole Gulf at 5km resolution. The model is forced by monthly heat and momentum fluxes. With an ensemble of runs we explore the role of boundary conditions, atmospheric forcing, and nesting. We investigate the predictability of the Gulf circulation comparing model realizations differing only in the initial conditions and model output versus observations. The potential for predictability varies regionally and seasonally, and depends on changes in wind and runoff direction. Higher predictability is found in April-August, when southeasterly winds and maximum discharge occur. Predictability potential is limited by the inability to model the timing of the loop current eddy shedding due to its intrinsic variability.

Session: 008 -

Track: Physical Oceanography of the Northern Gulf of Mexico

Date: Monday, January 21 16:30 - 18:30

Type: Poster

## Laboratory investigation of the De Soto canyon and its influence in the deep-ocean exchange with the shelf

**Presenter:** Nicolas Choplain – Geophysical Fluid Dynamics Institute

**Authors:** Nicolas Choplain, Florida State University; Kevin Speer, Florida State University

### Abstract:

The present work, which is part of the the Deep-C (Deep Sea to Coast Connectivity in the Eastern Gulf of Mexico) project, studies the interactions of the DeSoto Canyon with the general circulation of the Gulf of Mexico. The observed paths of the oil spill from the recent Deepwater Horizon incident suggested that the DeSoto canyon plays a key role into the exchange between the deep-water ocean and the shelf. The aim here is to develop an experimental set-up able to simulate the interactions of the regional circulation with the peculiar bathymetry of the DeSoto canyon. The role of the canyon in upwelling events and transport within the canyon will be explored. In particular, attention will be given to the movement of suspended particules in and near the canyon, in order to evaluate the role of the canyon in the dispersion of pollutants. Experiments will take place on a rotating table at the Geophysical Fluid Dynamics Institute using a variety of shapes, including a scale model of the DeSoto canyon

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Session: 008 -

Track: Physical Oceanography of the Northern Gulf of Mexico

Date: Monday, January 21 16:30 - 18:30

Type: Poster

## Across-shelf current and transport on a coastal shelf directly influenced by estuarine outflow

**Presenter:** Kyeong Park – University of South Alabama

**Authors:** Kyeong Park, University of South Alabama; Brian Dzwonkowski, Dauphin Island Sea Lab

### Abstract:

A time-series data from a mooring site on the Alabama inner shelf are used to examine across-shelf circulation and transport. Despite the predominant east wind (downwelling), the surface transport is primarily offshore. During spring/summer, an asymmetric response to the along-shelf wind stress favors upwelling that contributes to the offshore surface transport. During fall/winter, although weaker compared to the along-



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shelf response, the response to the across-shelf wind stress results in offshore surface transport. On synoptic time scales, wind stress magnitude and stratification show significant relationships with the across-shelf transport. The wide range of stratification conditions provides new insight to the importance of stratification. Under weak stratification, across-shelf wind stress plays a significant forcing role and there is no apparent relationship with along-shelf transport efficiency. As stratification increases, across-shelf wind stress becomes less important and the transport efficiency increases to a point, above which there is again no clear relationship.

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**Session: 008 -**

Track: Physical Oceanography of the Northern Gulf of Mexico

Date: Monday, January 21 16:30 - 18:30

Type: Poster

## Circulation Transport and Connectivity in the Gulf of Mexico

**Presenter:** Hui Qian – North Carolina State University

**Authors:** Hui Qian, North Carolina State University; Ruoying He, North Carolina State University; Yizhen Li, North Carolina State University

### Abstract:

The coastal ocean connectivity associated with the Gulf of Mexico (GOM) surface flow fields in 2004-2012 is studied using surface numerical particle trackings based on realistic regional ocean circulation hindcast solutions. Surface particles are released every five days in each year, and their trajectories are carefully represented by Lagrangian probability density function calculations. The coastal connectivity is further quantified using the connectivity matrix, source and destination functions. Our results demonstrate the importance of circulation dynamics in determining the material property transport. For example, strong connections between west and central GOM are largely due to the westward propagation of anti-cyclonic eddies after their separations from the Loop Current. The connectivity matrix reveals interesting transport variations relative to the mean condition. Such seasonal to interannual variability can significantly alter the tempo-spatial distributions of biological species (such as fish larvae used in this study) in the Gulf.

**Session: 008 -**

Track: Physical Oceanography of the Northern Gulf of Mexico

Date: Monday, January 21 16:30 - 18:30

Type: Poster

## Deep Ocean Response to Hurricane Ivan Along the Northern Rim of the DeSoto Canyon

**Presenter:** Lynn Shay – University of Miami

**Authors:** Ryan Schuster, University of Miami; Lynn K. Shay, University of Miami; Benjamin Jaimes, University of Miami

### Abstract:

During the passage of Hurricane Ivan in 2004, an array of Acoustic Doppler Current Profiler (ADCP) moorings, deployed as part of a Naval Research Laboratory Experiment focusing on cross-shelf exchange, measured the oceanic response along the northern rim of the DeSoto Canyon. These moorings provided vertical and horizontal velocity components throughout the upper ocean to as deep as 500 m. At the deep moorings, current meters measured the temperature and pressure response at 1000 m. The momentum response was associated with forced near-inertial motions and the downward propagation of energy from the surface mixed layer. The response consisted of energetic baroclinic and weaker barotropic components as observed during Frederic (1979). Vertical velocities approached 0.5 cm s<sup>-1</sup> (~500 m d<sup>-1</sup>) even at depth, suggesting strong upwelling signals along the northern rim of the DeSoto Canyon consistent with remote sensing studies.

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**Session: 008 -**

Track: Physical Oceanography of the Northern Gulf of Mexico

Date: Monday, January 21 16:30 - 18:30

Type: Poster

## Physical oceanographic conditions on the continental shelf and slope of the north central Gulf of Mexico near the Deepwater Horizon site in 2012

**Presenter:** Laura Spencer – Texas A&M University

**Authors:** Laura Spencer, Texas A&M University; Steven DiMarco, Texas A&M University; Norman Guinasso, Texas A&M University

### Abstract:

We report on the horizontal and vertical distributions of current velocity in the north central Gulf of Mexico during the summer of 2012. ADCP time series data collected from 16 fixed platform stations in the Mississippi Canyon region are used to determine the vertical construction of the currents by analyzing selected depths in the water column. Progressive vector diagrams are created to show general flow

# Science Abstracts

characteristics in the summertime of 2012 in support of the dye tracer release experiment conducted in that area. These observations provide temporal context to hydrographic observations collected in early July 2012. During the summer of 2012 the loop current was observed mostly south of the study region (south of 27 N). Satellite altimeter data show a weak cyclone in the vicinity of the study region. This study is part of the Gulf Integrated Spill Research Consortium.

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**Session: 008 -**

Track: Physical Oceanography of the Northern Gulf of Mexico

Date: Monday, January 21 16:30 - 18:30

Type: Poster

## **Moorings and Floats in the De Soto Canyon**

**Presenter:** Nico Wienders – Florida State University

**Authors:** Nico Wienders, Florida State University

### **Abstract:**

We present the physical oceanography field work component of the Deep-C project. Six moorings were deployed in May 2012 from 700 meters to 50 meters along the De Soto Canyon axis. All are equipped with temperature and salinity recorders, acoustic doppler current profilers. Additionally, 36 acoustic rafts floats were deployed at the depth of 300 meters.

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# Science Abstracts

## Session: 009 The Submesoscale Route to Transport and Mixing

Session: 009 - 1

Track: The Submesoscale Route to Transport and Mixing

Date: Monday, January 21 10:30 AM

Type: Oral Presentation

### Submesoscale, Wave-Influenced Currents in the Upper Ocean

**Presenter:** James C. McWilliams – UCLA

**Authors:** James C. McWilliams, UCLA

#### Abstract:

An overview is presented for submesoscale circulation and material transport generated through down-scale processes from mean and mesoscale flows. Their structures are typically fronts, filaments, vortices, wakes, ageostrophic instabilities, and emitted inertia-gravity waves. They are especially active in the upper ocean, partly overlap with the surface turbulent boundary layer, and are significantly influenced by surface gravity waves primarily through Stokes-drift vortex and Coriolis forces and Lagrangian material advection.

Session: 009 - 2

Track: The Submesoscale Route to Transport and Mixing

Date: Monday, January 21 10:45 AM

Type: Oral Presentation

### Near-surface horizontal velocity gradient estimates from hundreds of simultaneous GLAD drifter observations near the Deepwater Horizon site

**Presenter:** Bruce Lipphardt – University of Delaware

**Authors:** Bruce Lipphardt, Jr., University of Delaware; H. S. Huntley, University of Delaware; M. Sulman, University of Delaware; A. D. Kirwan, Jr., University of Delaware; S. Chen, University of Miami; E. Coelho, NRL; M. Gough, University of Miami; A. Griffa, University of Miami; B. Haus, University of Miami; A. Haza, University of Miami; P. Hogan, NRLSSC; M. Iskandarani, University of Miami; G. Jacobs, NRLSSC; N. Laxague, University of Miami; A. Valle-Levinson, University of Florida; A. Mariano, University of Miami; G. Novelli, University of Miami; M. J. Olascoaga, University of Miami; T. Ozgokmen, University of Miami; A. C. Poje, CUNY-SI; A. Reniers, University of Miami; E. H. Ryan, University of Miami; C. Smith, University of Miami; M. Wei, NRLSSC

#### Abstract:

During the GLAD experiment (July-August 2012) more than 300 drifters were launched near the Deepwater Horizon site using carefully constructed groupings designed to measure deformation and dispersion

processes at scales from 100 meters to hundreds of kilometers. These CODE-style drifters, drogued at a depth of one meter, reported positions at five-minute intervals over roughly sixty days. Here, this unprecedented set of highly-resolved trajectories is used to estimate the horizontal gradients of the horizontal velocity. These estimates are used to investigate variations in vorticity, horizontal divergence, and the Okubo-Weiss parameter over small time and space scales. Since velocity gradient estimates at these scales have previously only been available from ocean models, these results afford a unique opportunity to characterize small-scale deformation processes and to assess the ability of ocean models to accurately simulate them.

Session: 009 - 3

Track: The Submesoscale Route to Transport and Mixing

Date: Monday, January 21 11:00 AM

Type: Oral Presentation

### Surface relative dispersion measurements in the CARTHE's Grand Lagrangian Deployment (GLAD) experiment.

**Presenter:** Angelique Haza – University of Miami

**Authors:** A. Haza, University of Miami; A. Poje, CUNY; T. Ozgokmen, University of Miami; A. Griffa, CNR-ISMAR; B. Haus, University of Miami; H. Huntley, University of Delaware; P. Hogan, NRL; G. Jacobs, NRL; A.D. Kirwan Jr., University of Delaware; B. Lipphardt, University of Delaware; G. Novelli, University of Miami; J. Olascoaga, University of Miami; F. Beron-Vera, University of Miami; A. Reniers, University of Miami; E. Ryan, University of Miami

#### Abstract:

Relative dispersion metrics are sensitive to turbulent and scalar fluctuations in the underlying flow field, and allow for a better understanding of dispersion events involving biogeochemical transport.

In particular, the scale-dependent Finite Scale Lyapunov Exponent (FSLE) isolates the scales of dispersion and yields more precise information on the small-scale complex motions governing the dispersion at their own scales.

The GLAD experiment (from the CARTHE consortium) was in part configured to optimize in-situ submesoscale relative dispersion measurements in the Gulf of Mexico near the DeSoto Canyon, from a release of more than 300 surface drifters.

Results indicate high FSLE estimates and scale dependent dispersion properties at the submesoscales

for all regions covered.

A comparison to the relative dispersion from a high resolution forecast model is also presented.

# Science Abstracts

Session: 009 - 4

Track: The Submesoscale Route to Transport and Mixing

Date: Monday, January 21 11:15 AM

Type: Oral Presentation

## Ensemble Forecasting in the Gulf of Mexico during the CARTHE-GLAD experiment

**Presenter:** Patrick Hogan – Naval Research Laboratory

**Authors:** University of Miami: D. Bogocki, J. Beron-Vera, S. Chen, E. Coelho, M. Curcic, A. Griffa, M. Gough, B. Haus, A. Haza, M. Iskandarani, F. Judt, N. Laxague, A. Levinson, A. Mariano, G. Novelli, J. Olascoaga, T. Ozgokmen, E. Ryan, C. Smith; Naval Research Laboratory: P. Hogan, G. Jacobs, P. Thoppil, M. Wei; University of Delaware: H. Huntley, D. Kirwan, B. Lipphardt; College University of New York: A. Poje; Naval Postgraduate School: A. Reniers; Naval Oceanographic Office: B. Lunde

### Abstract:

Results are presented from the U.S. Navy's various circulation models that routinely perform forecasts of ocean quantities in the Gulf of Mexico. The forecast systems differ in many aspects, primarily horizontal and vertical resolution, boundary conditions, and wind forcing. All models assimilate operational observations. These different models form the basis is multi-model ensembles (MMEs).

Different aspects of the systems are presented, including model-data comparisons, model-model comparisons, in the context of the 3-dimensional Gulf of Mexico circulation. The ensembles of ocean circulation variables produce Probability Distribution Functions (PDF's) which depict areas of high and low uncertainty in forecast skill. These PDF's are useful for mission planning and sampling purposes. The MMEs are compared to Single Model Ensemble Comparisons (SMEs) and form the basis for evaluation (in the context of where the highest forecast uncertainty is expected) with the CARTHE-sponsored GLAD drifter trajectories.

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Session: 009 - 5

Track: The Submesoscale Route to Transport and Mixing

Date: Monday, January 21 11:30 AM

Type: Oral Presentation

## Initial dispersion of a deep tracer in the Gulf of Mexico

**Presenter:** James Ledwell – Woods Hole Oceanographic Institution

**Authors:** James R. Ledwell, Woods Hole Oceanographic Institution

### Abstract:

A 25-km long streak of tracer (16.8 kg of CF<sub>3</sub>SF<sub>5</sub>) was released on an isopycnal surface at approximately 1100 m depth near 28.33 N, 88.9 W

on 28 July 2012. The mean height above bottom was 152 m. Two RAFOS floats deployed with the tracer indicated that the flow was approximately along isobaths to the southwest at a speed of about 0.06 m/s. The tracer patch was sampled with a towed array from 1 to 9 August as the tracer also moved along isobaths to the southwest. Preliminary analysis indicates that both diapycnal and along-isopycnal spreading of the tracer were enhanced, perhaps due to the proximity of the boundary. Peak concentrations observed 10 days after release were around 14 picomoles/kg, down by nearly a factor of 4E+05 from about 3 micromoles/kg in the initial injection plume.

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Session: 009 - 6

Track: The Submesoscale Route to Transport and Mixing

Date: Monday, January 21 11:45 AM

Type: Oral Presentation

## Submesoscale impact on Eulerian and Lagrangian transport in the northern Gulf of Mexico

**Presenter:** Annalisa Bracco – Georgia Tech

**Authors:** Annalisa Bracco, Georgia Tech; Yisen Zhong, Georgia Tech; Yuley Cardona, Georgia Tech; Hao Luo, Georgia Tech; Joseph P. Montoya, Georgia Tech

### Abstract:

I will discuss a suite of numerical simulations of the Gulf of Mexico that resolve the submesoscale dynamics in the northern portion of the basin. The runs are obtained using ROMS and exploiting its nesting strategies. The horizontal resolution reaches 1km and the vertical varies between 35 and 70 sigma layers.

The validation of the modeled circulation is obtained with a comparison with satellite products and in-situ data collected during five cruises during the last 3 years.

Passive Eulerian and Lagrangian tracer experiments will be presented, focusing on the role that the submesoscale plays in the transport and mixing throughout the water column and in the tracer' vertical dispersion.

Additionally, I will show a preliminary analysis of simulations using ROMS coupled to a planktonic ecosystem model. The goal of this analysis is to quantify the role of submesoscale mixing around the Mississippi river plume in the modeled ecosystem response.

# Science Abstracts

Session: 009 - 7

Track: The Submesoscale Route to Transport and Mixing

Date: Monday, January 21 12:00 PM

Type: Oral Presentation

## Geodesic LCS-core analysis of simulated currents during GLAD

**Presenter:** Maria Olascoaga – RSMAS, University of Miami

**Authors:** M. Josefina Olascoaga, University of Miami; F. Beron-Vera, University of Miami; H. Huntley, University of Delaware; G. Haller, ETH Zurich; A. Griffa, University of Miami; B. Haus, University of Miami; A. Haza, University of Miami; P. Hogan, NRL; G. Jacobs, NRL; A. Kirwan, University of Delaware; B. Lipphardt, University of Delaware; T. Ozgokmen, University of Miami; A. Poje, CUNY-SI; A. Reniers, University of Miami; E. Ryan, University of Miami; A. Valle-Levinson, University of Florida

### Abstract:

Geodesic transport theory enables objective identification of key material lines which shape mixing patterns in a flow: centerpieces of stretching and folding, shear jets, and coherent eddy boundaries. In particular, the centerpieces of stretching and folding, broadly known as Lagrangian Coherent Structures (LCSs), can admit highly attracting cores that lead to inevitable material instabilities even under uncertainties or unexpected perturbations to the flow. These LCS cores thus have the potential to forecast imminent changes in the shape of a passive tracer, even before the instability fully materializes and the motion of large masses of fluid becomes evident. In this talk we report on the application of a geodesic LCS-core analysis to simulated surface ocean currents in an attempt to predict aspects of the evolution of drifting buoys deployed during the Grand Lagrangian Deployment (GLAD) experiment. Two different ocean general circulation models, HYCOM (HYbrid-Coordinate Ocean Model) and NCOM (Navy Coastal Ocean Model), are used and whose performances are compared.

Session: 009 - 8

Track: The Submesoscale Route to Transport and Mixing

Date: Monday, January 21 12:15 PM

Type: Oral Presentation

## Can satellite chlorophyll data be used to monitor submesoscale transport and mixing in the ocean ?

**Presenter:** Marina Lévy – LOCEAN/CNRS

**Authors:** Marina Levy, LOCEAN CNRS

### Abstract:

The ocean is a turbulent flow, populated by numerous, strongly interacting, mesoscale eddies. These eddies have diameter of the order of

100 km and a life time of a few months. Their interaction leads to intense sub-mesoscale features, mostly in the form of filaments of only a few km width and duration of a few days.

Oceanic filaments are important features of transport at the surface of the ocean, and their signature is evident on satellite images of sea-surface temperature and chlorophyll (Chl).

In this presentation, I will review the physical mechanisms occurring at sub-mesoscale and show how they can affect sources, sinks and distribution of Chl. I will distinguish between lateral stirring processes, which create large Chl gradients over very small spatial scale, and vertical processes, which modify the supplies of nutrients and the amount of light received by the cells and needed for photosynthesis.

Session: 009 -

Track: The Submesoscale Route to Transport and Mixing

Date: Monday, January 21 16:30 - 18:30

Type: Poster

## Upper ocean energetics during the Grand Lagrangian Deployment (GLAD) Experiment

**Presenter:** Darek Bogucki – Texas A&M University-Corpus Christi

**Authors:** Texas A&M University Corpus Christi: D. Bogucki, K. K. Ariyaratne, C. Mitchell; University of Miami: F. J. Beron-Vera, S. Chen, M. Curcic, M. Gough, A. Griffa, B. Haus, A. Haza, M. Iskandarani, N. Laxague, A. Mariano, G. Novelli, M.J. Olascoaga, T.M. Ozgokmen, A. Reniers, E.H. Ryan, C. Smith; University of Delaware: H.S. Huntley, A.D. Kirwan Jr., B.L. Lipphardt; Naval Research Laboratory: E. Coelho, P. Hogan, G. Jacobs, M. Wei; CUNY-SI: A. Poje; University of Florida: A. Valle-Levinson

### Abstract:

During the GLAD experiment, planned and executed by the CARTHE consortium, we have carried out measurements of the turbulent kinetic energy dissipation (TKED) and the temperature dissipation (TD) rates in vicinity of the DWH (Deep Water Horizon) site and over the De Soto Canyon.

Our data set includes vertical profiles down to 100 m and the fixed depth 0.6 m below surface measurements over O(20 km) long horizontal transect

where we have collected TKED and TD every 0.5 second.

Using the parameterizations of Osborn, 1980, we have quantified the vertical distribution of eddy diffusivity of density and temperature. Based on the approach of Sundermayer and LeLong, 2005, we have estimated the variability of near surface lateral dispersion within our O(20km) long horizontal transects.

# Science Abstracts

The data from fixed depth of 0.6 m horizontal transect permitted us to quantify energy and temperature dissipation rates dependence on the surface wave phase.

Our initial observation shows that in the presence of long waves with period of  $O(20 \text{ sec})$  with a small amplitude  $O(0.2 \text{ m})$  swell and at 0.6 m below the surface, the TKED typically varies by a factor of 2 within a single wave.

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Session: 009 -

Track: The Submesoscale Route to Transport and Mixing

Date: Monday, January 21 16:30 - 18:30

Type: Poster

## Parametrization of particle transport at submesoscales in the Gulf of Mexico.

**Presenter:** Angelique Haza – University of Miami

**Authors:** A. Haza, University of Miami; T. Ozgokmen, University of Miami; A. Griffa, CNR-ISMAR; P. Hogan, NRL; L. Zamudio, NRL

### Abstract:

Submesoscale flows have a significant impact on the transport at their own scales, yet require extensive data sets and numerical computations, making them challenging to approach deterministically.

A recent Lagrangian parametrization to correct particle transport at the submesoscales is implemented for the surface circulation of the Gulf of Mexico, combining mesoscale transport from the deterministic Lagrangian Coherent Structures (LCS) and statistical Lagrangian subgridscale (LSGS) models over the submesoscale range.

Two HYCOM simulations configured for the GoM and run with identical forcing conditions but different horizontal grid resolutions are considered: a  $1/25$  degree grid as the eddy-permitting

model field, and a  $1/100$  degree grid capable of resolving submesoscales in the 2-10km range, as the control run. The LSGS models are used in conjunction with the  $1/25$  degree HYCOM solution to statistically approach the scale-dependent dispersive characteristics of the  $1/100$  degree solution.

Session: 009 -

Track: The Submesoscale Route to Transport and Mixing

Date: Monday, January 21 16:30 - 18:30

Type: Poster

## Modeling transport and discharge from cold seeps using a high resolution regional ocean model

**Presenter:** Hao Luo – Georgia Institute of Technology

**Authors:** Hao Luo, Georgia Institute of Technology; Annalisa Bracco, Georgia Institute of Technology

### Abstract:

In the northern Gulf of Mexico, gas and oil are continuously released at natural seeps located in the western and central portions of the continental slope. In this work, as part of the ECOGIG project, we investigate if and how vertical velocities associated with ageostrophic motions at the ocean submesoscale affect the transport from the deep waters to the surface. We do so with a set of simulations using the Regional Ocean Modeling System (ROMS) and a two-way nesting strategy. The model is configured with 70 vertical layers and horizontal resolution varying from 5km to 1.6km at the continental slope. We also release a passive tracer in correspondence of GC600 to quantify advective time-scales, transport and mixing in the water column, and we analyze the interplay between topography, ocean currents, inertial motions and mesoscale structures along the continental slope.

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Session: 009 -

Track: The Submesoscale Route to Transport and Mixing

Date: Monday, January 21 16:30 - 18:30

Type: Poster

## A modeling study of salt exchange for Mobile Bay, a northern Gulf of Mexico estuary

**Presenter:** Kyeong Park – University of South Alabama

**Authors:** Kyeong Park, University of South Alabama; Choong-Ki Kim, Stanford University

### Abstract:

A three-dimensional hydrodynamic model is applied to Mobile Bay, a northern Gulf of Mexico estuary, to study salt exchange through the mouth, Main Pass (MP). Both the volume discharge rate  $Q_f$  and salt transport rate  $FS$  vary greatly with the range of variation 1-2 orders of magnitude larger than the mean. During the period of strong stratification, the landward shear dispersive salt transport  $FE$  peaking during equatorial tides and the landward tidal oscillatory salt transport  $FT$  peaking during tropic tides, respectively, balance the seaward advective transport  $Q_{fSo}$ . During the period of relatively weak



# Science Abstracts

Session: 009 -

Track: The Submesoscale Route to Transport and Mixing

Date: Monday, January 21 16:30 - 18:30

Type: Poster

stratification, FS at MP is almost entirely determined by QfSo and its variability is well correlated with north-south (along-estuary) wind, which is associated with the barotropic (water level) adjustment. East (along-shelf) wind events induce onshore Ekman transport and thus coastal sea level set-up, resulting in landward flow throughout the relatively well-mixed water column and thus making FS almost entirely determined by QfSo with a negligible contribution from FE or FT.

Session: 009 -

Track: The Submesoscale Route to Transport and Mixing

Date: Monday, January 21 16:30 - 18:30

Type: Poster

## Inertial Currents in the Northern Gulf of Mexico During The GLAD Experiment

**Presenter:** Ad Reniers – rsmas/um

**Authors:** M. Gough; A. Reniers; B. Haus; F.J. Beron-Vera; S. Chen; E. Coelho; A. Griffo; A. Haza; P. Hogan; S. Howden; H.S. Huntley; M. Iskandarani; G. Jacobs; A.D. Kirwan, Jr.; N. Laxague; A. Levinson; B.L. Lipphardt, Jr.; A. Mariano; G. Novelli; M.J. Olascoaga; T. Ozgokmen; A. Poje; E.H. Ryan; C. Smith; M. Sulman; B. Webb; M. Wei

### Abstract:

More than 300 GPS-tracked surface drifters were deployed beyond the shelf in the northern Gulf of Mexico (GoM) as part of the Great Lagrangian Deployment (GLAD), July 17 – 30, 2012. Also during this time three HF radar systems, maintained by the University of Southern Mississippi, were monitoring surface currents over the shelf. Here we combine HF radar and Lagrangian drifter data to investigate inertial currents in the northern GoM with unique spatial and temporal resolution.

The significance of inertial currents over the continental slope in the northern GoM is well documented [Jarosz et al., 2007]. Although strong inertial currents in the GoM are typically generated by strong winds associated with the passage of winter cold fronts, strong inertial currents can also be generated by resonating diurnal wind forcing at approximately 30° N latitude where diurnal and inertial frequencies are equivalent [Jarosz et al., 2007; Simpson et al., 2002].

During the GLAD Experiment we observed a period of diurnal wind forcing at NDBC buoys 42020 and 42012 in the northern GoM. Coinciding with the diurnal wind forcing, initial observations exhibit significant inertial motions with unique temporal and spatial variability which will be presented at the conference.

## Removal of Louisiana Crude Oil from Natural Coastal Surfaces with Corexit 9500A: Factorial Analysis of Environmental Parameters

**Presenter:** Berrin Tansel – Florida International University

**Authors:** Berrin Tansel, Florida International University; Mengshan Lee, Florida International University; Jillian Berbakov, Florida International University; Urpiana Koklonis, Florida International University; Derya Tansel, Florida International University

### Abstract:

The dispersion of oil-mineral aggregate may affect the treatment options for oil spills near shore lines. This study aims to evaluate the coverage and washing efficiency of the crude oil after application of dispersants Corexit 9500A and Corexit 9527A on different natural surfaces in costal environments in Florida. Experiments were conducted using media collected from costal environment (i.e., beach sand, sea shells, mangroves, seaweed, and sea grass). The samples were exposed to conditions similar to the ocean environment for salinity and weathering profiles. Change in surface tension with application of dispersants show the enhanced dispersion of crude oil into smaller and denser droplets, as observed in the sample with 15% of dispersant at 34‰ salinity. Small oil droplets lead to impairing of the binding of oil to mineral substances. Size of substrate also affects the penetration rate of the oil and leads to the different rate of oil mass removal.

# Science Abstracts

## Session: 010 Advances in Modeling the Gulf of Mexico

Session: 010 - 1

Track: Advances in Modeling the Gulf of Mexico

Date: Tuesday, January 22 8:30 AM

Type: Oral Presentation

### Real-Time Coupled Ocean-Atmosphere-Wave Simulations in the Gulf of Mexico

**Presenter:** Patrick Hogan – Naval Research Laboratory

**Authors:** Patrick J. Hogan, Naval Research Laboratory; Travis A. Smith, Naval Research Laboratory; Richard A. Allard, Naval Research Laboratory; S. Chen, Naval Research Laboratory; Paul J. Martin, Naval Research Laboratory; Shelley Riedlinger, Naval Research Laboratory; Eric Rogers, Naval Research Laboratory; Clark D. Rowley, Naval Research Laboratory; O.M. Smedstad, Quinette North America; Prasad Thoppi, Naval Research Laboratory; Eric Chassignet, Florida State University

#### Abstract:

Results from the U.S. Navy's Coupled Ocean-Atmosphere Mesoscale Prediction System (COAMPS) are presented. This system includes the COAMPS atmosphere, SWAN wave model, NCOM ocean model, and NCODA (ocean) and NAVDAS (atmosphere) data assimilation systems. The current configuration is a 4-way coupled system, and the feedback mechanisms for wave to ocean and atmosphere are under development. The atmosphere is 6 km resolution and includes sophisticated microphysics for cloud parameterization. The wave and ocean models are 3 km resolution. The system was initialized from the global NCOM model on 07 August 2012, runs in real-time, and produces a 24 hour forecast every 12 hours.

Details of the system are discussed, including observations, the system components, and the data assimilation. Comparisons between the 3 km coupled system and a 3 km non-coupled system (also based on NCOM) are discussed. Significant wave heights during and after Hurricane Ernesto (09 August 2012) are contrasted. Both surface and subsurface ocean circulation features are compared to available observations.

Session: 010 - 2

Track: Advances in Modeling the Gulf of Mexico

Date: Tuesday, January 22 8:45 AM

Type: Oral Presentation

### An integrated Ocean Circulation, Wave, Atmosphere and Marine Ecosystem Prediction System for the Gulf of Mexico

**Presenter:** Ruoying He – North Carolina State University

**Authors:** Ruoying He, North Carolina State University; George Xue, North Carolina State University; Joseph Zambon, North Carolina State University

#### Abstract:

A 3-dimensional marine environmental nowcast/forecast system has been constructed and is running quasi-operationally for the South Atlantic Bight and Gulf of Mexico. The system is based on the Coupled Ocean (ROMS)-Atmosphere (WRF)-Wave-(SWAN)-Sediment Transport (COAWST) model, and is driven by realistic meteorological boundary forcing, tides, river, and deep ocean boundary conditions provided by a data assimilative global ocean model. Model output from this nowcast/forecast system, including marine weather, ocean wave, ocean circulation and marine ecosystem variable are generated daily and available for public access at <http://omgsrv1.meas.ncsu.edu:8080/ocean-circulation/>. The construction of this prediction system, model validations and case studies on air-sea interactions during major hurricanes will be discussed in this presentation.

Session: 010 - 3

Track: Advances in Modeling the Gulf of Mexico

Date: Tuesday, January 22 9:00 AM

Type: Oral Presentation

### A High-Resolution Operational Forecast System for the Gulf of Mexico based on the Coupled Regional Climate Model

**Presenter:** Raffaele Montuoro – Texas A&M University

**Authors:** Raffaele Montuoro, Texas A&M University; Jaison Kurian, Texas A&M University; Xu Zhao, Texas A&M University; Ping Chang, Texas A&M University; R. Saravanan, Texas A&M University

#### Abstract:

The implementation of a high-resolution operational forecast system for the ocean and atmosphere over the Gulf of Mexico, as well as its ability to predict and assist emergency responders in the event of oil spills and hurricanes will be discussed in detail.

The forecast system is based on a locally developed Coupled Regional Climate Model (CRCM), which takes into account energy exchanges

# Science Abstracts

between the ocean—described by Rutgers/UCLA's Regional Ocean Modeling System (ROMS)—and the atmosphere—described by NCAR's Weather Research and Forecast System (WRF)—to improve the predictions' accuracy. The model is run on Texas A&M University's flagship high-performance computing system at 3km resolution, and forecast charts are made available in real-time through the Web (<http://sc.tamu.edu/crcm>).

The system has shown its potential during Summer 2012 by supporting the work of field scientists during a deep dispersion experiment, and by predicting the path of hurricane Isaac.

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Session: 010 - 4

Track: Advances in Modeling the Gulf of Mexico

Date: Tuesday, January 22 9:15 AM

Type: Oral Presentation

## A Decadal Ocean Reanalysis for the Gulf of Mexico

**Presenter:** Dong Ko – Naval Research Laboratory

**Authors:** Dong S. Ko, Naval Research Laboratory; Zhen Li, Bureau of Ocean Energy Management

### Abstract:

A decadal ocean reanalysis for the Gulf of Mexico was produced applying the Intra-Americas Sea Ocean Nowcast/Forecast System (IASNFS). IASNFS covers Gulf of Mexico, Caribbean Sea and part of western North Atlantic. The grid resolution is ~6 km with 40 vertical layers. The data for data assimilation are from satellite altimeters and AVHRR. Surface forcing is from NOGAPS and boundary conditions from global NCOM. IASNFS has been in real-time operation at NRL since 2003, producing 72-hr forecast daily ([http://www7320.nrlssc.navy.mil/IASNFS\\_WWW/](http://www7320.nrlssc.navy.mil/IASNFS_WWW/)). During the DWH oil spill, IASNFS was one of the backbone models that provided forecasts to NOAA for oil spill trajectory prediction. The decadal reanalysis has been evaluated against sea level variation from NOS tide gauges and satellite altimetry analysis, SST from NBDC buoys and MCSST. Results show that IASNFS reanalysis has a high correlation with observations. (Reanalysis is supported by BOEM and BP-GRI via LSU).

Session: 010 - 5

Track: Advances in Modeling the Gulf of Mexico

Date: Tuesday, January 22 9:30 AM

Type: Oral Presentation

## Interannual variability of the Gulf of Mexico loop current and eddies from models and satellite observations

**Presenter:** Eric Chassignet – Florida State University (COAPS)

**Authors:** Eric Chassignet, Florida State University; Dmitry Dukhovskoy, Florida State University; Cody Hall, University of Colorado Boulder; Robert Leben, University of Colorado Boulder; Steve Morey, Florida State University; Robert Nedbor-Gross, Florida State University

### Abstract:

The Gulf of Mexico loop current and associated eddies are the main source of energy for mesoscale activities in the Gulf. The most notable characteristic of the loop current is its highly stochastic behavior characterized by the large scales of spatial variability in its frontal position. At irregular intervals, the loop current penetrates far north into the Gulf and sheds anticyclonic rings. Both the loop current and eddies affect large areas of the Gulf throughout the whole water column. While satellite observations are the major observational sources responsible for our current knowledge of the loop current and eddy shedding process, the record length may not be long enough to derive reliable statistics of the system's behavior. This will be discussed by comparing the loop current behavior from a multi-decadal non-assimilative run of the 1/25 degree Gulf of Mexico HYCOM to the satellite observations.

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Session: 010 - 6

Track: Advances in Modeling the Gulf of Mexico

Date: Tuesday, January 22 9:45 AM

Type: Oral Presentation

## Evaluating forecasts Gulf of Mexico surface heat fluxes and thermal energy balances on seasonal to diurnal time scales

**Presenter:** Charlie Barron – Naval Research Laboratory

**Authors:** Charlie N. Barron, Naval Research Laboratory; Peter Spence, QinetiQ North America; Jan M. Dastugue, Naval Research Laboratory

### Abstract:

Sea surface temperature (SST) and thermal stratification in the Gulf of Mexico exhibit variability on diurnal to seasonal scales due to the interactions of surface heat fluxes, Loop Current intrusion, eddy shedding, and biological modification of solar attenuation. Variational treatment of mismatches between forecasts and observations of these conditions can be used to diagnose and mitigate model errors that lead to

# Science Abstracts

consistent biases. The impacts of various satellite data streams and alternative assimilation methodologies are evaluated in this context by comparing model analyses and forecasts to unassimilated ship and buoy observations. Seasonal and diurnal trends in the forecast errors identify low SST biases during the summer and local afternoon, periods of peak solar radiation. Assimilative model studies are used to estimate the relative contributions of errors in heat flux/total energy input and errors in solar attenuation/thermal stratification/vertical energy distribution.

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Session: 010 - 7

Track: Advances in Modeling the Gulf of Mexico

Date: Tuesday, January 22 10:00 AM

Type: Oral Presentation

## Upper-layer mesoscale circulation and deep currents in the Gulf of Mexico inferred from the 1/25° HYCOM GOMI

**Presenter:** Dmitry Dukhovskoy – COAPS FSU

**Authors:** Dmitry Dukhovskoy, FSU; Eric Chassignet, FSU

### Abstract:

The upper-layer circulation in the Gulf of Mexico is dominated by the Loop Current and Loop Current Eddies. Observational and model studies show relationship between the deep ocean circulation and the upper layer dynamics. Previous studies link Loop Current and Loop Current Eddies to generation of deep eddies and Topographic Rossby Waves over a sloping bottom. Linkage between the upper ocean mesoscale circulation and deep currents is analyzed from a multi-decadal non-assimilative model run of the 1/25-degree Gulf of Mexico HYCOM. Impact of varying vertical resolution on representation of the deep currents in the model is discussed.

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Session: 010 - 8

Track: Advances in Modeling the Gulf of Mexico

Date: Tuesday, January 22 10:15 AM

Type: Oral Presentation

## Deep currents near Steep Bathymetry from a Numerical Simulation of DeSoto Canyon

**Presenter:** Steve Morey – The Florida State University

**Authors:** Steve Morey, Florida State University; Dmitry Dukhovskoy, Florida State University; Eric Chassignet, Florida State University

### Abstract:

A 1 km-resolution numerical simulation of the DeSoto Canyon region has been configured using the Navy Coastal Ocean Model with a Vanishing Quasi-Sigma (VQS) vertical grid. The VQS grid has been developed and

implemented in NCOM to increase the accuracy of simulating currents with short horizontal and vertical trapping scales near steep topography, particularly in deep water. The DeSoto Canyon region has numerous steep salt domes at depth along the western periphery and is bordered to the east by the West Florida Escarpment. Prior work in other regions of the Gulf of Mexico with steep topography suggests deep currents may be intermittently enhanced along the steep slopes in water depths greater than 1000m, possibly associated with interaction of deep eddies with the bathymetry. Analyses of numerical simulations using this DeSoto Canyon model, as well as of the limited observational data sets in the region, are presented to look for evidence of intensification and links to larger scale deep and upper-ocean circulation features.

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Session: 010 - 8

Track: Advances in Modeling the Gulf of Mexico

Date: Tuesday, January 22 11:00 AM

Type: Oral Presentation

## West Florida Continental Shelf Circulation in 2010

**Presenter:** Robert Weisberg – Univ. of South Florida

**Authors:** Robert Weisberg, University of South Florida; Lianyuan Zheng, University of South Florida

### Abstract:

Missing from the oil tracking toolbox during the Deepwater Horizon incident was a model that could downscale from the deep ocean, across the continental shelf and into the estuaries. Motivated by the spill, such model development was completed, and used for simulating the West Florida Shelf circulation from Pensacola to the Florida Keys for 2010. 2010 experienced a prolonged, anomalous upwelling circulation beginning in May and lasting through most of the year. As in 1998 this anomalous upwelling was the response to remote, deep-ocean forcing by the Loop Current impinging on the shelf slope near the Dry Tortugas, plus additional eddy interactions. These prolonged deep-ocean influences resulted in a sharp thermocline and cold water extending landward to the 20 m isobath. In situ observations provide a degree of model veracity enabling us to describe the circulation and how it modified water properties. We now have an effective tool for use in many applications including spill tracking, harmful algae and fisheries ecology.

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Session: 010 - 9

Track: Advances in Modeling the Gulf of Mexico

Date: Tuesday, January 22 11:15 AM

Type: Oral Presentation

## Freshwater Pathways in the Mississippi/Atchafalaya River Plume System

**Presenter:** Robert Hetland – Texas A&M University

**Authors:** Robert Hetland, Texas A&M University; Xiaoqian Zhang, Texas A&M University; Martinho Marta-Almeida, Texas A&M University

### Abstract:

A series of numerical models are used to examine circulation on the Texas-Louisiana continental shelf. Comparisons between model results and shipboard and moored observations suggests that the models are capable of reproducing primary circulation patterns and tracer distributions over the shelf. A model covering the Louisiana shelf was nested within a variety of data-assimilative parent models. Comparison of nested model results with hydrographic observations indicates that nesting improves model skill. However, using different parent models results in similar improvements, so it appears that it does not matter much which parent model is used to generate boundary conditions. Perturbation experiments using modified forcing, by increasing and decreasing the amplitude of the fresh water and wind forcing, result in an ensemble spread that is greater than the deviation in the ensemble mean. In other words, small perturbations in forcing conditions causes large differences between simulations. The region of largest differences in ensemble members is along the Mississippi/Atchafalaya plume front. We believe this ensemble spread is caused primarily by small-scale, non-linear instabilities in the flow along the plume front, and results in a substantial noise floor that limits model predictive ability. Because these eddy-like features have space and time scales smaller than those typically resolved by hydrographic surveys, data assimilation is unlikely to reduce this model noise. A separate set of numerical experiments tagged Mississippi and Atchafalaya river outflows with a numerical dye, so that water from these two rivers can be followed separately. A shelf-wide budget for tagged fresh water from each river suggests residence time on the shelf ranging from about 3 to 12 months, with the Atchafalaya water having a longer residence time than Mississippi water.

Session: 010 - 10

Track: Advances in Modeling the Gulf of Mexico

Date: Tuesday, January 22 11:30 AM

Type: Oral Presentation

## Did the Mississippi River plume influence the surface spreading of the Deepwater Horizon oil spill patch?

**Presenter:** Villy Kourafalou – University of Miami/RSMAS

**Authors:** Villy Kourafalou, University of Miami; Yannis Androulidakis, University of Miami

### Abstract:

The close proximity of the Deepwater Horizon oil rig to the Mississippi River (MR) Delta raised early questions from disaster managers about the possible influence of river plume related circulation on oil patch evolution. Did the May 2010 Mississippi flood help to initially keep oil from reaching coastal marshes? We have explored this intriguing question, quantifying synergistic patterns in the evolution of riverine and oil covered waters. We show the unprecedented influence of a large river plume on a surface oil patch resulting from a deep oil release. The MR induced circulation was found to substantially influence the transport of oil. The relationship had different aspects east and west of the Delta. The broad MR plume regime over the MAFLA shelf created a front that restrained onshore transport. Conversely, a narrow coastal current area supported by the river plume and enhanced during downwelling-favorable winds imposed oil transport along the LATEX coast. Ecosystem implications include the increased role of oil on Dissolved Oxygen depletion, compared to river induced hypoxia.

Session: 010 - 11

Track: Advances in Modeling the Gulf of Mexico

Date: Tuesday, January 22 11:45 AM

Type: Oral Presentation

## Investigating interactions between a sand-starved barrier island and an artificial berm

**Presenter:** Joseph Long – U.S. Geological Survey

**Authors:** Joseph W. Long, U.S. Geological Survey; Nathaniel G. Plant, U.S. Geological Survey; Asbury H. Sallenger Jr., U.S. Geological Survey

### Abstract:

From 2010-2011, a 15-kilometer long, 2-meter high sand berm was constructed along Chandeleur Island, Louisiana, with the intent of providing coastal and estuarine protection against the Deepwater Horizon oil spill and to provide sediment to the disintegrating and fragmented island. Four berm-island configurations resulted from the construction



# Science Abstracts

due to variations in placement of the berm material relative to the island: 1) berm on a submerged island platform, 2) berm seaward of the island, 3) berm on the subaerial island, and 4) island where no berm was constructed. In order to document the morphologic evolution of the berm caused by storms and longer-term processes and to assess berm-island interactions, we analyzed time series of satellite images, topographic/bathymetric surveys, oceanographic measurements, and numerical model results. Initial results indicate that the berm provides only ephemeral protection from typical winter and tropical storms and it is unclear whether the berm sediment has affected the longer-term evolution of the barrier island.

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Session: 010 - 12

Track: Advances in Modeling the Gulf of Mexico

Date: Tuesday, January 22 12:00 PM

Type: Oral Presentation

## Vertical transport of passive tracers in the cumulus topped marine boundary layer

**Presenter:** Ping Zhu – Florida International University

**Authors:** Ping Zhu, Florida International University

### Abstract:

Vertical transport of passive tracers in the cumulus topped marine boundary layer is investigated using large eddy simulations (LESs). In particular, we examined the development of shallow cumuli and their impact on the vertical transport of passive tracers in response to the change of sea surface temperature (SST) and the strength of the capping inversion and large-scale subsidence. The simulations show that the vertical transport processes are substantially sensitive to these external forcings, but the convective updrafts and downdrafts associated with the cumuli are responsible for most part of the total vertical fluxes of passive tracers. The vertical transport processes associated with the precipitating and non-precipitating clouds are significantly different mainly due to the change of downdrafts induced by precipitation. The life cycle of cumulus clouds and the associated vertical transport processes are also examined using the LES data.

Session: 010 - 13

Track: Advances in Modeling the Gulf of Mexico

Date: Tuesday, January 22 12:15 PM

Type: Oral Presentation

## Representativeness Error of Velocity Assimilation into Navy Coastal Ocean Model of Gulf of Mexico

**Presenter:** Peter Spence – QinetiQ North America/NRL

**Authors:** Peter Spence, QNA/NRL; Gregg Jacobs, NRL; Charlie Barron, NRL; Brent Bartels, QNA/NRL; Clark Rowley, NRL

### Abstract:

Observational data are assimilated into Navy Coastal Ocean Model (NCOM) via Navy Coupled Ocean Data Assimilation (NCODA) system. NCODA quality controlled input are (in this study) remotely sensed sea surface temperature, sea surface height anomaly (SSHA), and in situ observations of temperature and salinity. Although configured to, NCODA is not currently used to assimilate velocity observations because there is no balance operator in place between the velocity field and the density (temperature and salinity) field. Further, enforcing geostrophic balance between velocity and density is undesirable where ageostrophic flow is significant. Using a regional NCOM of the Gulf of Mexico, modeled and observed currents are compared to geostrophic currents computed from the model output of temperature, salinity, and SSHA. The representativeness error plus model error are quantified. Velocity observation representativeness error is computed and used to weight velocity observations input to NCODA. Resulting assimilation by NCODA and ultimately NCOM is evaluated.

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Session: 010 - 14

Track: Advances in Modeling the Gulf of Mexico

Date: Tuesday, January 22 2:00 PM

Type: Oral Presentation

## Large eddy simulations of high wind oceanic boundary layers and the impact of surface waves

**Presenter:** Peter Sullivan – NCAR

**Authors:** Peter Sullivan, NCAR

### Abstract:

Large-scale parallel computing, coupled with advances in numerical algorithms, is allowing us to ask novel questions about air-sea interaction processes using turbulence resolving simulations. Of particular interest is the role surface gravity waves play in coupling the atmosphere and ocean boundary layers over a range of spatial scales. Here, we describe recent



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advances in developing a high Reynolds number large eddy simulation (LES) model for the oceanic marine boundary layer that incorporate surface wave effects under high wind (hurricane) conditions. These challenging simulations are routinely performed using 1024 cores or more depending on the computational resources available to our application. In high winds the ocean boundary layer (OBL) deepens under the combined influence of surface cooling, wind induced shear, and wave (Stokes drift) generated Langmuir turbulence. We examine the combined impact of these processes by carrying out LES of the hurricane OBL using high resolution (1024x1024x256) meshes over a time period of 72 hours. The surface wind and wave fields input to the LES are products derived from the wave prediction code WAVEWATCH III. The high amplitude transient winds force wind-waves and swell that are most often misaligned with the local winds, and the wavy OBL responds by developing temporally and spatially transient Langmuir turbulence. The Langmuir cells tend to track the local winds on the resonant side of the storm track and become vigorous at the time of maximum winds. An opposite pattern happens on the non-resonant side of the storm track as cells weaken and become nearly non-existent. These coherent structures impact the mean currents, SST, vertical velocity moments, entrainment at the thermocline, and dissipation.

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Session: 010 - 15

Track: Advances in Modeling the Gulf of Mexico

Date: Tuesday, January 22 2:15 PM

Type: Oral Presentation

## Observations and Coupled Model Forecasts from Calm Winds to Hurricane Isaac (2012) during GLAD Field Campaign

**Presenter:** Shuyi Chen – RSMAS/University of Miami

**Authors:** University of Miami: S. Chen, M. Curcic, F. Judt, A. Griffo, M. Gough, B. Haus, A. Haza, M. Iskandarani, N. Laxague, A. Mariano, G. Novelli, J. Olascoaga, T. Ozgokmen, A. Reniers, E. Ryan, C. Smith; Texas A&M Corpus Christi: D. Bogocki; Scripps Institute of Oceanography: L. Centurioni; NRL SSC: C E. Coelho, P. Hogan, G. Jacobs, M. Wei; University of Delaware: H. Huntley, D. Kirwan, B. Lipphardt; Rosetta Consulting: J. Morzel; CUNY: A. Poje

### Abstract:

Seven surface drifters equipped with meteorological instruments were deployed during the Grand Lagrangian Deployment (GLAD) field campaign in July 2012, which was organized by the Consortium for Advanced Research on Transport of Hydrocarbon in the Environment (CARTHE). They provide in situ observations of sea-level pressure (SLP), sea surface temperature (SST), and surface wind speed and direction (on three of the seven drifters) over more than two months period from July to September. The data cover a wide range of weather conditions in the

Gulf of Mexico from calm winds with large diurnal cycle of SST to the extreme high winds during the passage of Hurricane Isaac. The University of Miami Coupled Model (UMCM) has been used to provide realtime forecasts of the atmospheric and ocean circulations as well as the surface waves during GLAD. In addition to the GLAD drifters, ten SIO (Scripps Institute of Oceanography) drifters were air-deployed by the Air Force C130 over the same region during Isaac. Together these drifter data provide unprecedented in situ observations in space and time for coupled model evaluation and verification. Preliminary analyses show some complex, multi-scale circulations during and after the passage of Isaac, as well as the tropical storm-induced cold wake and recovery in the ocean, which may have some important implications for understanding of potential transport of hydrocarbon in the Gulf of Mexico.

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Session: 010 - 16

Track: Advances in Modeling the Gulf of Mexico

Date: Tuesday, January 22 2:30 PM

Type: Oral Presentation

## Wind and Wave Induced Ocean Currents in Hurricane Isaac (2012): Analyses from a Coupled Atmosphere-Wave-Ocean Model and in situ Observations

**Presenter:** Milan Curcic – University of Miami

**Authors:** University of Miami: Milan Curcic, Shuyi S. Chen, Falko Judt, Tamay Ozgokmen, Brian Haus; Scripps Institute of Oceanography: Luca Centurioni, Lance Braasch; Rosetta Consulting: Jan Morzel; University of Delaware: Bruce Lipphardt

### Abstract:

Wind and wave induced ocean circulation in hurricanes is the focus of this study. The University of Miami Coupled Model (UMCM) has been developed to explicitly resolve the coupled atmosphere-wave-ocean processes. UMCM forecast fields of Hurricane Isaac (2012) are compared with in situ observations from the Grand Lagrangian Deployment (GLAD) Experiment. More than 300 surface drifters were deployed in the Gulf of Mexico in July 2012. Ten additional Met drifters were air-deployed by the Air Force C130 aircraft ahead of Hurricane Isaac on 26 August 2012.

UMCM consists of the Weather Research and Forecasting (WRF) model for the atmosphere, University of Miami Wave Model (UMWM) for surface waves, and HYbrid Coordinate Ocean Model (HYCOM) for the ocean component. Model components are coupled through a unified interface that treats momentum fluxes between models in a consistent manner. The coupled model and observations will help quantify contributions to ocean surface transport from the winds, mean ocean currents, and wave-induced drift. Partitioning between these three

# Science Abstracts

contributions is highly complex under fast-turning winds in a moving tropical storm.

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**Session: 010 - 17**

Track: Advances in Modeling the Gulf of Mexico

Date: Tuesday, January 22 2:45 PM  
Type: Oral Presentation

## Multi-Phase Air-Oil Interface Model for Hurricane Conditions

**Presenter:** Alexander Soloviev – Nova SE Univ Oceanographic Center

**Authors:** Alexander Soloviev, Nova Southeastern University; Silvia Matt, Nova Southeastern University; Atsushi Fujimura, University of Miami

### Abstract:

Oil on the sea surface is known to dampen surface waves even under very strong winds. We have implemented a two-phase model of the air-sea interface using the Volume of Fluid multi-phase method with a computational fluid dynamics software ANSYS Fluent. We have run the model under hurricane force wind stress ( $4 \text{ N m}^{-2}$ ) for two cases: air-water interface and air-weathered oil interface. In both cases, we observed the effect of direct disruption of the air-sea interface due to Kelvin-Helmholtz type instability. In the case of the air-water interface, we observed formation of a relatively thin transitional layer consisting of a mixture of air-bubbles and sea spray accompanied by chaotic short-wave motions at the interface. In the case of air-oil interface, the transition layer was still present; however, short surface waves were practically suppressed. Consideration of the regime of marginal stability maintained by direct disruptions of the air-water interface results in an estimate for the gas phase hydrocarbons flux from the ocean to the atmosphere under hurricane conditions.

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**Session: 010 - 18**

Track: Advances in Modeling the Gulf of Mexico

Date: Tuesday, January 22 3:00 PM  
Type: Oral Presentation

## Estimating Lagrangian predictability and uncertainties in the Gulf of Mexico using RELO ensemble system

**Presenter:** Mozheng Wei – Naval Research Laboratory

**Authors:** Mozheng Wei, Naval Research Laboratory; Gregg Jacobs, Naval Research Laboratory; Clark Rowley, Naval Research Laboratory; Charlie Barron, Naval Research Laboratory; Pat Hogan, Naval Research Laboratory; Peter Spence, Qinetiq-North America

### Abstract:

The US Navy's RELO ensemble system with 32-member and 3km resolution is used to study the predictability and uncertainties in the Gulf of Mexico (GOM) during the period of June - August 2012.

Repelling and attracting Lagrangian coherent structures (LCSs), which have major impacts on the ocean tracer dispersion such as oil spills in the GOM, are identified by using the finite-time Lyapunov exponents. The uncertainties of LCSs are assessed using the RELO ensemble with different perturbation schemes or resolutions. The impacts of the ensemble spread and model resolutions on Lagrangian predictability are studied.

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**Session: 010 - 19**

Track: Advances in Modeling the Gulf of Mexico

Date: Tuesday, January 22 3:15 PM  
Type: Oral Presentation

## Contour Dynamics by Optimized Canonical Transformations

**Presenter:** William Rosenthal – University of Arizona, Program in Applied Mathematics

**Authors:** Steven Rosenthal, University of Arizona; Juan Restrepo, University of Arizona; Shankar Venkataramani, University of Arizona; Arthur Mariano, University of Miami

### Abstract:

Phase errors are ubiquitous in the data assimilation of imperfect models and data that have a very prominent hyperbolic nature. Localization errors have serious impact on problems in which one seeks to determine fronts and sharp transition zones. Several authors have imposed various phase constraints to minimize the impact of this type of error, exploiting specific aspects of the flow they wish to assimilate. However, no one has developed a general and robust methodology. In this talk we describe progress in developing a general contour dynamics methodology, combining nonlinear non-Gaussian data assimilation techniques, estimators tailored to features, and phase correcting mappings. The admissible displacement mappings are drawn from a parameterized set of canonical transformations. These locally volume conserving mappings can be thought of as reorienting model contours, so that the structure of volume related fields such as mass are preserved. Several examples are given to illustrate and validate this methodology for optimizing with respect to phase error in an analysis.

# Science Abstracts

Session: 010 - 20

Track: Advances in Modeling the Gulf of Mexico

Date: Tuesday, January 22 3:30 PM

Type: Oral Presentation

## Quantifying Initial Conditions Uncertainties in a Gulf of Mexico HYCOM Forecast

**Presenter:** Mohamed Iskandarani – University of Miami

**Authors:** Ashwanth Srinivasan, University of Miami; Mohamed Iskandarani, University of Miami; William Carlisle Thacker, NOAA-AOML; Omar M. Knio, Duke University

### Abstract:

The method of Polynomial Chaos (PC) is applied to propagate the initial condition uncertainty of a Gulf of Mexico oceanic forecast. First, empirical orthogonal functions describing the variability in the Gulf of Mexico are extracted from a long running HYCOM simulation. These modes are then perturbed stochastically using a PC approach, and an ensemble of simulations is then carried out to compute the PC modes. The size of the ensemble, and hence its computational cost, is dictated by a number of factors including the accuracy of the expansion for a given forecast time, the number of modes retained in the expansion, and the numerical quadrature type. Here we report on the analysis of an initial experiment emphasizing the fidelity of the PC expansion as a function of time for various quantities of interest.

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Session: 010 - 21

Track: Advances in Modeling the Gulf of Mexico

Date: Tuesday, January 22 3:45 PM

Type: Oral Presentation

## A Practical Probabilistic Approach To Parameter Tuning in ADCIRC

**Presenter:** Nusret Balci – University of Arizona

**Authors:** Nusret Balci, University of Arizona; Juan M. Restrepo, University of Arizona; Shankar Venkataramani, University of Arizona

### Abstract:

We present preliminary results on application of a Bayesian framework to the ADCIRC model.

An example is the bottom drag parametrization. We use various tools including polynomial chaos expansion and Monte Carlo simulations. We emphasize practicality and use of data. Joint work with Juan Restrepo and Shankar Venkataramani.

Session: 010 - 22

Track: Advances in Modeling the Gulf of Mexico

Date: Wednesday, January 23 10:30 AM

Type: Oral Presentation

## BOEM'S RECENT ADVANCES IN OIL SPILL MODELING IN THE GULF OF MEXICO

**Presenter:** Rebecca Green – Department of the Interior/BOEM

**Authors:** Rebecca Green, Bureau of Ocean Energy Management; Walter Johnson, Bureau of Ocean Energy Management; Jeff Ji, Bureau of Ocean Energy Management; Zhen Li, Bureau of Ocean Energy Management

### Abstract:

The Bureau of Ocean Energy Management (BOEM) invests in ocean research through its Environmental Studies Program to promote environmental stewardship and provide science in support of management decisions. This presentation will provide an overview of the Bureau's recent observational and modeling studies relevant to the fate and transport of oil spills in the Gulf. Since the 1990's, BOEM has increasingly focused on deepwater oceanographic studies, with present observational research including the Loop Current Dynamics study and a Lagrangian Study of Deep Circulation in the Gulf. New observations such as these are critical for improving the hydrodynamic model inputs to future oil-spill models. BOEM is currently funding several new spill-modeling studies, including development of a next-generation, multi-phase blowout model and an in-depth analysis of spill remote-sensing imagery. These studies will contribute new understanding to BOEM's Oil Spill Risk Analysis (OSRA) modeling, as it continues to provide critical information on potential spill contact with environmental resources.

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Session: 010 - 23

Track: Advances in Modeling the Gulf of Mexico

Date: Wednesday, January 23 10:45 AM

Type: Oral Presentation

## Ocean Condition Forecasts Using a Multi-Model Consensus during the Grand Lagrangian Deployment (GLAD) Experiment

**Presenter:** Emanuel Coelho – UNO/NRLSSC

**Authors:** E. Coelho, D. Bogucki, J. Beron, S. Chen, M. Curcic, A. Griffo, M. Gough, B. Haus, A. Haza, P. Hogan, H. Huntley, M. Iskandarani, G. Jacobs, F. Judt, D. Kirwan, N. Laxague, A. Levinson, B. Lipphardt, A. Mariano, G. Novelli, J. Olascoaga, T. Ozgokmen, T. Prasad, A. Poje, A. Reniers, E. Ryan, C. Smith, M. Wei

### Abstract:

GLAD is part of CARTHE and is designed to understand the dispersion of surface materials under the action of ocean surface processes. Several

# Science Abstracts

ocean models were used to assist the deployment of 300 surface drifters in the Gulf of Mexico in July 2012. The models were the Navy Coastal Ocean Model (NCOM) at 1km and 3km resolutions, the Navy operational NCOC at 3km resolution, and two versions of the Hybrid Coordinates Ocean Model set at 4km. All models showed good skills in capturing the general regional dynamics during the experiment.

A sub-set of drifters deployed before the main experiment were used to build a multi-model consensus by combining the skills of the different models into a single forecast through an ensemble Kalman filter. Results showed the consensus forecasts provided an improvement relative to any of the single model runs. Since trajectory predictions are very sensitive to the accurate timing and positioning of fronts and jets, the scarcity of in-situ profile and currents used in real-time for data assimilation limited the overall accuracy obtained with the consensus.

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**Session: 010 - 24**

Track: Advances in Modeling the Gulf of Mexico

Date: Wednesday, January 23 11:00 AM

Type: Oral Presentation

## **Sensitivity of conditional probability of potential oil spill contacts in the Gulf of Mexico to wind stress and surface currents**

**Presenter:** Zhen Li – Bureau of Ocean Energy Management

**Authors:** Zhen Li, Bureau of Ocean Energy Management; Walter Johnson, Bureau of Ocean Energy Management; Jeff Ji, Bureau of Ocean Energy Management

### **Abstract:**

The oil-spill risk analysis (OSRA) is conducted by the Bureau of Ocean Energy Management (BOEM) prior to a lease sale for oil and gas exploration in the Gulf of Mexico Outer Continental Shelf. The OSRA uses model-simulated surface currents and the reanalysis winds to drive the oil-spill trajectory model for estimating the probability of potential oil spill contacts with environmental resources. The estimation of conditional probability relies on analysis of hundreds of thousands of particle trajectories launched from the hypothetical oil spill locations. In this study we will generate map distributions of potential conditional contact probability by launching the hypothetical oil spill over the entire leasing areas. The seasonal variations of the conditional probability for the time period of 1993-1998 and 2000-2007 will be discussed here. The method proves to be very effective evaluating different winds and surface currents on the conditional probability of an oil spill and useful in assessing the potential environmental impacts on natural resources in the GOM.

**Session: 010 - 25**

Track: Advances in Modeling the Gulf of Mexico

Date: Wednesday, January 23 11:15 AM

Type: Oral Presentation

## **An integrated modeling framework for oil transport from deep ocean leak to surface drift and weathering processes**

**Presenter:** Guillaume Novelli – RSMAS

**Authors:** Guillaume Novelli, RSMAS; Ashwanth Srinivasan, RSMAS; Tamay Ozgokmen, RSMAS; Andrew Poje, CUNY; Mohamed Iskandarani, RSMAS

### **Abstract:**

We introduce a hybrid framework in order to span the disparity of physics and scales between the near-field deep buoyant plumes and the far-field transport by oceanic currents. It is noted that the core of the plume, while being limited in spatial extent, contains very high vertical velocities and has critical importance for transport. Nevertheless, not only is it computationally very demanding to solve accurately the turbulent flow in the vicinity of the plume and apply upscaling, but buoyant plumes are beyond the scope of ocean models because of the hydrostatic approximation.

We experiment with a low-order, yet extremely fast non-hydrostatic solver to approximately simulate deep buoyant plumes (Fast Plume Model, FPM). The results from FPM are evaluated using a highly-accurate spectral element model Navier-Stokes solver. FPM is then used in conjunction with a Lagrangian drift model in order to compute the three-dimensional far-field transport within the context of HYCOM. The approach of compromising numerical accuracy for full physics and computational speed can be a promising avenue to overcome the dynamical limitations of ocean models when applied to very small-scale buoyant plumes associated with oil spills from deep wells.

# Science Abstracts

Session: 010 - 26

Track: Advances in Modeling the Gulf of Mexico

Date: Wednesday, January 23 11:30 AM

Type: Oral Presentation

## Reconstruction of the Deepwater Horizon oil spill

**Presenter:** Jorge Zavala-Hidalgo – Centro de Ciencias de la Atmosfera, UNAM

**Authors:** Universidad Nacional Autonoma de Mexico: Jorge Zavala-Hidalgo, Rosario Romero-Centeno, Elena Osorio-Tai, Fernando Arellano-Guerrero; Florida State University: Steven L. Morey, Eric Chassignet

### Abstract:

Based on the information of the amount of oil budget reported by the Federal Interagency Solutions Group and using a hindcast simulation with the Hybrid Coordinate Ocean Model (HYCOM) and a forecast simulation with the Weather Research and Forecasting (WRF) model, a reconstruction of the oil concentration and its evolution along the period April 20-December 31, 2010 is done. The daily COAPS-FSU ocean circulation hindcast for the ocean currents and the winds from the operational numerical forecast of the Centro de Ciencias de la Atmósfera (CCA), UNAM, were used. There is a particular interest on the activities carried out to reduce oil impact and on the concentrations in the Mexican coasts and waters. Three scenarios are simulated: the first one with inert particles; the second one considering the controlled oil burning, skimming, surface recovering, evaporation, and natural and chemical dispersion with a decaying time scale of 60 days; and the third one with the same processes than the second, but with a decaying time scale of 12 days.

Session: 010 - 27

Track: Advances in Modeling the Gulf of Mexico

Date: Wednesday, January 23 11:45 AM

Type: Oral Presentation

## Validation of Ocean-Atmosphere Coupled Forecasting System for Gulf of Mexico Oil Spill Studies

**Presenter:** Jaison Kurian – Texas A&M University

**Authors:** Jaison Kurian, Texas A&M University; Raffaele Montuoro, Texas A&M University; Ping Chang, Texas A&M University; Zhao Xu, Texas A&M University

### Abstract:

The Gulf of Mexico (GoM) Deepwater Horizon oil spill on April 20, 2010 has accentuated the need to study major processes influencing the distribution and fate of oil released into the ocean. As a part of the Gulf

Integrated Spill Research Consortium, we have employed a real-time automated high resolution (3 km) ocean-atmosphere coupled model forecasting system for the GoM using the TAMU (Texas A&M University) CRCM (Coupled Regional Climate Model). We tested this forecasting system during a tracer injection and sampling cruise in the Deepwater Horizon oil spill location during July/26-Aug/12, 2012. We have deployed floats and injected dyes in the ocean model in a similar way to the field experiment. The forecasted distribution of model dyes and floats and several other fields (like currents, winds, rain etc.) were uploaded online in every fifteen minutes as pictures and animations. It has been found that the model predictions were reasonably accurate and the real-time forecasts were of immense help to the field team to know the direction and speed of dye transport. We will present the details of model formulation and validation of forecast results using field observations and other datasets.

Session: 010 - 28

Track: Advances in Modeling the Gulf of Mexico

Date: Wednesday, January 23 12:00 PM

Type: Oral Presentation

## Improving simulations of the subsea oil from the Macondo well blowout using a high-resolution application of the hybrid coordinate ocean model (HYCOM)

**Presenter:** David Lindo-Atichati – University of Miami

**Authors:** David Lindo-Atichati, University of Miami; Claire B. Paris, University of Miami; Matthieu Le Henaff, University of Miami; Vassiliki H. Kourafalou, University of Miami

### Abstract:

During the Deepwater Horizon oil spill, crude oil and natural gas flowed into the Gulf of Mexico from 1520 m underwater. A validated multi-scale numerical framework, the Connectivity Modeling System, coupled the Gulf of Mexico Hybrid Coordinate Ocean Model (GoM-HYCOM) to an oil-fate stochastic module and an oil multi-fraction module to simulate the surface and subsurface oil transport. Here we test the multi-scale capabilities of the CMS by incorporating a high-resolution ( $1/50^\circ$ ,  $\sim 1.8$  km) ocean model based on HYCOM, which includes the majority of the northern gulf coastline. Nested within the lower-resolution ( $1/25^\circ$ ,  $\sim 3.6$  km) data-assimilative GoM-HYCOM, the high resolution ocean model provides lateral boundary conditions that incorporate the Loop Current, mesoscale eddy circulation, and freshwater sources. We compare this technique with previous simulations and run sensitivities analyses showing improvement of the oil spill hind cast.



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Session: 010 - 29

Track: Advances in Modeling the Gulf of Mexico

Date: Wednesday, January 23 12:15 PM

Type: Oral Presentation

## Utilization of the Northern Gulf Operational Forecast System to Predict Trajectories of Surface Oil from a Persistent Source Offshore of the Mississippi

**Presenter:** Amy MacFadyen – NOAA Office of Response and Restoration

**Authors:** Amy MacFadyen, NOAA; Eugene Wei, NOAA; Christopher Warren, NOAA; Glen Watabayashi, NOAA

### Abstract:

Operational forecasting of oil movement is critical to spill response for planning, allocation of resources, and direction of assets. Although spills like the Deepwater Horizon incident are relatively infrequent, NOAA's Emergency Response Division provides trajectories for numerous small spills (typically ~140 per year). The evaluation of trajectory forecast accuracy is critical to understanding uncertainty and improving our future modeling capability. In this study, a persistent source of leaking oil is utilized for such an evaluation in the Northern Gulf of Mexico.

A cluster of wells and/or contaminated sediments approximately 10 miles offshore of the Mississippi River Delta (MRD) have been persistently leaking small amounts of oil since they were damaged in 2004. Slicks associated with this source are frequently detected in satellite imagery analysis (~80 images since August 2010). Slicks are typically elongated in the along isobath direction with typical dimensions of 1-2 km by 5-35 km varying with wind conditions.

An operational forecast model that includes the MRD region (Northern Gulf of Mexico Operation Forecast System or NGOFS) has recently been developed. The hydrodynamic model is FVCOM, an unstructured grid model which allows variable grid resolution ranging from 10 km offshore to ~600 m near the coastline. The model is forced with the 4-km North American Mesoscale weather prediction model and utilizes real-time water level, temperature and salinity observations, USGS river data and the ADCIRC ec2011 tide database. The outer open water boundary forcing is derived from the Navy Coastal Ocean Model.

The NGOFS and NAM models will be used to calculate surface oil trajectories originating from the known source. Comparison of these results with satellite imagery analysis will improve our understanding of our ability to accurately predict oil movement around the MRD – an oceanographically complex region of extensive oil and gas exploration and development.

Session: 010 -

Track: Advances in Modeling the Gulf of Mexico

Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

## A multiscale model for the Interaction of oil, waves and currents in shelf waters

**Presenter:** Hamidreza Arabshahi – The University of Texas at Austin

**Authors:** Hamidreza Arabshahi, The Institute for Computational Engineering and Sciences; Clint Dawson; Juan M. Restrepo; Shankar Venkataramani

### Abstract:

We will present a novel oil spill transport model coupled to the advanced circulation (ADCIRC) hydrodynamic model. It's a multiphase oil spill model which takes into account waves, currents, slick and subsurface oil with a kinetic exchange describing vertical mixing between the layers and spatio-temporal scales of the Gulf Coast Shelf. We will describe a hierarchical approach, first implementing an advection-diffusion equation for the oil model and then adding various terms to better capture the oil behavior. For the

numerical stability a streamline upwind Petrov Galerkin (SUPG) algorithm is implemented for the solution of the oil equation. We will present results for some case scenarios focusing on oil transport in the near shore.

Session: 010 -

Track: Advances in Modeling the Gulf of Mexico

Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

## Reconstruction of the subsurface oil spill of Gulf of Mexico.

**Presenter:** Fernando Arellano Guerrero – Centro de Ciencias de la Atmosfera

**Authors:** Fernando Arellano Guerrero, Centro de Ciencias de la Atmosfera UNAM; Jorge Zavala-Hidalgo, Centro de Ciencias de la Atmosfera UNAM; Rosario Romero Centeno, Centro de Ciencias de la Atmosfera UNAM; María Elena Osorio Tai, Centro de Ciencias de la Atmosfera UNAM

### Abstract:

The fate of the subsurface oil spill caused by the accident of the platform of the company British Petroleum on April 20, 2010 in the Gulf of Mexico, is modelled using a three-dimensional ocean model. The trajectory followed by the plume and the oil concentration is reconstructed for the period of the spill and until December, 31 2012. Dispersion, biodegradation, dilution and buoyancy changes are considered in the model, allowing to the the oil buoyancy and precipitation. The oil spill is



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divided in different components with specific evolution. A numerical simulation with the Hybrid Coordinate Ocean Model (HYCOM) is used to obtain the currents in the subsurface column water and the temperature, which will allow us to determine the decay-time as a function, among other variables, of the estimated temperature. This model will help to estimate the trajectory of future events of this type.

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**Session: 010 -**

Track: Advances in Modeling the Gulf of Mexico

Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

## **Assimilation of in-situ velocity data in the northern Gulf of Mexico using the Navy Coastal Ocean Model 4DVAR (NCOM-4DVAR)**

**Presenter:** Matthew Carrier – Naval Research Laboratory

**Authors:** Matthew Carrier, Naval Research Laboratory; Hans Ngodock, Naval Research Lab; Scott Smith, Naval Research Lab; Philip Muscarella, ASEE

### **Abstract:**

Eulerian velocity fields are derived from 300 drifters released in the Gulf of Mexico by The Consortium for Advanced Research on Transport of Hydrocarbon in the Environment (CARTHE) during the summer 2012 Grand Lagrangian Deployment (GLAD) experiment. In addition to this, high-frequency (HF) radar surface velocity data are also available in the experiment space and time domain. These data are directly assimilated into the NCOM-4DVAR in a series of experiments. The NCOM-4DVAR is formulated for weak-constraint data assimilation based on the in-direct representer method and as such can account for both initial condition and surface forcing errors. The assimilation experiments take advantage of this velocity data along with other available data sources from in situ and satellite measurements of temperature, salinity, and sea surface height. The resulting analyses and subsequent forecasts are compared to future drifter tracks and moored ADCP data to determine the performance of the analysis procedure and the forecast model.

**Session: 010 -**

Track: Advances in Modeling the Gulf of Mexico

Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

## **Another oil model for Deep Water Horizon**

**Presenter:** Bruno Deremble – Florida State University

**Authors:** Bruno Deremble, Florida State University; Ashley Stroman, Florida State University; Nicolas Wienders, Florida State University; William Dewar, Florida State University

### **Abstract:**

The modeling of the Deep Water Horizon oil spill is a complex issue. The material release from the well head included oil, water, gas and tar and other miscible or immiscible constituents. We are extending an existing ocean general circulation model to include a module that computes these elements as members of a mixture in an Eulerian framework (as opposed to the classical Lagrangian plume model). This model predicts the evolution of the center of mass of the mixture using the 3d Navier-Stokes equations. The velocity of each constituent is corrected to model differential buoyancy effects with the correction treated as a slip velocity. This permits separation of the light and heavy elements. At the same time, chemical reactions – such as formation of hydrate, or dissolution – can modify the composition of the mixture. These reactions are parametrized to suit the Eulerian framework.

This mixture model is imbedded in a large scale ocean model with the eventual goal to predict the evolution of the oil in the open ocean.

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**Session: 010 -**

Track: Advances in Modeling the Gulf of Mexico

Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

## **Improved Synthetic Ocean Profiles for Data Assimilation**

**Presenter:** Robert Helber – Naval Research Laboratory

**Authors:** Robert Helber, Naval Research Laboratory; Tamara Townsend, Naval Research Laboratory; Charlie Barron, Naval Research Laboratory; Jan Dastugue, Naval Research Laboratory

### **Abstract:**

A new method is developed to utilize the abundant satellite observations of sea surface temperature (SST) and sea surface height (SSH) to create three-dimensional synthetic fields of temperature and salinity for assimilation. Traditional methods for creating synthetics are designed to estimate the values of temperature and salinity without constraint on vertical gradients, which are important for ocean currents and acoustic

# Science Abstracts

transmission. A new system has been developed to more correctly represent the ocean's vertical gradients using a three layer approach accounting for the ocean's (1) surface mixed layer, (2) vertical gradients below the mixed layer through the thermocline, and (3) relatively quiescent depths. These Improved Synthetic Ocean Profiles (ISOP) are evaluated relative to prior capabilities in reconstruction of observations from numerous CTDs that were recently deployed (July 2012) in the Northeastern Gulf of Mexico as part of the GoMRI CARTHE drifter experiment.

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**Session: 010 -**

Track: Advances in Modeling the Gulf of Mexico

Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

## **Forecast error estimation in the NRL relocatable ocean ensemble forecast system**

**Presenter:** Clark Rowley – Naval Research Laboratory

**Authors:** Clark Rowley, Naval Research Laboratory; Mozheng Wei, Naval Research Laboratory; Emanuel Coelho, University of New Orleans; Pete Spence, Qinetiq-North America

### **Abstract:**

The NRL relocatable ocean ensemble forecast system supports risk assessment to operations due to environmental forecast uncertainty. It is based on the Navy Coupled Ocean Data Assimilation 3DVar assimilation system and the Navy Coastal Ocean Model. The Ensemble Transform using the variance from the analysis represents initial condition error, perturbed atmospheric forcing or an atmospheric ensemble represents uncertainty in surface forcing, and perturbations of the global model represent resolved errors at the open boundary. The analysis error determines the initial condition spread, and its growth. We estimate analysis error using forecast variability, recent forecast error, and historical model or climate uncertainty with specified growth, accounting for subsurface sampling. The growth back to historical error in the periods between sampling improves ensemble spread measured with analyses and observations. We present an overview of the analysis error estimation and impact on ensemble skill and spread in a regional model of the Gulf of Mexico.

**Session: 010 -**

Track: Advances in Modeling the Gulf of Mexico

Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

## **The impact of velocity data assimilation from drifters using the Navy Coupled Ocean 3D Variational Data Assimilation System (NCODA-VAR)**

**Presenter:** Scott Smith – Naval Research Laboratory

**Authors:** Scott Smith, Naval Research Laboratory; Gregg Jacobs, Naval Research Laboratory; Robert Helber, Naval Research Laboratory; Matt Carrier, Naval Research Laboratory; Peter Spence, Qinetiq North America

### **Abstract:**

The Navy Coupled Ocean 3D variational Data Assimilation (NCODA-VAR) system is used to ingest, process, quality control, and assimilate observations in near-real time to update and improve skill of Navy ocean prediction systems. Present reliance on satellite data sources limits skill in representing submesoscale features: sea surface height data are typically too coarse, and sea surface temperature lacks the vertical correlation with the subsurface to sufficiently steer the analysis. Capabilities to assimilate velocity observations are being added to NCODA, primarily by adding error covariances between velocity (geopotential), temperature, and salinity throughout the water column. Inclusion of velocity data assimilation should improve NCODA's ability to resolve submesoscale eddies. To test this hypothesis, velocity data will be inferred and assimilated from 100s of surface drifters that were recently released (July 2012) in the Northeastern Gulf of Mexico as part of the GoMRI CARTHE drifter experiment. The resulting analyses will be compared to a subset of withheld drifter data.

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**Session: 010 -**

Track: Advances in Modeling the Gulf of Mexico

Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

## **Non-hydrostatic modeling of the near-field multi-phased plume in a deep water blowout**

**Presenter:** Ashley Stroman – Florida State University

**Authors:** Ashley Stroman, Florida State University; William Dewar, Florida State University; Nicolas Wienders, Florida State University; Bruno Deremble, Florida State University

### **Abstract:**

In the near-field region of an oil-well blowout in deep water, the flow is described as a plume consisting of mixed water, oil, gas, gas hydrates, and tar. The objective of this study is to investigate the dispersal of each

# Science Abstracts

constituent and to model the behavior of the multi-phase plume in the near-field region. Because of its non-hydrostatic capability, the Massachusetts Institute of Technology general circulation model (MITgcm) is used, and we propose improved equations of state and momentum equations for each constituent of the plume along with the parameterization of “slip velocities”. Our simulations are meant to serve as boundary conditions for large-scale far-field oil spill models.

# Science Abstracts

## Session: 011 Public Health Impacts of the Deepwater Horizon Oil Spill

Session: 011 - 1

Track: Public Health Impacts of the Deepwater Horizon Oil Spill

Date: Tuesday, January 22 8:30 AM

Type: Oral Presentation

### NIEHS GuLF STUDY – Study Overview and the Exposure Assessment Process

**Presenter:** Richard Kwok – NIEHS

**Authors:** Richard Kwok, NIEHS; Patricia Stewart, NIEHS; Mark Stenzel, NIEHS; Larry Engel, NIEHS; Aaron Blair, NCI; Aubrey Miller, NIEHS; Dale Sandler, NIEHS

#### Abstract:

This presentation will provide an overview of the NIEHS GuLF STUDY being conducted on workers involved in the response and cleanup associated with the Gulf of Mexico Deepwater Horizon oil spill. The presentation will discuss the agents being assessed and the study questionnaire being administered to participants and how it is linked to the exposure scenarios developed based on area, job or task, date, geographic location and degree of weathered oil. In addition, the overall exposure assessment process to develop inhalation exposures arising from both tasks and the general environment and dermal exposures will be described.

Session: 011 - 2

Track: Public Health Impacts of the Deepwater Horizon Oil Spill

Date: Tuesday, January 22 8:45 AM

Type: Oral Presentation

### LSU's Women and their Children's Health (WATCH) Study : Research on the Health of Women and Children after the Oil Spill

**Presenter:** Edward Trapido – LSUHSC-SPH

**Authors:** Edward Trapido, LSUHSC-NO; Edward Peters, LSUHSC-NO; Elizabeth T.H. Fonham, LSUHSC-NO; Ariane Rung, LSUHSC-NO; Daniel Harrington, LSUHSC-NO; Joseph Hagan, LSUHSC-NO; Samaah Sullivan, LSUHSC-NO; Megan Bronson, LSUHSC-NO; Ann Clesi, LSUHSC-NO; Meghan Brashear, LSUHSC-NO

#### Abstract:

The Women and their Children's Health (WATCH) Study is a prospective cohort study of the physical, mental and community health effects resulting from the Deepwater Horizon oil spill and its aftermath. WATCH collects information on exposure/proximity to the oil spill, loss of income, reproductive history, symptoms, comorbidities, seafood consumption,

neighborhood social environment and collective efficacy, community cohesion, and other prior disaster exposures. WATCH Study investigators will assess whether health outcomes associated with the spill are modified by community and individual resilience and social capital. We are also studying the impacts of the oil spill on children's resiliency, and how parental and social forces codify the spill's effects on children. WATCH is being conducted among women and their children in the seven SE Louisiana parishes closest to the oil spill. In this presentation, we will present analyses on physical symptoms and health issues associated with the spill which have been reported by the first 150 women enrolled.

Session: 011 - 3

Track: Public Health Impacts of the Deepwater Horizon Oil Spill

Date: Tuesday, January 22 9:00 AM

Type: Oral Presentation

### Research on the Mental Health Effects of the Deepwater Horizon Oil Spill Among Women in Southern Coastal Louisiana: the WATCH Study

**Presenter:** Ariane Rung – LSU School of Public Health

**Authors:** Ariane Rung, LSUHSC School of Public Health; Edward Peters, LSUHSC School of Public Health; David Abramson, Columbia University Mailman School of Public Health; Elizabeth T.H. Fonham, LSUHSC School of Public Health; Joseph Hagan, LSUHSC School of Public Health; Daniel Harrington, LSUHSC School of Public Health; Megan Bronson, LSUHSC School of Public Health; Edward Trapido, LSUHSC School of Public Health

#### Abstract:

The Women and their Children's Health (WATCH) Study is a prospective cohort study of the physical, mental and community health effects resulting from the Deepwater Horizon oil spill (DWOS) among women in 7 coastal Louisiana parishes. Research on previous oil spills combined with preliminary data on the DWOS suggest significant mental health impact for residents exposed to the oil spill. The objective of this presentation is to describe the mental health characteristics of women exposed to the DWOS compared to unexposed women. A telephone interview on randomly selected women in each parish was conducted. Preliminary results are presented on the first 150 women enrolled. Two mental health measures were assessed: depression, measured with the CES-D, and non-specific distress, measured with the K6. Exposure to the oil spill was assessed via a series of 6 items determining how much direct contact with oil respondents had. Results from this study may help quantify mental health needs in a disaster-impacted community, leading to improved provision of services.

# Science Abstracts

Session: 011 - 4

Track: Public Health Impacts of the Deepwater Horizon Oil Spill

Date: Tuesday, January 22 9:15 AM

Type: Oral Presentation

## Community Assessment of Health Effects Following the Gulf Coast Oil Spill—Alabama 2010 and 2011

**Presenter:** Amy Wolkin – Centers for Disease Control and Prevention

**Authors:** Amy Wolkin, Centers for Disease Control and Prevention; Melissa Morrison, Centers for Disease Control and Prevention

### Abstract:

The immediate health impact of the Deepwater Horizon oil spill on Gulf Coast residents was unknown. Recognizing some health effects may not be severe enough to seek care, the Alabama Department of Public Health and the Centers for Disease Control and Prevention conducted an assessment of health needs in two coastal counties to identify potential health effects. In August 2010, we administered questionnaires to households in these counties to assess health effects. Using a two-stage cluster sampling method we selected 210 households from each county. The survey was repeated in the same sampling frame August 2011. In 2010, >50% of households reported a respiratory condition, 30% reported headache, >25% reported a cardiovascular symptom, and >15% reported an eye or skin condition. In 2011, questions were added regarding medical care for reported symptoms; 54% reported they sought care and 45% reported seeing a family doctor. Health symptoms did not differ significantly between 2010 and 2011 surveys. The cause of the prevalence of the reported health conditions remains uncertain.

Session: 011 - 5

Track: Public Health Impacts of the Deepwater Horizon Oil Spill

Date: Tuesday, January 22 9:30 AM

Type: Oral Presentation

## Acute health effects surveillance in response to the Deepwater Horizon disaster – Alabama, May 15-October 15, 2010

**Presenter:** Melissa Morrison – CDC/Alabama Department of Public Health

**Authors:** Melissa Morrison, Centers for Disease Control and Prevention; Jacquelyn P. Skinner, Alabama Department of Public Health; Sherri Davidson, Alabama Department of Public Health

### Abstract:

In response to the Deepwater Horizon disaster, the Gulf States rapidly implemented surveillance to detect acute health effects from oil exposure. In collaboration with CDC, each developed surveillance tailored to

existing state capabilities and needs, while reporting common data elements to inform regional situational awareness. The Alabama Department of Public Health implemented acute health effects surveillance in urgent care clinics and emergency departments, and tracked reports of oil spill related calls to the Alabama Poison Centers. Oil exposure was reported for 285 patients, with an overall rate of 2.7/1,000 visits (range 0.9 to 4.4/1,000 visits); among patients reporting oil exposure, 62% were AL residents and 7% were cleanup workers/volunteers. Symptoms reported included: respiratory (45%), dermatologic (20%), nausea/vomiting (16%), headache (14%). The majority of calls were received in June, July and August, peaking at 37.4/1,000 calls. The surveillance provided an evidence base for public health action and informed the development of community assessment activities.

Session: 011 - 6

Track: Public Health Impacts of the Deepwater Horizon Oil Spill

Date: Tuesday, January 22 9:45 AM

Type: Oral Presentation

## Incidence of post-spill physical and mental health symptoms among children along the Gulf Coast: Findings from the Gulf Coast Population Impact Study

**Presenter:** David Abramson – Columbia University NCDP

**Authors:** David Abramson, Columbia University; Jaishree Beedasy, Columbia University; Jonathan Sury, Columbia University; Akilah Banister, Columbia University; Thomas Aguilar, Columbia University; Rebecca May, Columbia University

### Abstract:

To evaluate the extent of exposure to the oil spill and emergent health symptoms among children living along the Gulf Coast, we surveyed 1,437 parents in randomly sampled census blocks between Florida and Louisiana during the period April-August 2012. This household survey followed an earlier effort by the research team, in which 1,203 residents of the Gulf Coast were surveyed 3 months after the Oil Spill, and which revealed that more than 40% of the population living within ten miles of the coast had been directly exposed to the oil spill, and more than a third of the parents reported physical or mental health symptoms among their children. In this second phase of the study, we focused on the following topics: (1) what proportion of the children living in this high impact coastal area had been physically, environmentally, or economically exposed to the oil spill?; (2) what was the incidence of pediatric physical and mental health symptoms that had emerged since the Oil Spill?; and (3) to what extent did oil exposure or access to health care predict these pediatric symptoms?

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Session: 011 - 7

Track: Public Health Impacts of the Deepwater Horizon Oil Spill

Date: Tuesday, January 22 10:00 AM

Type: Oral Presentation

## Community Attachment, Natural Resource Employment, and Health Impacts Following the BP Deepwater Horizon Disaster

**Presenter:** Michael Cope – Louisiana State University

**Authors:** Michael R. Cope, Louisiana State University; Tim Slack, Louisiana State University; Troy C. Blanchard, Louisiana State University; Matthew R. Lee, Louisiana State University

### Abstract:

On April 20, 2010, the BP Deepwater Horizon (BP-DH) oil rig exploded, resulting in the largest marine oil spill in history. In this study we utilize one-of-a-kind household survey data—the Louisiana Community Oil Spill Survey—to examine the impacts of the BP-DH disaster on the mental and physical health among spill affected residents of coastal Louisiana, with a special focus on the influence of community attachment and natural resource employment. We find that levels of both negative mental and physical health were significantly more pronounced at baseline compared to later time points. We show that greater community attachment is linked to lower levels of negative health impacts in the wake of the oil spill and that the disaster had a uniquely negative impact on households involved in the fishing and seafood industry. Further, we demonstrate that over time higher levels of community attachment shields residents from negative health related impacts, while employment in the fishing and seafood industry exacerbates disaster related negative health impacts. Implications for research and policy are discussed.

Session: 011 - 8

Track: Public Health Impacts of the Deepwater Horizon Oil Spill

Date: Tuesday, January 22 10:15 AM

Type: Oral Presentation

## Characteristics and Predictors of Favorable Mental Health Outcome 9 Months Post Gulf of Mexico Oil Spill

**Presenter:** Lynn Grattan – University of Maryland School of Medicine

**Authors:** Lynn Grattan, University of Maryland School of Medicine; Sparkle Roberts, University of Maryland School of Medicine; Lorien Baker, University of Maryland School of Medicine; Sailor Holobaugh, University of Maryland School of Medicine; Alexandra Toben, University of Maryland School of Medicine; Babette Brumback, University of Florida; Yi Zhang, University of Florida; J. Glenn Morris, University of Florida

### Abstract:

Considerable psychological distress was reported during the Gulf of Mexico Oil Spill. However, the recovery period and factors associated with better mental health outcomes remain unknown. Toward this end, standard measures of psychological distress, risk perception, self-reported resilience, and media exposure were administered to 133 NE Gulf Coast residents 9 months post spill. Findings were compared to data collected during the spill and analyzed using multivariate procedures. Results indicated a decline in depression and anxiety. Time since spill, risk perception, income status, exposure (direct vs. indirect), and self-reported resilience were significantly associated with better mental health outcomes. In contrast, age, race, gender, and media exposure were not significantly associated with outcome. Multiple non-traditional factors contributed to positive mental health outcome 9 months post oil spill. Since perceived risk and self-reported resilience are potentially modifiable, these processes may be important targets for public health prevention and early intervention.

Session: 011 - 9

Track: Public Health Impacts of the Deepwater Horizon Oil Spill

Date: Tuesday, January 22 11:00 AM

Type: Oral Presentation

## Behavioral Health in the Gulf Coast Region Following the Deepwater Horizon Oil Spill

**Presenter:** Sharon Larson – SAMHSA

**Authors:** Sharon Larson, PSAMHSA; Deborah Gould, CDC

### Abstract:

In September 2010, the Substance Abuse and Mental Health Services Administration (SAMHSA) and the Centers for Disease Control and Prevention (CDC) began parallel public health surveillance efforts related to the behavioral health of residents of the Gulf Coast affected by the Deepwater Horizon spill. These efforts focused on the residents of Gulf Coast counties and parishes in Alabama, Florida, Louisiana, and Mississippi and reported on the prevalence of mental health and substance use disorders and chronic health conditions, as well as on the utilization of behavioral health services. Methods: SAMHSA data collection consisted of adding a supplemental sample of approximately 2,000 interviews in 32 counties/ parishes in the four affected States to the 2011 National Survey on Drug Use and Health (NSDUH), an annual survey of drug use and mental health problems among the civilian, household population aged 12 or older. CDC data collection consisted of the Gulf States Population Survey (GSPS), a telephone survey of approximately 38,000 adults in those same four States, with the majority of the interviews conducted in 25 coastal counties/ parishes. Results and



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Conclusions: The NSDUH results indicate that, after the oil spill, there were increases in past month marijuana and alcohol use among persons aged 12 or older and aged 26 or older; and increases in past year depression, serious suicide thoughts, and suicide plans, mostly among 18 to 25 year olds. Rates of cigarette use, nonmedical use of pain relievers, substance use disorder, psychological distress, any mental illness, serious mental illness, suicide attempts, and mental health services utilization were similar before and after the spill in the populations examined. GSPS results indicated that people living in the coastal counties were more likely than those living in noncoastal counties to report decreased income or lost jobs because of the oil spill but did not indicate any substantial differences in chronic physical or mental health conditions or health behaviors between coastal and noncoastal counties in the region. These data may be informative to public health officials as for planning and administration of mental and behavioral health services in this region.

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Session: 011 - 10

Track: Public Health Impacts of the Deepwater Horizon Oil Spill

Date: Tuesday, January 22 11:15 AM

Type: Oral Presentation

## Risk Assessment Methods to Determine the Safety of Consuming Seafood Following Oil Spills in Marine Waters

**Presenter:** Susan Klasing – Office of Environmental Health Hazard Assessment

**Authors:** Susan Klasing, California Environmental Protection Agency; Robert Brodberg, California Environmental Protection Agency

### Abstract:

When an oil spill occurs in a marine environment, there is often significant public concern over the safety of consuming fish and shellfish from the impacted area. Various petroleum products may contain a large and diverse number of chemical components; it is the job of the risk assessor to evaluate their relative toxicities and potential to accumulate in seafood. When dispersants are used in the response, their uptake and toxicity must also be addressed. Further, in order to set a criterion to protect public health, factors about the population at risk, such as body weight, consumption rate and exposure duration, must be calculated or assumed. Because of the inherent uncertainty and variability associated with chemical toxicity and population characteristics, substantial conservatism is built into the risk assessment process. A general overview of the potential chemicals of concern and methods for determining exposure and risk associated with seafood consumption following oil spills will be provided.

Session: 011 - 11

Track: Public Health Impacts of the Deepwater Horizon Oil Spill

Date: Tuesday, January 22 11:30 AM

Type: Oral Presentation

## Response to Seafood Safety Concerns following the 2010 Deepwater Horizon Oil Spill

**Presenter:** Robert Dickey – FDA Center for Food Safety and Applied Nutrition

**Authors:** Robert W. Dickey, FDA Center for Food Safety and Applied Nutrition

### Abstract:

The 2010 Deepwater Horizon (DWH) accident in the Gulf of Mexico resulted in the largest oil spill in U.S. history. The spill impacted shorelines and coastal waters of the northern Gulf states, and more than a third of federal waters were closed to fishing. Federal and state agencies concerned about the safety of Gulf seafood implemented a unified seafood safety protocol for testing and re-opening fisheries. Waters were not reopened for fisheries harvest until oil had dissipated and testing showed that seafood was safe for consumption. Chemical markers of human health risk from exposure to crude oil and dispersant were selected for critical analyses of impacted fisheries. More than 10,000 specimens were tested. Testing results were consistently 100 to more than 1000-fold below levels of public health concern. As is the case with many parts of the response to the DWH accident, the seafood safety response during this crisis was unprecedented, and successful. The unified seafood safety protocol and testing results will be reviewed.

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Session: 011 - 12

Track: Public Health Impacts of the Deepwater Horizon Oil Spill

Date: Tuesday, January 22 11:45 AM

Type: Oral Presentation

## Impact of the Deepwater Horizon Oil Spill on Seafood Consumption Rates in Louisiana

**Presenter:** Daniel Harrington – LSUHSC-NO, School of Public Health

**Authors:** Daniel Harrington, LSUHSC-NO School of Public Health; Ann Clesi, LSUHSC-NO School of Public Health; Edward Peters, LSUHSC-NO School of Public Health; Elizabeth T.H. Fonham, LSUHSC-NO School of Public Health; Ariane Rung, LSUHSC-NO School of Public Health; Joseph Hagan, LSUHSC-NO School of Public Health; Megan Bronson, LSUHSC-NO School of Public Health; Edward Trapido, LSUHSC-NO School of Public Health

### Abstract:

A prominent public health concern after the Deepwater Horizon Oil Spill was whether or not seafood from the affected area was safe to eat. The

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Food and Drug Administration (FDA) conducted a health risk assessment to determine when to reopen oil spill-affected waters to commercial and recreational fishing. The overall seafood consumption rates used by the FDA were considerably lower than consumption rates that have been observed in coastal Louisiana, and if you underestimate consumption rates then you potentially underestimate risk. We are conducting The Women and their Children's Health (WATCH) Study, a prospective cohort study of the health effects of the oil spill in seven coastal Louisiana parishes. In part, the WATCH study is measuring the impact of the oil spill on seafood consumption patterns and rates. We will present these results from the first 150 enrolled women. When the WATCH study is complete we will develop seafood consumption rates specific to coastal Louisiana, and these consumption rates will be available to improve future health risk assessments in this region.

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Session: 011 - 13

Track: Public Health Impacts of the Deepwater Horizon Oil Spill

Date: Tuesday, January 22 12:00 PM  
Type: Oral Presentation

## Integrating Local Communities in the Health Risk Assessment Process Following the Deepwater Horizon Oil Spill--A Focus on Vietnamese-Americans

**Presenter:** Mark Wilson – Tulane University

**Authors:** Mark J. Wilson, Tulane University School of Public Health and Tropical Medicine; Scott Frickel, Washington State University; Daniel Nguyen, Mary Queen of Vietnam Community Development Corporation; Jessi L., Howard, Tulane University School of Public Health and Tropical Medicine; Bridget R. Simon, Tulane University School of Medicine, bsimon@tulane.edu; Jeffrey K. Wickliffe, Tulane University School of Public Health and Tropical Medicine

### Abstract:

Vietnamese-American populations in southeast Louisiana consist largely of commercial and subsistence fisherfolk and represent one of the highest seafood consuming groups in the Gulf South. We collected targeted survey data from a Vietnamese-American fishing community in Orleans Parish, Louisiana, to determine shrimp consumption rates, body weights, ages, and genders in order to conduct deterministic and probabilistic health risk assessments tailored to this unique population. Cancer risk estimates and levels of concern (LOCs) for several polycyclic aromatic hydrocarbons were determined using GC/MS in SIM mode on a sample of white shrimp collected from the Gulf with shrimpers from this community. Our approach also developed health risk assessments using LOCs, oral slope factors, and risk levels used by the Food and Drug Administration and the Natural Resources Defense Council. Our results demonstrate the need to include key populations in the risk assessment

process and measure risk model parameters in such populations rather than rely solely on generic exposure assumptions.

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Session: 011 - 14

Track: Public Health Impacts of the Deepwater Horizon Oil Spill

Date: Tuesday, January 22 12:15 PM  
Type: Oral Presentation

## Assessing safety of inshore-harvested seafood from the Gulf of Mexico: Addressing public health and community concerns after the Deepwater Horizon oil

**Presenter:** Andrew Kane – University of Florida

**Authors:** Andrew Kane, University of Florida; Stephen Roberts, University of Florida; John Munson, University of Florida; Margaret James, University of Florida; Marianne Kozuch, University of Florida; Leah Stuchal, University of Florida; Roxana Weil, University of Florida; Tracy Irani, University of Florida; Makyba Charles, University of Florida; Ross Brooks, University of Florida; J. Glenn Morris, University of Florida; Jeffrey Wickliffe, Tulane University; Shkeel Ansari, University of Texas Medical Branch; Edward Overton, Louisiana State University

### Abstract:

This study discerns the analytical toxicology of inshore seafood species to address community concerns regarding seafood safety in the Gulf of Mexico. Combined with consumption patterns of coastal high-end consumers of Gulf seafood, these data will be used to develop probabilistic, community-based risk assessments. Inshore finfish, shrimp, and blue crab samples were field-processed, homogenized and prepared using dispersive solid phase extraction, and analyzed using GC/MS-SIM. Results for individual PAHs from fish, shrimp and crab taken from Florida to Louisiana, between November 2010 and February 2012, were <2.0 ppb or below limits of quantitation. Surface sediments analyzed from Barataria Bay, LA indicate baseline levels of total aromatics ranging from 122-661 ppb. Aromatic contaminant levels in the non-commercially harvested seafood samples evaluated thus far are remarkably low and indicate that inshore-sampled seafood products evaluated in this study do not have quantifiably elevated body burdens of PAHs.

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Session: 011 - 15

Track: Public Health Impacts of the Deepwater Horizon Oil Spill

Date: Tuesday, January 22 2:00 PM

Type: Oral Presentation

## Polycyclic Aromatic Hydrocarbons Research at the National Toxicology Program

**Presenter:** Cynthia Rider – NIH/NIEHS/DNTP/TB

**Authors:** Cynthia Rider, NIEHS; Suramya Waidyanatha, NIEHS; Cynthia Smith, NIEHS; John Bucher, NIEHS; Scott Masten, NIEHS

### Abstract:

The Deepwater Horizon Gulf Oil Spill brought to light long-standing deficiencies in our knowledge regarding human health hazards of polycyclic aromatic hydrocarbons (PAHs). Thus, the National Toxicology Program (NTP) identified improved characterization of exposure and toxicity of PAHs as a priority research topic. PAHs are present in the environment from a variety of sources as complex and dynamic mixtures. Estimating the human health risk from exposure to real-world PAH mixtures requires an understanding of the cumulative effects associated with this class of compounds. The NTP is currently developing a PAH research program to address multiple knowledge gaps and inform the cumulative risk assessment process. Research efforts include characterizing the PAH profile of fresh and weathered oil and toxicity evaluations to characterize the hazard associated with less well-studied individual PAHs (alkylated and oxygenated PAHs), as well as select defined and complex PAH mixtures.

Session: 011 - 16

Track: Public Health Impacts of the Deepwater Horizon Oil Spill

Date: Tuesday, January 22 2:15 PM

Type: Oral Presentation

## Methylated phenanthrenes are more potent than phenanthrene in a bioassay of human aryl hydrocarbon receptor (AhR) activation

**Presenter:** Yue Sun – Tulane Univ. Sch. Medicine

**Authors:** Yue Sun, Tulane University School of Medicine; Charles Miller; Tulane University School of Public Health; Diane Blake, Tulane University School of Medicine

### Abstract:

Activation of aryl hydrocarbon receptor (AhR) by the binding of polycyclic aromatic hydrocarbons (PAHs) is required for carcinogenesis and other toxic effects. Alkylated polycyclic aromatic hydrocarbons (APAHs) are specific markers for environmental contamination from oil spills and seeps. However, little toxicological data are available for the APAHs found in crude oil. As a first step in the development of such data, a series

of monomethylated phenanthrenes were evaluated for their ability to activate the human AhR in a yeast-based bioassay (A. Alnafisi et al. (2007) Environ. Toxicol. Chem. 26:1333). Monomethylphenanthrenes (1,2,3,4 or 9 position) were compared to unsubstituted phenanthrene in the bioassay. The APAHs were 2-4 times more potent in activating human AhR than unsubstituted phenanthrene. The 1-, 2- and 3-monomethylphenanthrenes were more potent in activating AhR than the 4- and 9-methylphenanthrenes. Further research in additional model systems will be required to determine if residual APAHs pose significant risks at the concentrations found in the Gulf of Mexico ecosystem.

Session: 011 - 17

Track: Public Health Impacts of the Deepwater Horizon Oil Spill

Date: Tuesday, January 22 2:30 PM

Type: Oral Presentation

## Autophagy, apoptosis and increased reactive oxygen species induced by Corexit dispersants in human airway epithelial cells

**Presenter:** Danielle Major – Tulane University

**Authors:** Danielle Major, Tulane University; He Wang, Tulane University

### Abstract:

Nearly two million gallons of Corexit dispersants were used in response to the Deepwater Horizon oil spill disaster. The objective of this study was to assess the potential cytotoxicity of dispersants Corexit 9500, 9527 and 9580 on human airway epithelial cells since the dispersants were airborne when applied. BEAS-2B cells were cultured and exposed to the selected dispersants for 2 or 24 hours. Cell viability was measured by 3-(4,5-Dimethylthiazol-2-yl)-2,5-Diphenyltetrazolium Bromide (MTT) assay. Autophagic reaction was assessed by measuring autophagy marker, Light Chain 3 (LC3B) using western blot method. Apoptotic response was investigated using apoptosis markers of cleaved caspase-3 and cleaved poly [ADP-ribose] polymerase (PARP). In order to examine whether the apoptosis or autophagy is associated to generation of reactive oxygen species (ROS) in the treated cells, intracellular ROS were measured by ROS-sensitive fluorescent probe 2',7'-Dichlorodihydrofluorescein diacetate (DCFH2-DA). Activities of antioxidant enzymes including superoxide dismutase (SOD)1, SOD2 and SOD3, were assessed by western blot. The results showed that the viabilities of BEAS-2B cells were significantly decreased in response to Corexit 9527 or Corexit 9500 dispersant whereas no decrease was found in the cells treated by Corexit 9580 within the dose range of 0 to 300ppm. Apoptotic reaction was detectable in the cells treated by Corexit 9527 at 300ppm concentration. No apoptosis could be detected in the cells treated by Corexit 9500 or 9580. LC3B, a marker of autophagy, increased significantly in cells

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treated by Corexit 9527 or Corexit 9500 dispersant. ROS levels were increased significantly in the cells treated by all the selected Corexit dispersants only at the 300 ppm exposure level, but there were no significant changes in SOD1, SOD2 and SOD3 proteins. There was no correlation between ROS generation and cell viability loss or autophagy and apoptosis. However, further studies are required to understand the relationship between ROS generation and cell death in response to each of the selected dispersants.

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Session: 011 - 18

Track: Public Health Impacts of the Deepwater Horizon Oil Spill

Date: Tuesday, January 22 2:45 PM

Type: Oral Presentation

## **Gulf Oil Spill and Related Mental Health Issues: Role of Training and Education in oil spills and other disaster responses**

**Presenter:** Joseph Hughes – HHS-NIH-NIEHS

**Authors:** Joseph T. Hughes Jr., NIEHS; James Remington, NIEHS

### **Abstract:**

While the mental health impacts of environmental disasters on response personnel has been rarely assessed, mental health training and educational materials intended for response workers has not been systematically evaluated to understand if it is helpful in preventing or reducing adverse mental health outcomes. The NIEHS Worker Training Network offers an invaluable forum to assess the effectiveness or utility of the response workers, including mental health workers, current training practices, educational materials, networking system, and needs. Additionally, new training and educational materials are being developed and assessed in response to identified needs in order to help improve the response to future environmental disasters. This session will report on the work being carried out through resources from SAMSHA and NIEHS and local Gulf coast community organizations with the overall goal of improving the mental health-related resiliency, networking, education, and training of response cleanup and healthcare, including mental health, workers along the Gulf Coast.

Session: 011 - 19

Track: Public Health Impacts of the Deepwater Horizon Oil Spill

Date: Tuesday, January 22 3:00 PM

Type: Oral Presentation

## **Academic Initiatives and a Sustainable Community Health Worker Corps: Framing a holistic training approach with core competencies & research specialty**

**Presenter:** Farah Arosemena – Tulane University, SPHTM

**Authors:** Farah Arosemena, Tulane University; Laila Fox, Tulane University; Steven Picou, University of South Alabama; Maureen Lichtveld, Tulane University

### **Abstract:**

Significant research gaps exist on academic initiatives linking trained community health workers (CHWs) to health improvements. While competency-based education of health professionals is well established, CHW training varies widely in quality, consistency and focus. The research objective is to explore how competency based trained CHWs embedded into academic research strengthens public health interventions and affect health outcomes especially in health disparate communities. Informed by established CHW pedagogy and adult learning theory, core and specialty competency standards and a logic model-driven approach benchmarked transdisciplinary CHW training and research specialization in environmental health sciences, reproductive health, and quality of life. Resulting in a standardized skillset, the competency driven CHW training framework can be applied in diverse settings, learner levels, and public health research. The project demonstrates the benefits of the CHW-academic research collaborative network to research implementation and health outcomes in Gulf Coast communities.

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Session: 011 - 20

Track: Public Health Impacts of the Deepwater Horizon Oil Spill

Date: Tuesday, January 22 3:15 PM

Type: Oral Presentation

## **The evaluation and research capacity of the Gulf Region Health Outreach Program**

**Presenter:** Ayanna Buckner – Morehouse School of Medicine

**Authors:** Ayanna Buckner, Morehouse School of Medicine; Lisanne Brown, Louisiana Public Health Institute; Maureen Y. Lichtveld, Tulane University School of Public Health and Tropical Medicine; Howard J. Osofsky, Louisiana State University Health Sciences Center; J. Steven Picou, University of South Alabama

### **Abstract:**

This panel discussion describes the evaluation and research capacity of the Gulf Region Health Outreach Program (GRHOP), a series of four

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integrated community-based projects designed to be embedded in and to complement the existing efforts undertaken by the public health community along the Gulf Coast. Funded from the Deepwater Horizon Medical Settlement, the GRHOP target beneficiaries are residents of 17 coastal counties and parishes in Louisiana, Mississippi, Alabama, and the Florida Panhandle. The evaluation and research capacity of GRHOP will be examined in four areas: capacity of primary care community health clinics in the region, mental/behavioral health expertise of health professionals in the Gulf and awareness of local communities, environmental health expertise of health professionals in the Gulf and awareness of local communities, and training a cadre of community health workers to help residents navigate the healthcare system and access needed care. An evaluation and research roadmap will bolster the capacity building potential of this innovative public health program.

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Track: Public Health Impacts of the Deepwater Horizon Oil Spill

Date: Tuesday, January 22 3:30 PM

Type: Oral Presentation

## **A New Model of Resilience in Primary Care: Collaborative Telemental Health**

**Presenter:** John Wells – LSU Health Sciences Center

**Authors:** John Wells, LSUHSC New Orleans; Howard Osofsky, LSUHSC New Orleans

### **Abstract:**

Louisiana was devastated by Hurricane Katrina in 2005 and many of the same communities were highly impacted by the Gulf Oil Spill in 2010. The unique populations and topography of the Louisiana Gulf Coast present logistical challenges to provision of mental health care due to limited resources, dearth of providers, vulnerability to disaster, and cultural identifications. Funded by the Deepwater Horizon Medical Settlement, the LSU Health Sciences Center and the Mental and Behavioral Health Capacity Project for Louisiana will increase capacity of primary care to treat mental and behavioral health. A model of collaborative care integrated within the primary care setting is proposed utilizing telehealth and in-person treatment. In this model mental health specialists work as a team with primary care, providing an individualized level of care in an efficient manner. Pooled resource telehealth clinics give multiple remote clinics timely access to specialist providers in psychiatry and psychology for all age ranges. Resources are shifted to areas with greatest need in real time during regional stress, ensuring continuity of care and resilience of the system. Care coordinators register cases, measure response, evaluate utilization, and ensure communication of best-practices. Finally, the model will be evaluated by comparison of

participating clinics with clinics serving similar populations but outside the service area of the grant.

**Session: 011 -**

Track: Public Health Impacts of the Deepwater Horizon Oil Spill

Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## **Coping Styles, Resilience, and Depression in People with Income Loss after the Gulf of Mexico Oil Spill**

**Presenter:** Lorien Baker – University of Maryland School of Medicine

**Authors:** Lorien Baker, University of Maryland School of Medicine; Sparkle Roberts, University of Maryland School of Medicine; J. Glenn Morris, University of Florida; Lynn Grattan, University of Maryland School of Medicine

### **Abstract:**

Coping refers to things people do to protect themselves from harm induced by life stressors. After oil spill, coping responses are used to regulate psychological distress and manage the problems that cause distress. Since income loss was a significant stressor in many NE Gulf Coast communities after the Gulf of Mexico Oil Spill, we studied coping, self-reported resilience, and depression in 68 people who lost income 9 months post oil spill. Findings indicated that both problem- and emotion-focused coping strategies were used with significantly greater frequency in people with income loss compared to those with stable income. When emotional disengagement strategies were used in the income loss group, there was a trend toward lower levels of resilience and a significant increase in depression. Most people with income loss were actively engaged in trying to cope with their distress. When they were disengaged, their ability to “bounce back” was weakened. Interventions focused on active skill building and problem solving may have utility in the aftermath of oil spill.



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Track: Public Health Impacts of the Deepwater Horizon Oil Spill

Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## Anger, Bitterness, and Health Outcome After the Gulf of Mexico Oil Spill

**Presenter:** Lorien Baker – University of Maryland School of Medicine

**Authors:** Lorien Baker, University of Maryland School of Medicine; Sparkle Roberts, University of Maryland School of Medicine; Babette Brumback, University of Florida; Yi Zhang, University of Florida; J. Glenn Morris, University of Florida; Lynn Grattan, University of Maryland School of Medicine

### Abstract:

Anger and bitterness are often considered normal stress responses to perceived injustice. However, persistence of these negative emotions can lead to poor health and mental health outcomes. This study examines the relationship between anger, bitterness, and health outcome after the oil spill over time. 133 people were studied with measures of anger and bitterness during and 9 months post Gulf of Mexico Oil Spill. People with elevated anger scores during the oil spill had higher self-reported resilience and less depression than those who were still angry 9 months later. Bitterness at 9 months post spill was associated with greater mood disturbance, more post-traumatic symptoms, and the more frequent use of emotion-focused and disengagement coping styles. At both time epoch's, anger was correlated with number of health symptom complaints. Persistent anger and bitterness may lead to poor health and mental health outcomes through excessive rumination, hyperarousal, and the use of avoidant coping strategies.

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Track: Public Health Impacts of the Deepwater Horizon Oil Spill

Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## Electronic Data Collection Tools Used for the Women and Their Children's Health (WaTCH) Study

**Presenter:** Megan Bronson – LSUHSC-NO SPH

**Authors:** Megan Bronson, LSUHSC-NO; Edward Peters, LSUHSC-NO School of Public Health; Elizabeth T.H. Fonham, LSUHSC-NO School of Public Health; Ariane Rung, LSUHSC-NO School of Public Health; Daniel Harrington, LSUHSC-NO School of Public Health; Ann Clesi, LSUHSC-NO School of Public Health; Joseph Hagan, LSUHSC-NO School of Public Health; Edward Trapido, LSUHSC-NO School of Public Health

### Abstract:

The Women and Their Children's Health (WaTCH) Study is a prospective cohort study of the physical, mental and community health effects resulting from the Deepwater Horizon oil spill (DWOS) among women and their children in 7 southeastern Louisiana parishes. The WaTCH study explores the impact of the DWOS on residents by inviting adult women to participate in an hour-long phone interview and home visit. Phone interviews are conducted using either WinCATI® or REDCap® software. Use of the Computer Assisted Telephone Interview (CATI) software packages eliminates the need for double data entry as well as improves the measurement of interviewer capabilities. In order to enable research staff to more quickly and accurately collect home visit data, forms are designed using the iForm® application to be administered on iPads®. Multiple study modules are created in the iForm® application to collect biospecimen collection data, home survey data from both the adult woman and child, and a neighborhood audit. Use of the iPads® virtually eliminates all need for paper forms, including Informed Consent and Assent documents, which are also designed to be read and signed on iPads. This presentation will provide an overview of the use of these newer electronic data capture tools in a population based epidemiologic study.

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Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## p53 Mutagenesis by petrogenic Polycyclic Aromatic Hydrocarbon quinones

**Presenter:** Jeffrey Field – University of Pennsylvania

**Authors:** Jeffrey Field, University of Pennsylvania; Pratik Bhojnagarwala, University of Pennsylvania; Sushmita Sen, American Association for Cancer Research

### Abstract:

The US Geological Survey estimates that The Deepwater Horizon accident released about 18-30 million gallons of crude oil. Crude oil contains several hydrocarbons, the most dangerous of which are Polycyclic Aromatic Hydrocarbons (PAHs). Some PAH, PAH quinones, undergo futile redox cycling in the presence of NADPH, which causes oxidative stress. We have studied the amount of oxidative stress and DNA damage caused by three petrogenic PAH: Acenaphthenequinone (ANQ), 1,4-Anthraquinone (AQ) and 9,10-Phenanthrenequinone(PNQ). For comparison we used Benzo[a]pyrene-7-8 dione (BP-7,8 dione), a well studied PAH quinone. We employed three in vitro assays, under redox cycling and non redox cycling conditions: NADPH oxidation, DNA strand scission and p53 mutagenesis. PNQ and AQ oxidized NADPH at high



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concentrations (10 $\mu$ M and 20 $\mu$ M), but ANQ did not oxidize NADPH. The DNA strand scission assay showed that damage caused by 20 $\mu$ M PNQ is similar to that caused by 0.5 $\mu$ M BP-7,8 dione. The AQ and the ANQ did not cause any DNA damage even at high concentrations. In the p53 mutagenesis assay, the PNQ was about 20 times less mutagenic than BP-7,8 dione. The AQ showed slightly weaker mutagenicity than PNQ and the ANQ showed very little mutagenic capabilities. We conclude that the relative mutagenicity of these petrogenic PAH under non-enzymatic conditions is PNQ>AQ>ANQ. Experiments are under way to assess the redox potential in cellular models, where enzymes such as NQO1 may assist redox cycling.

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Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## Alabama Seafood Testing Program: Results and Evaluation

**Presenter:** John Guarisco – Alabama Department of Public Health

**Authors:** John Guarisco, Alabama Department of Public Health; Joseph Basile, Alabama Department of Agriculture and Industry; Chris Blankenship, Alabama Department of Conservation and Natural Resources; Michael Davis, Alabama Department of Public Health; Chris Denson, Alabama Department of Conservation and Natural Resources; Carol Dorsey, Alabama Department of Public Health; Michael Huff, Alabama Department of Public Health

### Abstract:

The Deepwater Horizon accident has raised concerns as to the safety of Alabama seafood. To ensure the safety of our seafood, the Alabama Departments of Agriculture and Industry (ADAI), Conservation and Natural Resources (Marine Resources Division) (ADCNR/MRD), and Public Health (ADPH) have instituted an initial three year seafood testing program in cooperation with British Petroleum. As a group, the three departments collected seafood samples (crabs, finfish, oysters, and shrimp) from open water and seafood processors, and then tested the samples for polycyclic aromatic hydrocarbons (PAHs) found in crude oil, and dioctyl sodium sulfosuccinate (DOSS) found in dispersants. The PAHs were screened using the liquid chromatography fluorescence screening method developed by NOAA/FDA. The DOSS analysis was performed using liquid chromatography mass spectroscopy methods approved by NOAA/FDA. All seafood samples screened for PAHs and DOSS are well below the FDA's levels of concern. The current results indicate that Alabama seafood is safe for human consumption.

## Metabolism of representative alkylated and oxygenated petrogenic polycyclic aromatic hydrocarbons in human hepatoma (HepG2) cells

**Presenter:** Meng Huang – University of Pennsylvania

**Authors:** Meng Huang, Perelman School of Medicine, University of Pennsylvania; Li Zhang, Perelman School of Medicine, University of Pennsylvania; Ian A. Blair, Perelman School of Medicine, University of Pennsylvania; Trevor M. Penning, Perelman School of Medicine, University of Pennsylvania

### Abstract:

Exposure to petrogenic polycyclic aromatic hydrocarbons (PAHs) in the food-chain is the major human health hazard associated with the Deepwater Horizon gulf-oil spill. Risk assessment is based on the assumption that petrogenic and pyrogenic PAHs have similar toxicological profiles yet petrogenic PAHs are either alkylated or oxygenated and information on their metabolism is lacking. We report the metabolic fate of 5-methylchrysene and retene as representative alkylated petrogenic PAHs, and 9,10-phenanthrenequinone as a representative oxygenated petrogenic PAH in human HepG2 cells. The structures of the metabolites were identified by HPLC-UV-fluorescence detection and LC-MS/MS. The identification of tetraols, ortho-quinones and O-sulfated catechols supports metabolic activation of 5-methylchrysene and retene by P450 and AKR isozymes. The identification of O-glucuronidated catechols and O-methylated-O-sulfated catechols supports metabolic detoxification of 9,10-phenanthrenequinone through termination of redox cycling by UGT, COMT and SULT isozymes. (Supported by U19ES020676-01 to TMP)

# Science Abstracts

Session: 011 -

Track: Public Health Impacts of the Deepwater Horizon Oil Spill

Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## Seafood Safety following the Deepwater Horizon Disaster

**Presenter:** Dan Jackson – University of Texas Medical Branch

**Authors:** Dan Jackson, The University of Texas Medical Branch;  
Harshica Fernando, The University of Texas Medical Branch;  
Shakeel Ansari, The University of Texas Medical Branch; Cornelis Elferink, The University of Texas Medical Branch

### Abstract:

The GC-HARMS consortium is conducting a 5-year longitudinal study to explore the health impact and community resiliency related to the 2010 Deepwater Horizon disaster. The consortium unites academic investigators with community partners to assess and communicate the human health risks of exposure to potentially hazardous food-borne petrogenic Polycyclic Aromatic Hydrocarbons (PAHs). Our goals developed in collaboration with our community partners are to, 1) assess PAH contamination of Gulf seafood consumed by and sold by the subsistence fishing communities, 2) determine the toxicity of petrogenic PAH, 3) measure the exposure levels in the human population, and 4) build community resiliency by disseminating the findings. PAH analyses using gas chromatography-mass spectrometry are being performed on shellfish and finfish harvested along the Gulf coast, giving preliminary estimates in the 100 ppb range. The toxicity of seafood-extracted PAH mixtures, including selected alkylated and oxygenated PAH metabolites is being determined as TCDD toxic equivalence, which along with human exposure measurements will inform future risk assessments of Gulf seafood safety.

Session: 011 -

Track: Public Health Impacts of the Deepwater Horizon Oil Spill

Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## Seafood consumption survey tools: Field guides to identify edible Gulf of Mexico fish species and cooked portion sizes

**Presenter:** Andrew Kane – University of Florida

**Authors:** Andrew Kane, University of Florida; Anne Mathews, University of Florida; Ross Brooks, University of Florida; Leah Stuchal, University of Florida; Roxana Weil, University of Florida; Stephen Roberts, University of Florida

### Abstract:

A field guide was developed to aid in identifying edible, in-shore seafood species from the Gulf of Mexico. The field document is a waterproof, spiral-bound instrument that graphically portrays over 80 species including finfish, crab, oyster and shrimp. Illustrations by Diane Peebles, Joseph Tomelleri and Kevin Brant were contributed to facilitate this product. High-resolution renderings of the illustrations, or actual photographs, were printed on the front of guide pages, without common or scientific names to facilitate visual identification without biasing participant selections. Reverse sides of pages include scientific name, common names, and meristics for positive identification. Also included on reverse sides are pictures of visually similar species to help differentiate between selected species and close look-alikes. Consumption portion guides were also developed for shrimp and fish filets. These guides were developed using standardized photographs of cooked product portions, with only graphic content portrayed on the different portion pages. Portion guides were validated in a tasting laboratory and more accurately represented recall of actual plated portions compared to "number of ounces."

Session: 011 -

Track: Public Health Impacts of the Deepwater Horizon Oil Spill

Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## Healthy Gulf—Healthy Communities: Areas of Concern for Community Agencies

**Presenter:** Samuel Mathews – University of West Florida

**Authors:** Samuel R. Mathews, University of West Florida; Jenna Moore, University of Illinois Urbana; Marcia Holland, University of West Florida

### Abstract:

Our goal for the COD core for Healthy Gulf-Healthy Communities is on understanding organizations' responses to disasters. Our presentation focuses on the organizations and agencies charged with providing support for individuals and communities as they recover. Data come from interviews with members of organizations providing assistance following disasters and participation in meetings of consortia representing these organizations. These data have yielded the following areas of concern on the part of our community partner agencies:

- Consistent and elevated levels of requests for assistance following the DWH disaster
- Lack of clear plans and resources for continued sustainability of services
- The description of a typical client is seen as changed

# Science Abstracts

- Lack of coordination of projects and programs being initiated from outside the region with local organizations and agencies

Our presentation will focus on these areas of concern, potential impacts to future disaster mitigation efforts and strategies for reducing the impact of these areas of concern.

Session: 011 -

Track: Public Health Impacts of the Deepwater Horizon Oil Spill

Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## Health Behavior Characteristics Among a Cohort of Women in Coastal Louisiana affected by the Deepwater Horizon Oil Spill (DHOS)

**Presenter:** Edward Peters – LSUHSC-School of Public Health

**Authors:** Edward Peters, LSUHSC School of Public Health; Ariane Rung, LSUHSC School of Public Health; Elizabeth T.H. Fonham, LSUHSC School of Public Health; Joseph Hagan, LSUHSC School of Public Health; Daniel Harrington, LSUHSC School of Public Health; Megan Bronson, LSUHSC School of Public Health; Edward Trapido, LSUHSC School of Public Health

### Abstract:

The Women and their Children's Health (WaTCH) Study is a cohort study to examine the health effects from the DHOS among 2500 randomly sampled women in 7 coastal Louisiana parishes. Prior research suggests individuals under stress increase their smoking and drinking behaviors. A telephone interview is being conducted to collect information on demographics, physical health, health behaviors, and exposure to the oil spill. Preliminary results will be presented on the first 150 women enrolled. DHOS exposure among women is estimated as direct contact with oil through clean-up activities, lost/damaged property, or through hunting/fishing activities. We are measuring smoking and drinking intensity and duration and whether this changed as a result of the DHOS. This presentation will describe smoking and alcohol consumption of women exposed to the DHOS compared to unexposed women and assess whether or not the exposure modified their behaviors. Results from our study may help identify specific health behaviors associated with stress and lead to improved health promotion activities.

Session: 011 -

Track: Public Health Impacts of the Deepwater Horizon Oil Spill

Date: Tuesday, January 22 16:30 - 18:00

Type: Poster

## Subjective Medical Symptom Complaints of NE Gulf Coast Residents Post Oil Spill

**Presenter:** Sparkle Roberts – University of Maryland School of Medicine

**Authors:** Sparkle Roberts, University of Maryland School of Medicine; Lorien Baker, University of Maryland School of Medicine; Alexandra Toben, University of Maryland School of Medicine; Babette Brumback, University of Florida

Yi Zhang, University of Florida, jamiezhong@ufl.edu

J. Glenn Morris

University of Florida, Emerging Pathogens Institute jgmorris@epi.ufl.edu

Lynn Grattan

University of Maryland School of Medicine LGrattan@som.umaryland.edu

### Abstract:

Diverse medical symptoms have been associated with disasters or toxic exposures with plausible health consequences. We studied medical symptom complaints in 94 NE Gulf Coast community residents with direct and indirect exposure to coastal oil within 9 months of the Gulf of Mexico Oil Spill (GoMOS). Data was collected within the context of a neuropsychological evaluation. During the spill, residents of oil exposed communities were more likely to report memory problems ( $p < .001$ ) and irritability ( $p = .028$ ) than the comparison group. However, based upon psychometric testing, there were no actual differences between the two groups on memory measures. Nine months later, the exposed group was more likely to report mood changes ( $p = .011$ ), irritability ( $p = .018$ ), and sleep disturbance ( $p = .017$ ). Medical symptom complaints during the first year after the GoMOS disaster were predominantly associated with anxiety and depression. Findings support the need for an increase in psychological and psychiatric services for at least one year post oil spill in impacted communities.

# Science Abstracts

## Session: 012 Socio-economic Impacts of the Deepwater Horizon Oil Spill

Session: 012 - 1

Track: Socio-economic Impacts of the Deepwater Horizon Oil Spill

Date: Monday, January 21 10:45 AM

Type: Oral Presentation

### Value of Gulf Ecosystem Services

**Presenter:** Andrew Shepard – Gulf University Research Collaborative

**Authors:** Andrew Shepard, Gulf University Research Collaborative; John Valentine, Dauphin Island Sea Lab; Christopher D'Elia, Louisiana State University

#### Abstract:

The Deepwater Horizon Oil Spill (DHOS) in 2010 was a Gulf of Mexico ecological and economic disaster adding to decades-long degradation of the region's coastal and marine environment, exacerbated by lack of funding, federal and state policies, and exploitation of living and non-living resources. Ultimately, a balance must be struck between market and non-market values, supported by wise management informed by science. A fundamental step to raising resources required for science and awareness, and for achieving this balance, is to understand and estimate these values, and a new valuation resource has been created for coastal and ocean economies. Based on the National Ocean Economics Program database (CBE, 2012), Gulf ecosystem goods and services contribute an estimated \$2.1 trillion per year to the nation's Gross Domestic Product, including over \$112 billion from ocean goods and services. In light of this value and trends in stressors, new investment is necessary to ensure a sustained healthy Gulf ecosystem.

Session: 012 - 2

Track: Socio-economic Impacts of the Deepwater Horizon Oil Spill

Date: Monday, January 21 11:00 AM

Type: Oral Presentation

### The Economic Effects of the BP Oil Spill on the South Alabama Economy after Tropical Storm Lee

**Presenter:** Louis Mancuso – Southern University at New Orleans

**Authors:** Louis Mancuso, Southern University at New Orleans; Marjorie Fox, Southern University at New Orleans; Biruk Alemayehu, Southern University at New Orleans

#### Abstract:

South Alabama has received a double whammy from the April 20, 2010 BP Oil Spill. The disaster wreaked havoc on the Gulf Coast for approximately six months. Then a year and half later Tropical Storm Lee churned up the Gulf of Mexico again and deposited tar balls on the South Alabama Coast line. Notwithstanding BP's claim that everything is now 'back to normal,' the Gulf Coast continues to suffer from four kinds of negative effects: environmental, economic, physical and psychological. This paper studies the economic effects observed in Southern Alabama 18 months after the occurrence of the Deepwater Horizon disaster and one month after Tropical Storm Lee.

Session: 012 - 3

Track: Socio-economic Impacts of the Deepwater Horizon Oil Spill

Date: Monday, January 21 11:15 AM

Type: Oral Presentation

### Changes in Coastal Alabama household income and activity following Deepwater Horizon oil spill – Baldwin and Mobile Counties, Aug 2010 and Aug 2011

**Presenter:** Melissa Morrison – CDC/Alabama Department of Public Health

**Authors:** Melissa Morrison, Centers for Disease Control and Prevention; Amy Wolkin, Centers for Disease Control and Prevention

#### Abstract:

Acute economic and social impacts of the Deepwater Horizon oil spill on coastal communities of Alabama were of concern. In August 2010, the Alabama Departments of Public Health, Mental Health and CDC conducted a community assessment to identify household-level impacts, including changes in income and activities. About one-third of households reported decreased income and > half reported decreased swimming and boating. Slightly < half reported decreased time outdoors. The percent of households reporting decreased consumption of local seafood was > 60%. The assessment was repeated in 2011. When comparing responses between assessments, there was no statistically significant change in the percent of households reporting decreased income. While the percent of households reporting decreased activities was significantly lower in 2011 than in 2010, the percent of households reporting decreased activity remained considerable (27.9 to 47.1%). The results indicate household income and activities were acutely impacted and effects continued to be reported one year after the initial assessment.

# Science Abstracts

Session: 012 - 4

Track: Socio-economic Impacts of the Deepwater Horizon Oil Spill

Date: Monday, January 21 11:30 AM

Type: Oral Presentation

## Impact of the Deepwater Horizon well blowout on the economics of US Gulf fisheries: a method for preliminary assessment

**Presenter:** Andres Cisneros-Montemayor – University of British Columbia

**Authors:** Andres M. Cisneros-Montemayor, University of British Columbia; U. Rashid Sumaila, University of British Columbia; Kristin Kleisner, University of British Columbia

### Abstract:

Marine oil spills usually harm organisms at two interfaces: near the water surface and on shore. However, because of the depth and magnitude of the 2010 Deepwater Horizon well blowout, deeper parts of the Gulf of Mexico are likely impacted and effects may remain for a longer period relative to past observed spills. We estimate the potential negative economic effects of this blowout and oil spill on commercial and recreational fishing, and mariculture, in the US Gulf area by integrating current knowledge on species-specific oil contamination effects from previous spills and computing potential losses throughout the fish value chain. We find that the spill could, in the next seven years, result in (midpoint) present value losses of total revenues, total profits, wages and economic impact of US\$3.7, US\$1.9, US\$1.2 and US\$8.7 billion, respectively. The estimation approach is intended to provide a flexible framework that can be applied at various spatial and temporal scales depending on available data, and the model assumptions can similarly be updated as better information emerges on the ecological impacts of oil on the affected marine ecosystem. We discuss the strengths and limitations of such an approach under various spill scenarios and management objectives, and present estimates at several spatial scales.

Session: 012 - 5

Track: Socio-economic Impacts of the Deepwater Horizon Oil Spill

Date: Monday, January 21 11:45 AM

Type: Oral Presentation

## Surviving the Spill: The Seafood Supply Chain in Alabama and Mississippi After the Deepwater Horizon Disaster

**Presenter:** Stefanie Christensen – Auburn University

**Authors:** Stefanie Christensen, Auburn University; Michelle R. Worosz, Auburn University

### Abstract:

This research is an investigation into the impact of the Deepwater Horizon oil spill on the commercial seafood supply chain in the coastal counties of Alabama and Mississippi. Through in-person interviews with seafood harvesters, processors, wholesalers, retailers, and restaurateurs, this project will elucidate the opinions and beliefs held by these stakeholders on a variety of topics including public perception of Gulf Coast seafood, seafood safety regulations, and the role of the media in food safety debates. Findings will illustrate the mounting challenges faced by the industry, as well as the implications of those challenges and the opportunities available to improve resilience in the Gulf Coast region.

Session: 012 - 6

Track: Socio-economic Impacts of the Deepwater Horizon Oil Spill

Date: Monday, January 21 12:00 PM

Type: Oral Presentation

## Enhancing Community Resiliency through Cooperative Extension Training

**Presenter:** Paul Monaghan – University of Florida

**Authors:** Paul Monaghan, University of Florida; Brian Mayer, University of Arizona; Joan Flocks, University of Florida; Tracy Irani, University of Florida

### Abstract:

The Deepwater Horizon oil spill revealed the limits for many Gulf coast communities in terms of disaster preparedness and resiliency. Even resilient coastal communities that regularly face economic challenges and natural disasters were tested by this man-made disaster. While the physical damage was not as great as a hurricane, the toll on jobs and the emotional stress was significant. Using focus groups and key informant interviews, we have collected community-level data on the issues pertaining to preparedness, response, recovery, communication, civic engagement and sustainability. We are taking a community based social marketing approach to translate these research findings on resiliency and develop educational outreach and training materials on best practices that communities can use. A social marketing approach requires that we use research to identify specific target audiences and understand the barriers to more resilient behavior at a community level. It also requires that we find measures of behavior change that will lead to greater resiliency. This presentation will summarize the initial findings of what we have learned about the impact of the oil spill in one pilot study community. We will demonstrate how we will use these findings to create a curriculum for Cooperative Extension that can be used to engage and teach communities to be more resilient.



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Session: 012 - 7

Track: Socio-economic Impacts of the Deepwater Horizon Oil Spill

Date: Monday, January 21 12:15 PM

Type: Oral Presentation

## Mitigation of the Human Dimensions of Spills in Coastal Louisiana: Collaboration Between NOAA's Office of Response and Restoration and LA Sea Grant

**Presenter:** Heather Ballesterio – UNH/Coastal Response Research Center

**Authors:** Heather Ballesterio, University of New Hampshire

### Abstract:

Garnering intra-agency collaboration between NOAA's Office of Response and Restoration (OR&R) and Sea Grant Program provides a liaison between federal spill responders and extension personnel who live and work in coastal regions. A pilot oil spill notification protocol between these two agencies was designed and tested in Louisiana (2007-2008). The goal of the project was to mitigate negative human dimensions issues arising from oil spills by providing timely and accurate spill information, response measures, and risk communication to residents and resource stakeholders in coastal parishes. The protocol consisted of OR&R notifying Sea Grant agents of a spill via email and the agents deciding how to disseminate the information to constituents. This protocol was used successfully during two spills in 2008. In light of Deepwater Horizon, this pilot protocol is revisited and reviewed for potential application to other U.S. coastal states to help mitigate negative impacts of spills (e.g., resource valuation, risk communication, subsistence disruption).

Session: 012 - 8

Track: Socio-economic Impacts of the Deepwater Horizon Oil Spill

Date: Monday, January 21 2:00 PM

Type: Oral Presentation

## The Emerging Role of Land Use Planning for Resiliency to Disasters

**Presenter:** Emily Powell – Coastal Sustainability Studio

**Authors:** Jeff Carney, Louisiana State University; Katrina A Durbak, Louisiana State University; Patrick W Michaels, Louisiana State University; Emily Powell, Louisiana State University

### Abstract:

Historically, disasters have catalyzed swift actions in Louisiana communities. Previous events, such as the 1927 flood and Hurricanes Betsy and Katrina, triggered significant physical and policy changes. Following Hurricanes Gustav and Ike in 2008, Louisiana elevated the role

of land use planning in preparing for future disasters through the Comprehensive Resiliency Pilot Program. Through a competitive process, the CRPP funded 30 affected Louisiana communities and parishes to develop plans that address their resilience to risk. As part of this effort, LSU's Coastal Sustainability Studio was chosen to establish the Louisiana Resiliency Assistance Program to support the 30 grantees and draw conclusions that will provide guidance for the future of planning in Louisiana. Disasters have historically opened a short window in which significant course correction can occur. As the state and federal government continue to respond to the BP oil spill we will present a strong case for land-use and community planning as an important part of disaster recovery allocations.

Session: 012 - 9

Track: Socio-economic Impacts of the Deepwater Horizon Oil Spill

Date: Monday, January 21 2:15 PM

Type: Oral Presentation

## Compensation and Relative Deprivation in the Gulf: Challenges to the Recovery Process

**Presenter:** Brian Mayer – University of Arizona

**Authors:** Brian Mayer, University of Arizona; Joan Flocks, University of Florida

### Abstract:

Evaluating one's own damages and recovery needs after a traumatic event in reference to others' has been observed in the disasters literature as an important component in the coping process. Sociological research on the impacts of disasters finds that disparate losses and compensation, perceived or real, can lead to a corrosive community whereby social bonds are eroded and replaced by mistrust, fear, and uncertainty. This paper explores the role of relative deprivation and reference groups in the formation of corrosive communities affected by the Deepwater Horizon Oil Spill. Based on interviews and focus groups with residents in coastal towns from 2011-2012, we find that the definition of an out-group - consisting of individuals receiving more compensation than perceived as deserved - significantly limits perceptions of satisfaction in the claims process and hinders individual and community recovery. Lacking transparency and consistency in its application, the compensation process can be seen as a potential contributor to ongoing individual and community distress.



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## Session: 012 - 10

Track: Socio-economic Impacts of the Deepwater Horizon Oil Spill

Date: Monday, January 21 2:30 PM

Type: Oral Presentation

### **BOEM: Oil Spill Research in the GOM**

**Presenter:** John Primo – DOI/BOEM

**Authors:** John Primo, DOI/BOEM; Harry Luton, DOI/BOEM

#### **Abstract:**

The social effects of the Deepwater Horizon spill in the U.S. Gulf of Mexico have been extensive and are still ongoing. Within weeks of the spill, BOEM modified an ongoing study in order to place experienced researchers in the field to observe, describe and document effects as they were occurring. BOEM (then MMS) worked loosely with researchers from the Bureau of Applied Anthropology at the University of Arizona to design and launch this study, which may be the only sustained observational study of social effects for the period from April 2010 through December 2011. A soon-to-be-released 2 volume report is now under BOEM review. Based on the results of this effort, BOEM designed a follow-up study that combines field researchers from the Bureau of Applied Anthropology with demographic expertise from the University of Texas at San Antonio. The follow-up effort was recently funded and is now underway. This session will describe the design and results of the first effort and the multi-methods design of the second.

## Session: 012 - 11

Track: Socio-economic Impacts of the Deepwater Horizon Oil Spill

Date: Monday, January 21 2:45 PM

Type: Oral Presentation

### **The Socioeconomic and Health Care Effects of the Deepwater Horizon Oil Spill (DWOS) Among Women in Southern Coastal Louisiana: the WATCH Study**

**Presenter:** Ariane Rung – LSU School of Public Health

**Authors:** Ariane Rung, LSUHSC School of Public Health; Edward Peters, LSUHSC School of Public Health; Elizabeth T.H. Fonham, LSUHSC School of Public Health; David Abramson, Columbia University Mailman School of Public Health; Joseph Hagan, LSUHSC School of Public Health; Daniel Harrington, LSUHSC School of Public Health; Megan Bronson, LSUHSC School of Public Health; Edward Tapido, LSUHSC School of Public Health

#### **Abstract:**

The Women and their Children's Health (WATCH) Study is a prospective cohort study of the health effects of the DWOS among women in 7 coastal Louisiana parishes. Prior oil spill research showed that those with the fewest economic resources are the most adversely affected in terms of

their economic and health impact. The objective of this presentation is to describe the socioeconomic and health access characteristics of women exposed to the DWOS compared to unexposed women. A telephone interview of randomly selected women in each parish was conducted. Preliminary results are presented on the first 150 women enrolled. Exposed women had direct contact with oil through clean-up activities, lost/damaged property, or through hunting/fishing activities. Economic impact was measured as oil spill-related loss of income/jobs, change in household finances, and relative impact compared to others in the community and to pre-oil spill. Access to care was measured by whether respondents had a personal doctor or health insurance. Results from this study may help identify vulnerable populations and their specific needs.

## Session: 012 - 12

Track: Socio-economic Impacts of the Deepwater Horizon Oil Spill

Date: Monday, January 21 3:00 PM

Type: Oral Presentation

### **Developing a barometer of health and balance: Measuring community well-being for coastal counties in the Gulf of Mexico**

**Presenter:** Maria Dillard – JHT, Hollings Marine Laboratory, NOAA

**Authors:** Maria Dillard, NOAA National Centers for Coastal Ocean Science; Susan Lovelace, NOAA National Centers for Coastal Ocean Science; Theresa Goedeke, NOAA National Centers for Coastal Ocean Science

#### **Abstract:**

To prepare for and respond to environmental events like Deepwater Horizon (DWH), decision makers, resource managers, and other government officials need information about the social and economic aspects of their communities. In order to characterize the baseline context and changes in society, secondary data were collected and analyzed to develop indicators of well-being. The researchers will present indicators for the quantification of community well-being at the county level for the US Gulf of Mexico, a region impacted by multiple, large-scale disasters. Indicators include health, safety, economic security, governance, education, food/water, housing, social services, social connectedness, and environmental use. By establishing a method for monitoring societal changes over time, this project will fill gaps in information about the status of impacted communities and their recovery from major ecosystem service disruptions of the past decade, including the DWH disaster. Indicator development will be presented alongside examples of county well-being profiles.

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Session: 012 - 13

Track: Socio-economic Impacts of the Deepwater Horizon Oil Spill

Date: Monday, January 21 3:15 PM

Type: Oral Presentation

## **Oil and gas development in the Gulf of St. Lawrence, Canada : learning from the Gulf of Mexico experience**

**Presenter:** Sylvain Archambault – St. Lawrence Coalition

**Authors:** Sylvain Archambault, CPAWS Quebec and St. Lawrence Coalition; Danielle Giroux, Attention Fragiles and St. Lawrence Coalition

### **Abstract:**

Consequences of the Deepwater Horizon blowout are far reaching and have strongly influenced the way oil and gas development is perceived in communities around the Gulf of St. Lawrence, a semi-enclosed sea, six times smaller than the Gulf of Mexico. An offshore drilling project astride the Quebec/Newfoundland border is currently under environmental review amidst deep public concerns. Coastal communities largely dependent on fishing and tourism for their livelihood see the Gulf of Mexico tragedy as a reminder of what could happen in the Gulf of St. Lawrence and have become wary of anything that could jeopardize their way of living. Drawing from the Gulf of Mexico experience, the public has realized that legal protection, spill response capacity, or financial liability in the Gulf of St. Lawrence are inadequate. The Gulf of Mexico incident now serves as a benchmark against which to evaluate potential risks and impacts of drilling projects in the Gulf of St. Lawrence. The St. Lawrence Coalition is asking for a moratorium on oil development in all of the Gulf of St. Lawrence.

Session: 012 - 14

Track: Socio-economic Impacts of the Deepwater Horizon Oil Spill

Date: Monday, January 21 3:30 PM

Type: Oral Presentation

## **Your good humor may depend on Mother Nature- Identifying relationships between coastal environmental health and well-being in the Gulf of Mexico**

**Presenter:** Susan Lovelace – JHT, Hollings Marine Laboratory, NOAA

**Authors:** Susan Lovelace, NOAA National Centers for Coastal Ocean Science; Maria Dillard, NOAA National Centers for Coastal Ocean Science; Theresa Goedeke, NOAA National Centers for Coastal Ocean Science

### **Abstract:**

While the Millennium Ecosystem Assessment makes it clear that well-being is contingent upon ecosystem services, in the U.S. some are often confident that we have minimized the dependency. Industrial disasters such as the Deepwater Horizon (DWH) explosion and natural disasters such as Hurricane Isaac serve to remind us of the acute power of the relationship. However, we are learning that these events and more subtle changes in environmental health have a prolonged or chronic impact on the social and economic and health aspects of communities. To better understand these relationships secondary social, economic, and environmental data collected during the last decade were analyzed to quantify these relationships. The researchers will discuss findings from this work in multiple counties and states of the northern Gulf of Mexico. Identifying the impact of changes in environment on indicators of well-being provides decision makers, resource managers, and government officials information to plan for environmental events like DWH and chronic issues affecting coastal environments.

Session: 012 - 15

Track: Socio-economic Impacts of the Deepwater Horizon Oil Spill

Date: Monday, January 21 3:45 PM

Type: Oral Presentation

## **The Financial Life Events Checklist: Preliminary Development and Validation for Field Use**

**Presenter:** Sailor Holobaugh – University of Maryland School of Medicine

**Authors:** Sailor Holobaugh, University of Maryland School of Medicine; Lynn Grattan, University of Maryland School of Medicine; Sparkle Roberts, University of Maryland School of Medicine; Lorien Baker, University of Maryland School of Medicine; Alexandra Toben, University of Maryland School of Medicine; J. Glenn Morris, University of Florida; Babette Brumback, University of Florida; Yi Zhang, University of Florida

### **Abstract:**

The broad economic impacts of the Gulf of Mexico Oil Spill (GoMOS) have been well documented. For individuals and families, this translates into financial decisions that impinge on the health, ongoing relationships, and activities of people every day. Despite its relevance, there is no generally accepted measure of the depth and breadth of economic hardship individuals and families face and adapt to post-disaster. To fill this gap, we developed the Financial Life Events Checklist based upon literature review, expert opinion, item analysis, field testing, and community feedback. Preliminary validation studies of this 27 item, self-reported, forced-choice measure were conducted with 94 Gulf Coast residents impacted by the GoMOS. Based upon cluster analysis,

# Science Abstracts

## Abstract:

The Gulf of St. Lawrence is free of oil production. However, interest is high and a few exploratory projects have recently been tabled, including the Old Harry drilling project. With images of the Gulf of Mexico incident in mind, many citizens, scientists, First Nations, fishermen and tourist associations, think that drilling in the Gulf of St. Lawrence is a very bad idea. The Gulf is a small semi-enclosed sea, six times smaller than the Gulf of Mexico, with a complex counterclockwise circulation pattern. The Gulf is unique in the world with a dozen whale species, including the endangered Blue Whale, migrating deep in the continent to feed on the exceptional productivity. Coastal communities are largely dependent on fishing and tourism for their livelihood. According to oil spill simulations by the David Suzuki Foundation and Environment Canada, a large spill has a high probability of affecting any of the five neighbour coastal provinces. The St. Lawrence Coalition is asking for a moratorium on oil development in all of the Gulf of St. Lawrence.

Session: 012 -

Track: Socio-economic Impacts of the Deepwater Horizon Oil Spill

Date: Monday, January 21 16:30 - 18:00

Type: Poster

## Potential Relationship between Harmful Algae Blooms and Tourism to Cape Cod, MA

**Presenter:** Lucy Flores – Harte Research Institute at TAMUCC

**Authors:** Lucy Flores, Texas A&M University Corpus Christi

## Abstract:

Certain species of marine algae produce chemicals (toxins) that are known to be harmful both to other marine life and to humans. When blooms of these species occur, they are called harmful algal blooms (HABs). In certain circumstances, the toxins produced by HABs can accumulate in the bodies of shellfish as they feed naturally on the algae as a food source. If the toxin concentration becomes high enough, then shellfish may become dangerous to eat and shellfish beds must be closed to prevent human consumption. It is possible that coastal tourism, can be affected negatively by HABs because of concerns about becoming sick due to shellfish toxins. Our goal is to determine whether or not there is a negative relationship between HABs and tourist visits to Cape Cod. If so, we might be able to predict fluctuations in tourism and regional economic impacts in the event of a HAB. We start with the null hypothesis that there is no effect between HABs and the tourist visits to Cape Cod.

subscales were identified and a satisfactory reliability coefficient was established for the measure (Cronbach alpha of .88, 95% CI [.84, .91]). Preliminary analyses support the use of the Financial Life Events Checklist in post-disaster studies to gauge the financial impact on individuals and families as they make important financial decisions that may impact outcome.

Session: 012 -

Track: Socio-economic Impacts of the Deepwater Horizon Oil Spill

Date: Monday, January 21 16:30 - 18:00

Type: Poster

## Public Perceptions of the Deepwater Horizon Oil Spill: Continuing Distrust of Gulf Coast Fisheries

**Presenter:** Sean Anderson – CSU Channel Islands

**Authors:** Sean Anderson, California State University Channel Islands

## Abstract:

Public perception of resource injury and contamination can have strong influences upon subsequent consumer behavior, particularly when it comes to the perceived safety of food. To begin to explore the effect of the Deepwater Horizon blowout upon perceptions of Gulf Coast seafood outside of the Gulf, I modified an ongoing, annual public opinion polling instrument, the CSUCI Survey of Public Opinion of Coastal Resources, in Fall 2010. Lack of transparency during the Deepwater Horizon response, the ensuing media firestorm about potential environmental impacts, and temporary closure of one-third of federal waters in the Gulf to fishing seem to have been behind 75% of the public feeling Gulf of Mexico seafood was either definitely unsafe to eat or were unsure as to its safety in late 2010. This hesitancy was consistent with other national polls. Surprisingly, I have found extremely little change in that high distrust of Gulf seafood in 2011 and 2012 surveys. This perception of ecosystem injury may have long-term consequences for the profitability of Gulf fisheries.

Session: 012 -

Track: Socio-economic Impacts of the Deepwater Horizon Oil Spill

Date: Monday, January 21 16:30 - 18:00

Type: Poster

## Oil and gas development in the Gulf of St. Lawrence, Canada : is it a good idea?

**Presenter:** Sylvain Archambault – St. Lawrence Coalition

**Authors:** Sylvain Archambault, CPAWS Quebec and St. Lawrence Coalition; Danielle Giroux, Attention Fragiles and St. Lawrence Coalition

# Science Abstracts

Session: 012 -

Track: Socio-economic Impacts of the Deepwater Horizon Oil Spill

Date: Monday, January 21 16:30 - 18:00

Type: Poster

## The Economic Effects of the BP Oil Spill on the South Alabama Economy after Tropical Storm Lee

**Presenter:** Marjorie Fox – Southern University at New Orleans

**Authors:** Louis C. Mancuso, Southern University at New Orleans;  
Marjorie Anne Fox, Southern University at New Orleans

### Abstract:

South Alabama has received a double whammy from the April 20, 2010 BP Oil Spill. The disaster wreaked havoc on the Gulf Coast for approximately six months. Then a year and half later Tropical Storm Lee churned up the Gulf of Mexico again and deposited tar balls on the South Alabama Coast line. Notwithstanding BP's claim that everything is now 'back to normal,' the Gulf Coast continues to suffer from four kinds of negative effects: environmental, economic, physical and psychological. This paper studies the economic effects observed in Southern Alabama 18 months after the occurrence of the Deepwater Horizon disaster and one month after Tropical Storm Lee.

Session: 012 -

Track: Socio-economic Impacts of the Deepwater Horizon Oil Spill

Date: Monday, January 21 16:30 - 18:00

Type: Poster

## Gender Differences in Perceived Levels of Resiliency One Year Post Disaster: Associations with Trust in Various Government Entities

**Presenter:** Jennifer Langhinrichsen-Rohling – University of South Alabama

**Authors:** Jennifer Langhinrichsen-Rohling, University of South Alabama; Christina Wright, University of South Alabama; Jessica Shenesy, University of South Alabama

### Abstract:

Little is known about predictors of perceived adaptability after a technological disaster. Even less is known about whether perceived adaptability varies as a function of trust in various types of authority for both men and women. A priori, post-disaster levels of perceived adaptability one year post the Deepwater Horizon disaster were expected to be associated with self-reported trust in governmental and industrial

entities after the disaster. These questions were explored via a telephone survey administered to residents of two coastal Alabama communities (n=812, 63.9% female, 36.1% male). Overall, men perceived themselves to be significantly more adaptable post-disaster than did women. Obtained results indicated that trust in BP significantly predicted men's adaptivity while trust in local, state and federal government all significantly contributed to the prediction women's perceived post-disaster adaptability. These findings are discussed and prevention implications are offered.

Session: 012 -

Track: Socio-economic Impacts of the Deepwater Horizon Oil Spill

Date: Monday, January 21 16:30 - 18:00

Type: Poster

## A Protocol for Rapid Appraisal of Community Social Structure

**Presenter:** Brian Mayer – University of Arizona

**Authors:** Brian Mayer, University of Arizona; Chris McCarty, University of Florida

### Abstract:

Residents of communities recovering from disasters rely on both formal and informal relationships for tangible and emotional support. The composition and structure of these relationships varies from one person to another and may result in different coping strategies. Within a small community, these personal networks may be part of a larger whole network structure with compositional and structural properties affecting how the personal networks are formed and access to resources. We present an analysis where we collected network data from stakeholders in three Gulf Coast communities where we asked respondents to list people they rely on following a disaster. Our results suggest that certain subgroups may be excluded in the sharing of resources and information that are vital to enhancing individual and community recovery. Our goals are to identify which combinations of sub-samples best represent the characteristics of the whole network and to develop a protocol for a Rapid Appraisal of Community Social Structure that can be generated quickly and with the least respondent burden.

# Science Abstracts

## Session: 013 Hydrocarbon Distributions, Cycling and Impacts in Blue Water Benthic and Pelagic Environments

Session: 013 - 1

Track: Hydrocarbon Distributions, Cycling and Impacts in Blue Water Benthic and Pelagic Environments

Date: Wednesday, January 23 10:30 AM  
Type: Oral Presentation

### Vertical distribution of hydrocarbons and intrusion formation for the Deepwater Horizon accidental blowout

**Presenter:** Scott Socolofsky – Texas A&M University

**Authors:** Scott A. Socolofsky, Texas A&M University; E. Eric Adams, Massachusetts Institute of Technology

#### Abstract:

The vertical partitioning of hydrocarbons throughout the water column of oil and gas released from the Deepwater Horizon (DH) accident occurred within reacting multiphase plumes in the near field of the spill. Socolofsky et al. (GRL, 2011, 38:L09602) classify the deepest part of the DH plume as stratification dominated and predict the lowest intrusion depth. We extend this work here using an integral plume model for stratification-dominated plumes, incorporating dissolution, hydrate formation, and effect of dispersants via simulation of a broad range of initial oil droplet sizes. Results are compared to field observations for hydrocarbon measurements throughout the water column. The model confirms that oil droplets above a few 100 microns in diameter rose rapidly to the surface to form a surface slick within a 2 km radius of the wellhead. Smaller droplets entered multiple subsurface intrusions, the most significant of which was between 800 and 1200 m depth. Dissolution was the primary mechanism for hydrocarbon mass to enter the deepwater intrusion layers.

Session: 013 - 2

Track: Hydrocarbon Distributions, Cycling and Impacts in Blue Water Benthic and Pelagic Environments

Date: Wednesday, January 23 10:45 AM  
Type: Oral Presentation

### Pelagic methane oxidation in the Northern Gulf of Mexico: Activity patterns before, during, and after the Macondo Blowout.

**Presenter:** Samantha Joye – University of Georgia

**Authors:** Samantha Joye, University of Georgia; Melitza Crespo-Medina, University of Georgia; Kimberley Hunter, University of Georgia; Vernon Asper, University of Southern Mississippi; Arne Diercks, University of Southern Mississippi; Ray Highsmith, University of Mississippi; Joseph P. Montoya, Georgia Institute of Technology

#### Abstract:

Pelagic methane oxidation rates determined between 2001 and 2012 at sites in the Northern Gulf of Mexico illustrate significant impacts on microbially-mediated methane cycling that can be linked to the Macondo Blowout. Before the blowout, methane concentration profiles showed maxima closest to the seafloor ( $<200$  nM  $\text{CH}_4$ ) with concentrations decreasing rapidly with distance above the seafloor to low levels in the upper water column ( $<7$  nM in the mixed layer). Aerobic methane oxidation rates were low, on the order of pmol/L/d, and the turnover time for the methane pool was 100's to 1000's of days. During the blowout, methane concentration profiles were altered near the wellhead, with concentrations reaching 100's of  $\mu\text{M}$  in deepwater plumes well above the seafloor. Methane oxidation rates reached unprecedented levels of micromol/L/d. These deepwater maxima in methane concentrations and oxidation rate were short-lived as plumes were dispersed throughout the water column by mid-July 2010. Rates of methane oxidation were elevated above background through 2012 despite methane concentrations that were comparable to pre-blowout levels. The data show that the Macondo Blowout had at least a 2-year impact on rates of pelagic microbial methane cycling.



# Science Abstracts

Session: 013 - 3

Track: Hydrocarbon Distributions, Cycling and Impacts in Blue Water  
Benthic and Pelagic Environments

Date: Wednesday, January 23 11:00 AM  
Type: Oral Presentation

## Dissolved methane and CO<sub>2</sub> in the Gulf of Mexico post Deep Water Horizon oil spill.

**Presenter:** Cédric Magen – Florida State University

**Authors:** Cedric Magen, Florida State University; Jeffrey Chanton, Florida State University

### Abstract:

Using profiles of methane concentrations,  $\delta^{13}\text{C}$  values of methane and dissolved inorganic carbon (DIC), and  $\Delta^{14}\text{C}$  values of DIC, we investigate the sources and sinks of methane dissolved in surface waters of the Gulf of Mexico. Water column samples were taken at an oil seep site (GC600), near the Macondo well (OC26) and at several stations in the Desoto Canyon. Preliminary results show that, as in most oceans surface waters, methane concentrations profiles display a sub-surface peak at 50 - 100 m water depth, with a maximum concentration of 60 nmol L<sup>-1</sup>.  $\delta^{13}\text{C}$  values of the methane ranged between -50.8‰ and -40.8‰ at 1880 and 125 m, respectively, consistent with production from methylated substrates at the surface maximum. This peak coincides with the chlorophyll maximum.  $\delta^{13}\text{C}$  values of the DIC dropped from 1.1 - 1.3‰ at the surface to 0.6 - 0.8‰ immediately below the chlorophyll and CH<sub>4</sub> maxima. The  $\Delta^{14}\text{C}$  values of the DIC revealed an 800 years old DIC at ~1000 m, reflecting the age of deep waters and respiration of old organic matter.

Session: 013 - 4

Track: Hydrocarbon Distributions, Cycling and Impacts in Blue Water  
Benthic and Pelagic Environments

Date: Wednesday, January 23 11:15 AM  
Type: Oral Presentation

## Spills, seeps, and pelagic foodwebs in the Northern Gulf of Mexico: What do stable isotopes tell us about oil, gas, and discolored zooplankton?

**Presenter:** Sarah Weber – Georgia Institute of Technology

**Authors:** Sarah Weber, Georgia Tech; Ajit Subramaniam, Columbia University; Melitza Crespo-Medina, University of Georgia; Samantha B. Joye, University of Georgia; Annalisa Bracco, Georgia Institute of Technology; Tracy A. Villareal, University of Texas; Joseph P. Montoya, Georgia Institute of Technology

### Abstract:

The Deepwater Horizon (DWH) released some five million barrels of oil in offshore waters of the Gulf of Mexico in April-July 2010. During

cruises shortly after the flow of oil was halted (OC468, 21 Aug-16 Sep 2010), after 10 months (EN496, 2-27 July 2011), 20 months (EN509/510, 25 May-5 Jul 2012), and 23 months (EN515, 5-16 Aug 2012), we collected suspended particles and zooplankton for elemental and isotopic analysis in regions of the Gulf affected by the spill as well as by natural seeps. In 2010, we encountered multiple subsurface features with low beam transmittance and high particle concentrations at depth, extending in all directions around the DWH wellhead. Although we found considerable scatter in the  $\delta^{13}\text{C}$  of particles, low  $\delta^{13}\text{C}$  values (-30 to -21‰) were strongly associated with the deep SW plume produced by the spill. In addition, many of our zooplankton were discolored and had a low  $\delta^{13}\text{C}$  (-22.5‰). We will use the elemental and isotopic composition of our samples to assess the biogeochemical impact of oil and gas on the water column of the Northern Gulf of Mexico.

Session: 013 - 5

Track: Hydrocarbon Distributions, Cycling and Impacts in Blue Water  
Benthic and Pelagic Environments

Date: Wednesday, January 23 11:30 AM  
Type: Oral Presentation

## Rates and fates of nitrogen and carbon in the water column: impact of seeps and spills on plankton biogeochemistry

**Presenter:** Joseph Montoya – Georgia Institute of Technology

**Authors:** Joseph Montoya, Georgia Institute of Technology; Sarah C. Weber, Georgia Institute of Technology; Ajit Subramaniam, LDEO; Andy Juhl, LDEO; Tracy Villareal, UTMSI; Annalisa Bracco, Georgia Institute of Technology, [abracco@gatech.edu](mailto:abracco@gatech.edu); Samantha B. Joye, University of Georgia

### Abstract:

The C and N cycles are multiply interconnected, with N frequently acting as a limiting nutrient in oceanic systems. We measured C- and N-fixation rates in surface and deep waters during a series of cruises to the Northern Gulf of Mexico beginning shortly after the Deepwater Horizon spill (OC468, 21 Aug-16 Sep 2010), and 10 months (EN496, 2-27 July 2011), 20 months (EN509/510, 25 May-5 Jul 2012), and 23 months later (EN515, 5-16 Aug 2012). We also carried out a series of nutrient amendment (N, P, Si) experiments to test the controls on phytoplankton growth in areas affected by oil and gas release. Our amendment showed a clear response to N, and sometimes N+P additions, implying widespread N limitation of production in the Gulf. We also found measurable, and at times high (>200  $\mu\text{mol N m}^{-2} \text{ d}^{-1}$ ) rates of N-fixation in the region, particularly in areas affected by the Mississippi River plume. We will discuss the hydrographic and biogeochemical context of our experiments, which document an important linkage between the N and C cycles in the Northern Gulf of Mexico.



# Science Abstracts

## Session: 013 - 6

Track: Hydrocarbon Distributions, Cycling and Impacts in Blue Water  
Benthic and Pelagic Environments

Date: Wednesday, January 23 11:45 AM  
Type: Oral Presentation

### Trace element distributions in waters influenced by the Deepwater Horizon oil well blowout

**Presenter:** DongJoo Joung – Department of Marine Science/The University of Southern Mississippi

**Authors:** DongJoo Joung, The University of Southern Mississippi; Alan M. Shiller, The University of Southern Mississippi

#### Abstract:

The impact of the Deepwater Horizon well blowout on dissolved trace elements was studied in areas around the oil rig explosion site during four cruises in early and late May 2010, October 2010 and October 2011. Analysis of the oil showed relatively low trace element concentrations compared to other crude oils (e.g., Boscan, Arabian). In surface water, correlations were observed between metals (Fe, Ni, Mn, Cu, Ba and Co) and salinity, implying mixing with river water is the dominant factor on metal distribution in these waters. In the subsurface plume (1000-1400 m), moderate increases in Co and Ba concentration were observed in late May relative to post blowout periods. Oil leaching experiments and a correlation with percent methylnaphthalenes indicate that the oil is the source of the Co, whereas Ba is likely related to drilling mud. A decreasing trend of Mn and Fe with distance away from the sediment indicates benthic input. However, Fe decreased toward the wellhead as well, suggesting biological uptake during oil/gas consumption.

## Session: 013 - 7

Track: Hydrocarbon Distributions, Cycling and Impacts in Blue Water  
Benthic and Pelagic Environments

Date: Wednesday, January 23 12:00 PM  
Type: Oral Presentation

### Nutrient depletion as a proxy for microbial growth in Deepwater Horizon subsurface oil/gas plumes

**Presenter:** Alan Shiller – University of Southern Mississippi

**Authors:** Alan M. Shiller, The University of Southern Mississippi; DongJoo Joung, The University of Southern Mississippi

#### Abstract:

The Deepwater Horizon accident resulted in a substantial uncontrolled hydrocarbon release to the northern Gulf of Mexico, much of which was entrained in deep submerged plumes. While bio-degradation of the hydrocarbons has been inferred from microbial biomass and genetics, the

amount of conversion of oil and gas carbon to biomass remains uncertain. Here we examine correlated depletions of nitrate, phosphate, and oxygen in the submerged plumes during May 2010. Combining these correlations with published estimates of overall oxygen consumption, we estimate that the substantial portion of hydrocarbons in these plumes was initially converted to biomass. This contrasts with nutrient-limited surface waters where other work has suggested respiration to carbon dioxide to be the dominant fate of the hydrocarbons. Our results suggest the need for better monitoring of changes in nutrients as well as study of nutrient recycling in similar future hydrocarbon releases.

## Session: 013 - 8

Track: Hydrocarbon Distributions, Cycling and Impacts in Blue Water  
Benthic and Pelagic Environments

Date: Wednesday, January 23 12:15 PM  
Type: Oral Presentation

### AUV Sub Sea Surveys

**Presenter:** Arne Diercks – University of Southern Mississippi

**Authors:** Arne-R. Diercks, University of Southern Mississippi; Vernon Asper, University of Southern Mississippi; Roy Jarnagin, University of Southern Mississippi; Max Woolsey, University of Southern Mississippi; Clayton Dike, University of Southern Mississippi

#### Abstract:

The National Institute for Undersea Science and Technology owns and operates two AUVs. The ISE built Explorer class Eagle Ray AUV and the WHOI built SeaBED class Mola-Mola AUV have two completely different operational tasks and requirements based on their physical shape and method of propulsion. The AUV work provides deep-sea site reconnaissance for instrument deployments and sampling sites for the ECOGIG consortium. The Eagle Ray AUV operating <50 meters off the seafloor, is used for multi beam, whereas the Mola-Mola AUV is used for close-up subsea photographic site investigation, using slow flight to collect high resolution digital photography of the target area. Both vehicles are rated to 2200m depth. A GeoAcoustics polarity preserving chirp sub-bottom profiler provides data of sub bottom sediment features. The combination of these AUV's is providing a unique tool to study seafloor morphology, sub bottom structure and provide high resolution imagery of targets of interest. Results of the combined work of these two AUV's will be presented at the meeting.

# Science Abstracts

Session: 013 - 9

Track: Hydrocarbon Distributions, Cycling and Impacts in Blue Water  
Benthic and Pelagic Environments

Date: Wednesday, January 23 2:00 PM  
Type: Oral Presentation

## Sediment Flux and Redistribution Near the Macondo Well

**Presenter:** Vernon Asper – University of Southern Mississippi

**Authors:** Vernon Asper, University of Southern Mississippi; Uta Passow, University of California at Santa Barbara; Arne Diercks, University of Southern Mississippi; Clayton Dike, University of Southern Mississippi

### Abstract:

During visits to the Macondo site during the spill, numerous aggregates of oil and organic matter were observed both near the surface and throughout the upper water column. To investigate the role of these “marine snow” aggregates in the transport and ongoing dynamics of the oil, we deployed a series of moorings at three sites in the Gulf of Mexico, including one just 4km from the well head and another at a natural seep at GC600. These moorings include time series sediment traps, ADCP current meters, and novel trap/camera systems that will measure the in situ sinking speeds of aggregates settling into a quiescent chamber. These data will be used to track resuspension events and the possible vertical and lateral transport and redistribution of oiled sediments.

Session: 013 - 10

Track: Hydrocarbon Distributions, Cycling and Impacts in Blue Water  
Benthic and Pelagic Environments

Date: Wednesday, January 23 2:15 PM  
Type: Oral Presentation

## Marine snow as drivers for oil transformation

**Presenter:** Uta Passow – Marie Science Institute

**Authors:** Uta Passow, University of California Santa Barbara; Kai Ziervogel, University of North Carolina at Chapel Hill; Vernon Asper, University of Southern Mississippi; Arne Diercks, University of Southern Mississippi

### Abstract:

The large marine snow formation event observed in oil-contaminated surface waters of the Gulf of Mexico (GoM) after the Deepwater Horizon accident possibly played a key role in the fate of the surface oil. Oil and gas derived from cold seeps also often reaches the surface ocean forming oil slicks, but little is known about their fate. Initial observations suggest that potentially a large fraction of this fossil carbon may settle to the seafloor via marine snow formed due to the presence of oil. We conducted aggregation experiments to investigate the formation and fate of such marine snow and the associated microbial processes. We investigated

marine snow formed in the presence of oil collected in the GoM after the spill, collected from cold seep-derived oil slicks and using Louisiana light crude oil. Results revealed that both the history of the oil and the microbial community determine marine snow formation, characteristics and fate significantly.

Session: 013 - 11

Track: Hydrocarbon Distributions, Cycling and Impacts in Blue Water  
Benthic and Pelagic Environments

Date: Wednesday, January 23 2:30 PM  
Type: Oral Presentation

## Settling Velocity of Marine Snow aggregates near the sea floor at the Macondo Well site.

**Presenter:** Clayton Dike – The University of Southern Mississippi

**Authors:** Clayton Dike, University of Southern Mississippi; Vernon Asper, The University of Southern Mississippi; Uta Passow, University of California Santa Barbara; Arne Diercks, The University of Southern Mississippi

### Abstract:

Marine snow aggregates throughout the water column achieve sinking speeds of 100-250m/day, significant in the vertical export of nutrients and organic carbon from the surface to depth. In the case of the Macondo oil spill, hydrocarbons incorporated in snow transported from subsurface plumes may reside in a flocculent layer where they can be redistributed by currents. To analyze settling velocity of snow from the nepheloid layer, a camera system was deployed 80 m from the bottom along with an ADCP and two time-series sediment traps at a site southwest of the Macondo well. The camera system consists of a stilling tube attached to a clear box. As aggregates settle into the box, they are photographed and their sinking speeds can be determined. Another camera system is scheduled to be deployed near an active natural seep about 250km to the west for comparison in September of 2012. The sinking speed vs size results will be compared to the sediment trap samples as well as the ADCP data to estimate the role of snow in the transport of hydrocarbons.

# Science Abstracts

Session: 013 - 12

Track: Hydrocarbon Distributions, Cycling and Impacts in Blue Water  
Benthic and Pelagic Environments

Date: Wednesday, January 23 2:45 PM  
Type: Oral Presentation

## Deep-sea Benthos Response to the Deepwater Horizon Blowout

**Presenter:** Paul Montagna – Texas A&M Univ.-Corpus Christi

**Authors:** Paul Montagna, Texas A&M University Corpus Christi; Jeff Baguley, University of Nevada Reno; Cynthia Cooksey, NOAA; Jeff Hyland, NOAA

### Abstract:

It is apparent that oil from the Deepwater Horizon blowout reached the bottom of the Gulf of Mexico leading to the question “were deep-sea living benthic resources affected?” Sediment cores were collected during Response cruises in fall 2010 to measure potential impacts on macrofauna and meiofauna – the two main soft-bottom benthic invertebrate groups. Changes in the abundance and diversity of these fauna were found with distance from the wellhead in various directions. The effects were correlated to total petroleum hydrocarbon and barium concentrations and distance to the wellhead, and not distance to known hydrocarbon seeps. Based on our current knowledge of deep sea biology, recovery rates are likely to be slow, on the order of decades or longer.

Session: 013 - 14

Track: Hydrocarbon Distributions, Cycling and Impacts in Blue Water  
Benthic and Pelagic Environments

Date: Wednesday, January 23 3:00 PM  
Type: Oral Presentation

## Dynamics of hydrocarbon vents: Focus on primary porosity

**Presenter:** Caroline Johansen – Florida State University

**Authors:** Caroline Johansen, Florida State University; William Shedd, Bureau of Ocean Energy Management; Tarek Abichou, Florida State University; Oscar Pineda-Garcia, Florida State University; Mauricio Silva, Florida State University; Ian R. MacDonald, Florida State University

### Abstract:

We investigated the dynamics of natural hydrocarbon releases by monitoring a single vent in a seafloor gas hydrate outcrop at 1215m depth in the Gulf of Mexico. A camera captured close-up images every 4 s for about 3.5 hours. The outcrop included an array of 38 tube-like openings which released oil bubbles at rates of 0 to 8 bubbles per min. We propose a descriptive model governing the release of oil from deep sub-bottom reservoirs through three different degrees of porosity: consolidated sediments (tertiary), unconsolidated sediments (secondary), and finally

through gas hydrate deposits at the sea floor (primary). Ice worms (*Hesiocaeca methanicola*) were abundant at this site; they may generate pathways for the passage of oil through the gas hydrate mound and contribute to gas hydrate decomposition. We will test our model against seismic data and additional close-up imaging.

Session: 013 - 15

Track: Hydrocarbon Distributions, Cycling and Impacts in Blue Water  
Benthic and Pelagic Environments

Date: Wednesday, January 23 3:15 PM  
Type: Oral Presentation

## Shift in sedimentation patterns and increased mass accumulation rates following the BP Blowout event: NE Gulf of Mexico.

**Presenter:** Rebekka Larson – Eckerd College/USF

**Authors:** Rebekka Larson, Eckerd College; Gregg, Brooks, Eckerd College; Patrick, Schwing, USF; David, Hollander, USF; Isabel, Romero, USF; Chris, Moore, Eckerd College; Aya Matsunaga, Eckerd College; Kacie Hill, Eckerd College

### Abstract:

Multicores from >40 sites along the NE Gulf of Mexico slope indicate shifts in sediment accumulation patterns during the months following the BP Blowout event. It is manifested as a 1-6 cm thick well-defined, internally stratified medium-dark brown surface layer of sandy mud, finer grained and higher organic content than underlying sediments. Due to the stratigraphic integrity of these cores, Th-234 is utilized as a geochronological tool, indicating active sedimentation during 4-6 months prior to core collection. Pb-210 is utilized to aid in defining pre-event sedimentation patterns and the natural variability over the past 100 years. Cores collected in Dec. 2010 indicated increased MAR's (mass accumulation rates) of 0.7-1.8 g/cm<sup>2</sup>/yr (Th-234 dating), as compared to pre-event rates 0.06-0.1 g/cm<sup>2</sup>/yr (Pb-210 dating). Re-collection of cores during Sept. 2011 indicated that sediment MAR's of 0.1-0.2 g/cm<sup>2</sup>/yr (Th-234 dating) had returned to similar rates as pre-event MAR's (Pb-210 dating). This indicates a pulse of sediment accumulation occurred between Aug. 2010 and Dec. 2010.

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Session: 013 - 16

Track: Hydrocarbon Distributions, Cycling and Impacts in Blue Water  
Benthic and Pelagic Environments

Date: Wednesday, January 23 3:30 PM  
Type: Oral Presentation

## Using short-lived radionuclide inventories and geochronology to quantify benthic foraminifera response to the BP oil blowout

**Presenter:** Patrick Schwing – U. South Florida, College of Marine Science

**Authors:** Patrick Schwing, University of South Florida; Benjamin Flower, USF; Gregg Brooks, Eckerd College; Rebekka Larson, Eckerd College; Isabel Romero, USF; David Hollander, USF

### Abstract:

A suite of sediment cores collected throughout the Northern Gulf of Mexico are used to determine the response of the benthic ecosystem exposed to a subsurface hydrocarbon plume related to the DwH blowout. Visual assessment of the cores show a gray homogeneous interval that is overlain by a laminated black layer and by a brown, fine-grain accumulation at the surface (3-8cm). Short-lived radioisotope chronology ( $^{210}\text{Pb}$ ,  $^{234}\text{Th}$ ) documents an order of magnitude increase in mass accumulations rates across the blowout interval (gray to black). The abundance of benthic foraminifera decreases across the black laminated interval which is characterized by the highest hydrocarbon concentrations. Sites farther (50-70 km) from the DwH blowout show a recovery in foram abundance whereas sites closer (20-30 km) to the blowout show a continued decline in abundance. Genera-specific accumulation rates and abundance will be discussed in the context of determining the long-term effects of the DwH blowout and assessing indicator species to show impact/recovery of the benthic ecosystem.

Session: 013 - 17

Track: Hydrocarbon Distributions, Cycling and Impacts in Blue Water  
Benthic and Pelagic Environments

Date: Wednesday, January 23 3:45 PM  
Type: Oral Presentation

## Event Stratigraphy of the Deepwater Horizon Blowout and its Record in the Deep-Sea: A Sedimentological and Geochemical Perspective

**Presenter:** Isabel Romero – University of South Florida

**Authors:** Isabel C. Romero; University South Florida; David J. Hollander, University South Florida; Gregg R. Brooks, Eckerd College; Patrick Schwing, University South Florida; Rebekka A. Larson, University South Florida; Ethan A. Goddard, University South Florida; Nicola Zenzola, University South Florida

### Abstract:

High-resolution analyses of deep-sea sediment cores collected in 2010-2011 reveal changes in contemporary sedimentary processes in the aftermath of the Deepwater Horizon blowout event (DwH). Sediment chronology from short-lived radioisotopes provides the basis for documenting DwH stratigraphy. The DwH is seen as an abrupt transition to laminated, non-bioturbated finer-grained surface sedimentary layers, particularly in the DeSoto Canyon region and to the southwest of the wellhead. Following the DwH sediment mass accumulation rates increase up to two orders of magnitude higher than pre-blowout rates. Interestingly, organic carbon accumulation rates are also elevated by two orders of magnitude and shows a negative shift in bulk  $\delta^{13}\text{C}$  values to -22‰. Independent of region, extractable hydrocarbons (HCs) from the surface layers exhibits a broad distributions of compounds with mixed sources including algae, bacteria, plant waxes, and oil-derived. These results are consistent with the hypothesis of a large, particle-rich blizzard-like depositional event directly after the DwH.

Session: 013 - 18

Track: Hydrocarbon Distributions, Cycling and Impacts in Blue Water  
Benthic and Pelagic Environments

Date: Wednesday, January 23 4:00 PM  
Type: Oral Presentation

## A Preliminary Assessment of DeSoto Canyon Sediment Macrofauna

**Presenter:** Amy Baco-Taylor – Florida State University

**Authors:** Amy Baco-Taylor, Florida State University; Arvind Shantharam, Florida State University

### Abstract:

Benthic macrofauna are effective indicators of biologically stressed systems and play a critical role in bioturbation of marine sediments. In October 2012, as part of the Deep-C benthic ecology program, we sampled 12 stations along 2 depth transects of the DeSoto canyon using replicate lowerings of a multicorer. Macrofauna and evidence of recent bioturbation were observed at every station. The top 10cm of sediment was collected from 4 cores at each lowering and macrofauna will be sorted to lowest taxonomic unit. Our goals are to assess macrofauna abundance, diversity and species composition at each station. These will be combined into a multivariate statistical analyses using PRIMER to assess patterns of community structure. The community structure results will be compared to environmental data from each station including depth, sediment grain size, redox layer depth, and data on levels of oil contamination, etc. to determine which factors correlate to community structure. We also sampled two canyon stations that had baseline pre-oil spill macrofauna data to determine if a change in community structure, abundance,

# Science Abstracts

diversity, or species composition could be detected. Preliminary results of these analyses will be presented.

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## Session: 013 -

Track: Hydrocarbon Distributions, Cycling and Impacts in Blue Water Benthic and Pelagic Environments

Date: Wednesday, January 23 8:30 - 10:30  
Type: Poster

### **Oil spill vs natural seepage: Contrasting weathering characteristics of oil from the Macondo well and Southern California oil seeps**

**Presenter:** Christoph Aeppli – Woods Hole Oceanographic Institution

**Authors:** Christoph Aeppli, Woods Hole Oceanographic Institution; David L. Valentine, University of California Santa Barbara; Matthias Kellermann, University of California Santa Barbara; Thomas D. Lorenson, US Geological Service; Christopher M. Reddy, Woods Hole Oceanographic Institution; Robert K. Nelson, Woods Hole Oceanographic Institution

#### **Abstract:**

Oil weathering affects the petroleum composition, and ultimately determines the fate of harmful oil compounds. Oil weathering processes, which include evaporation, dissolution, biodegradation and photooxidation, are specific for different situations. We therefore characterized weathering processes acting on oil during its transport from the source to beaches using bulk and molecular techniques, and we compared the Deepwater Horizon oil spill and natural seep sites offshore Southern California. The bulk characterization comprised quantification of the oxygenated hydrocarbon fraction and analysis of functional groups, while the molecular analysis included alkanes, polycyclic aromatic hydrocarbons and biomarker compounds. We found characteristic changes in composition of the residual petroleum for the both field sites. We will compare and contrast the two situations, and draw general conclusions about important oil weathering processes.

## Session: 013 -

Track: Hydrocarbon Distributions, Cycling and Impacts in Blue Water Benthic and Pelagic Environments

Date: Wednesday, January 23 8:30 - 10:30  
Type: Poster

### **Degradation of crude oil in Saline marsh soil under different redox conditions**

**Presenter:** Syam Dodla – Louisiana State University

**Authors:** Syam Dodla, Louisiana State University; Jim Wang, Louisiana State University; Negar Dehghani Tafti, Louisiana State University; Chagyoong Jeong, Louisiana State University; Ron DeLaune, Louisiana State University

#### **Abstract:**

The recent BP Horizon oil spill in the Gulf of Mexico had brought in volumes of crude into shoreline saline lands. Toxicity of crude oil to flora and fauna depends on its composition. It is important to understanding the fate of individual crude oil compounds the coastal wetland soils. In this study, degradation and transformation of crude oil was investigated in a saline soil under two redox conditions. Laboratory microcosms of saline soil were set up either under oxidized ( $E_h=350$  mV) or reduced ( $E_h=0$  mV) conditions with each receiving 2 % crude oil. Soil subsamples were collected at different intervals and analyzed for total petroleum hydrocarbons (TPH) and for assessing the degradation rate of various crude oil compounds. The results showed that under the oxidized condition about 76 % of the added crude oil was mineralized by the end of 8 days and more than 98 % by the end of 70 days. Also under the oxidized condition, almost all the petroleum compounds were degraded over time and no preferential degradation was observed. Only Fluorene and Benzo (g,h,i) Perylene was observed under oxidized condition at the end of incubation. On the other hand, under the reduced condition approximately 36-52 % of added crude oil still remained after 70 days, and preferential degradation of short chain compounds were observed. Aliphatic compounds shorter than 16C degraded at faster rate and disappeared by the end of 71 days whereas compounds longer than 17C were persisted. In addition, under the reduced condition the quantity of crude oil remained changed little after 17 days of incubation. Overall the presence of the reduced condition significantly suppressed the breakdown of compounds heavier than 16C whereas the oxidized condition mineralized most of the crude except few polyaromatic compounds.



# Science Abstracts

Session: 013 -

Track: Hydrocarbon Distributions, Cycling and Impacts in Blue Water  
Benthic and Pelagic Environments

Date: Wednesday, January 23 8:30 - 10:30  
Type: Poster

## Spectral measurements of laser-induced fluorescence of biological and organic constituents in the Gulf of Mexico.

**Presenter:** Nigel D'souza – Lamont Doherty Earth Observatory of  
Columbia University

**Authors:** Nigel D'souza, Columbia University; Mark Hafez, Columbia  
University; Alexander Chekalyuk, Columbia University; Beizhan Yan,  
Columbia University; Ajit Subramaniam, Columbia University; Andrew  
Juhl, Columbia University

### Abstract:

Laser-induced fluorescence spectra acquired from water samples collected from different depths were analyzed to create vertical profiles of the water column at sites in the Gulf of Mexico where natural oil seeps were observed. We used an Advanced Laser Fluorometer (ALF), capable of real-time spectral deconvolution analysis of the laser-stimulated emission excited at 375 nm (UV), 405 nm (blue) and 514 nm (green) respectively. The instrument provides instant assessment of chlorophyll-a, three taxa-specific spectral types of phycoerythrin, chromophoric dissolved oxygen matter (CDOM), as well as CDOM-corrected Fv/Fm assessments of phytoplankton photophysiology. In addition to the known spectral bands of these constituents characteristics, our analyses revealed other spectral fluorescence peaks, possibly associated with presence of hydrocarbons, in some deep-water samples and in surface samples where oil slicks were documented. We present the fluorescence spectra and discuss future applications of the ALF in studying the presence and distribution of hydrocarbons in the water column.

Session: 013 -

Track: Hydrocarbon Distributions, Cycling and Impacts in Blue Water  
Benthic and Pelagic Environments

Date: Wednesday, January 23 8:30 - 10:30  
Type: Poster

## Methane Concentrations and Methane Oxidation Rates Following the 2010 Macondo oil well blowout

**Presenter:** Virginia Fleer – University of Georgia at Athens

**Authors:** Virginia Fleer, University of Georgia at Athens; Melitza  
Crespo-Medina, University of Georgia at Athens; Ryan Sibert,  
University of Georgia at Athens; Joy Battles, University of Georgia at  
Athens; Samantha B. Joye, University of Georgia

### Abstract:

The 2010 Macondo oil well blowout released not only an incredible amount of oil but also a tremendous quantity of gaseous hydrocarbons such as methane into Gulf of Mexico waters. While oil was introduced into both surface and deep waters, methane was introduced largely into deep waters. Concentrations of methane, as well as rates of methane oxidation before, during, and after the spill were measured. A significant elevation in methane levels was observed

particularly during the first six weeks of the spill, and at that time, methane concentrations were highest in the water column between 1,000-1,300 meters. During the following 6 months (June –December), methane concentrations dropped and were spread throughout the water column. Methane oxidation activity dropped in concert with concentrations. Continued monitoring illustrated a recovery time of approximately two years to return methane concentrations to pre-spill levels. Comparisons of methane oxidation data with nutrient distributions suggest coupling between methane oxidation and nitrate reduction during this event.

Session: 013 -

Track: Hydrocarbon Distributions, Cycling and Impacts in Blue Water  
Benthic and Pelagic Environments

Date: Wednesday, January 23 8:30 - 10:30  
Type: Poster

## Polycyclic Aromatic Hydrocarbons in sediments of the Southern Gulf of Mexico

**Presenter:** Adolfo Gracia – Universidad Nacional Autónoma de  
México

**Authors:** Adolfo Gracia, Instituto de Ciencias del Mar y Limnología;  
Hector Alexander Valdes, Instituto de Ciencias del Mar y Limnología

### Abstract:

Polycyclic Aromatic Hydrocarbons concentrations in the 0-5 cm sediment stratum were analyzed in the south of the Gulf of Mexico in summer 2010. In the area in front Veracruz to Yucatan, 155 sampling locations were surveyed in coastal and oceanic areas using the R/V JUSTO SIERRA of the Universidad Nacional Autónoma de México and small vessels. Maximum concentration recorded was 953.46 µg/kg. It was found at 40 m depth in the oil platform area 75 km NW of Carmen City. The lowest value (3.48 µg/kg) was registered in the Carmen and Machona lagoon fluvial system. PAH Mean value estimated in the whole area was  $92.45 \pm 113.004$  µg/kg. which reflects the variability of PAH content in sediment of the area. This value was compared with previous PAH mean values measured in the five sediment stratum in the 1996-2010 period. High values ranging from 2,000 to 5,325 µg/kg, were recorded during 1996-2001 and decreased after 2002 with a mean value under 50 µg/kg in



# Science Abstracts

2002. In spite of the apparent decreasing trend, a small increase to 92.00 µg/kg was registered in 2010 surveys.

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## Session: 013 -

Track: Hydrocarbon Distributions, Cycling and Impacts in Blue Water  
Benthic and Pelagic Environments

Date: Wednesday, January 23 8:30 - 10:30  
Type: Poster

### Movement of petroleum hydrocarbons in wetland soils

**Presenter:** Changyoon Jeong – Louisiana State University, AgCenter

**Authors:** Changyoon Jeong, Louisiana State University; Jim J. Wang, Louisiana State University; Syam K. Dodla, Louisiana State University; Ronald DeLaune, Louisiana State University

#### Abstract:

Understanding the movement of petroleum within costal wetland soils is important for remediation of oil-contaminated soils. In this study, effect of biosurfactant (rhamnolipid) on petroleum movement in vertical wetland soil profiles was investigated using the miscible displacement technique under steady and water-saturated flow condition. Crude oil was applied on the surface of undisturbed wetland soil column and re-packed wetland marsh soil column, which were then saturated with artificial sea water. Soil columns were eluted with artificial sea water with and without biosurfactant. Break through curves (BTCs) of 3H as tracers were compared before and after conclusion of petroleum transport experiments. The CXTFIT model fitting with tracer experiments indicated an increase in retardation and a decrease in dispersion in both undisturbed and re-packed soil column. There was no petroleum movement with eluting solution without biosurfactant in both undisturbed core column and re-packed column, whereas petroleum movement was observed in eluting with biosurfactant in undisturbed wetland soil column. Analysis of sectioned undisturbed soil column after eluting with biosurfactant showed that as much as 65 % of total crude oil remained in the top 0-2 cm section and it was then gradually decreased in the rest of profile sections. Additionally, the compounds of relatively light aliphatic chains migrated down easily in the profile with biosurfactant whereas polyaromatic compounds moved little. However, there was insignificant vertical movement of crude oil with 98.7 % remained in re-packed wetland marsh soil column eluting with biosurfactant. The difference in crude oil movement was attributed to the variation in physical and chemical properties of the soil columns, which require further investigations to clarify their effects.

## Session: 013 -

Track: Hydrocarbon Distributions, Cycling and Impacts in Blue Water  
Benthic and Pelagic Environments

Date: Wednesday, January 23 8:30 - 10:30  
Type: Poster

### Stable carbon isotopes of ribosomal RNA as a tracer for microbial growth substrates: first data from Gulf of Mexico sediments and sediment traps

**Presenter:** Barbara MacGregor – University of North Carolina - Chapel Hill

**Authors:** Barbara J. MacGregor, University of North Carolina at Chapel Hill; Uta Passow, University of California Santa Barbara; Vernon Asper, University of Southern Mississippi; Arne Dierks, University of Southern Mississippi

#### Abstract:

Small-subunit ribosomal RNA (known as 16S rRNA in prokaryotes) gene sequences are the basis of modern microbial phylogeny, with both highly conserved and variable regions allowing the design of probes and primers with a wide range of phylogenetic specificities. Their direct sequencing from environmental samples allows the description of highly diverse microbial communities which are often composed primarily of uncultivated species. The 16S rRNA molecule itself is a useful indicator of the currently active population because its cellular concentration is often growth-rate regulated, and (in contrast to DNA) it is poorly preserved extracellularly in most environments. This has led to its application as a biomarker for microbial carbon substrate utilization: using phylogenetically specific probes, rRNA can be isolated from environmental samples for stable isotopic characterization, either at natural abundance or following label addition. In the Gulf of Mexico, we are using the natural-abundance carbon isotopic composition of rRNA to help constrain the degree to which isotopically light natural gas and petroleum carbon are incorporated into microbial biomass at natural seep, background, and spill-affected sites. We present here the first results from sediment RNA extractions, and the unexpected observation of high bacterial (and in one case archaeal) rRNA recoveries from HgCl<sub>2</sub>-preserved sediment trap samples, with temporally changing stable carbon isotope values. Whether this rRNA should be interpreted as preserved material or as the result of microbial activity within the traps is not yet known; either would have implications for the interpretation of other sediment trap data.

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Session: 013 -

Track: Hydrocarbon Distributions, Cycling and Impacts in Blue Water  
Benthic and Pelagic Environments

Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

## Petroleum Biomarker Levels in the Gulf Sediments Following the 2010 Macondo Blowout

**Presenter:** Patricia Medeiros – University of Georgia

**Authors:** Lydia Babcock-Adams, University of Georgia; Patricia M. Medeiros, University of Georgia; Samantha B. Joye, University of Georgia

### Abstract:

Between April-July 2010, approximately 700 million liters of oil were released into Gulf of Mexico waters via the Macondo Blowout. Additionally, ~7 million liters of chemical dispersant were applied at the wellhead and on the sea surface to reduce the amount of oil reaching the Gulf coastline. Sediments have been collected since the first stages of the oil spill, in May, September and December 2010, July 2011 and July 2012. Concentrations of petroleum biomarkers (hopanes, steranes, terpanes) in seafloor samples at impacted sites were much higher (by a factor of 2-4) in September 2010 than in May 2010, consistent with the idea that much of the oil released was deposited subsequently to the seafloor. Slightly lower levels of petroleum biomarkers were observed in sediments collected in December 2010. Samples collected in the following summers (2011 and 2012) are being analyzed to assess the more recent concentrations of petroleum biomarkers at impacted regions, as well as levels of those compounds in natural seepage and control areas.

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Track: Hydrocarbon Distributions, Cycling and Impacts in Blue Water  
Benthic and Pelagic Environments

Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

## Water Column Oxygen Anomalies in the Aftermath of the BP Oil Spill

**Presenter:** Christof Meile – University of Georgia

**Authors:** Ming-Jun Lai, University of Georgia; Christof Meile, The University of Georgia

### Abstract:

The 2010 Macondo oil spill injected an unprecedented amount of hydrocarbons into Gulf of Mexico deep waters. A poorly constrained fraction of this reduced carbon input dispersed in the water column. As the biological breakdown of reduced hydrocarbons consumes O<sub>2</sub>, depletion of this electron acceptor may indicate the past presence of

hydrocarbons. Here, we present attempts to quantify O<sub>2</sub> anomalies from a sparse data set using multivariate splines in 2 and 3 dimensions. We compare and contrast these results with those from alternative interpolation methods such as kriging. Our preliminary results indicate substantial uncertainties, highlighting challenges in the interpretation of sparse data.

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Track: Hydrocarbon Distributions, Cycling and Impacts in Blue Water  
Benthic and Pelagic Environments

Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

## Investigating the impact of oil on *Lophelia* *Pertusa* (Scleractinia).

**Presenter:** Catherine Sheline – Haverford College

**Authors:** Catherine R. Sheline, Haverford College; Erik E. Cordes, Temple University; Helen K. White, Haverford College

### Abstract:

*Lophelia pertusa* is the most widespread and abundant of all deep-water scleractinian corals. While *L. pertusa* colonies have been observed in the vicinity of natural oil seepage, its ability to tolerate oil is unknown. To examine the impact of oil on the food supply and lipid metabolism of *L. Pertusa*, samples were collected from three locations in the central region of the Gulf of Mexico at sites potentially exposed to oil originating from the Deepwater Horizon disaster and/or natural seepage. Oil residues were observed in all coral samples as evidenced by n-alkanes with carbon range of C<sub>14</sub>-C<sub>42</sub>, and an unresolved complex mixture (UCM) indicative of weathered oil. Concentrations of total oil quantified via gas chromatography coupled to a flame ionization detector (GC-FID) ranged from 20-50 µg/g of coral tissue. The relative abundance of storage lipids including triglycerides and wax esters was also examined via gas chromatography coupled to mass spectrometry (GC/MS) to examine the relationship between these storage lipids and the composition and quantity of oil present.

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Track: Hydrocarbon Distributions, Cycling and Impacts in Blue Water  
Benthic and Pelagic Environments

Date: Wednesday, January 23 8:30 - 10:30  
Type: Poster

## Depression of microbial respiration rates in Gulf of Mexico sediments following the Deepwater Horizon spill

**Presenter:** Ryan Sibert – University of Georgia Athens

**Authors:** Ryan Sibert, University of Georgia; Melitza Crespo-Medina, UGA; Kimberley Hunter, UGA; Joseph Montoya, Georgia Institute of Technology

### Abstract:

Microbial metabolism in sediments recycles organic matter and regenerates inorganic building blocks. In sediments impacted by hydrocarbon seepage or hydrocarbon contamination, microbial processes such as sulfate reduction and denitrification are responsible for significant rates of hydrocarbon oxidation. Since 2002, we have documented rates of sulfate reduction, anaerobic oxidation of methane, and methanogenesis using sensitive radiotracer techniques at a variety of cold seeps sites in the Gulf of Mexico. Rates of anaerobic oxidation of methane (AOM) and sulfate reduction (SR) rates in sediments near the BP Macondo well blowout were determined before the blowout, in the blowout's early stages, and over 2.5 years after the blowout. At MC118, a cold seep about 10 nm NW of the Macondo well, rates of SR and AOM are high (up to 1000 and 150 nmol/cc/d respectively). Rates of SR and AOM in layers deposited during the blowout were much lower ( $\sim 0.1 \pm 0.05$  nmol/cc/d and below detection for SR and AOM, respectively). Rates of microbial activity in the sediments beneath weathered oil layers were higher, suggesting that activity in surface layers was limited either by the highly recalcitrant nature of the weathered oil or due to inhibitory effects of dispersants.

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Track: Hydrocarbon Distributions, Cycling and Impacts in Blue Water  
Benthic and Pelagic Environments

Date: Wednesday, January 23 8:30 - 10:30  
Type: Poster

## Post-spill assessment of mesophotic reef communities

**Presenter:** Mauricio Silva – Florida State University

**Authors:** Mauricio Silva, Florida State University; Ian MacDonald, Florida State University; Kenneth Sulak, U.S. Geological Survey

### Abstract:

Image samples from RTLC (Rotary Time Lampe Camera) and HDC (High-resolution Digital Camera) were used to evaluate the potential consequences of the Deep Horizon Oil Spill over to the Mesophotic Coral Reef Communities and the fish fauna associated with two mesophotic reef sites: Alabama Alps Reef (AAL) and Rough Tongue Reef (RTR). The RTLC takes one image every 3 minutes and completes a 360 degree rotation after 10 images. These image sequences were used to quantify species composition and abundance of fish associated with mesophotic reefs. In both sites, *Pronotogrammus martinicensis* and *Anthias nicholsi* were the most conspicuous species and both showed diurnal behavior. HD camera provided high definition images of coral colonies to evaluate the damage presumably caused by the oil on the living tissue. We used the ranking proposed by White, et al (2011) to classify the healthy state of the colonies, starting from 0 (less 1% of damage) to 4 (more than 90% of damage). *Hypnognorgia* sp., *Thesea* sp., *Bebryce* sp. and *Swiftia* sp. were the species with more damage in both sites

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Track: Hydrocarbon Distributions, Cycling and Impacts in Blue Water  
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Date: Wednesday, January 23 8:30 - 10:30  
Type: Poster

## Optimization of proteomic profiling in the deep sea black coral, *Leiopathes glaberrima*

**Presenter:** Marc Slattery – University of Mississippi

**Authors:** Marc Slattery, University of Mississippi; Sridevi Ankisetty, University of Mississippi; Dannise Ruiz, Pennsylvania State University; Iliana Baums, Pennsylvania State University

### Abstract:

Natural or anthropogenic sources of oil, at depths of 1000m+, in the Gulf of Mexico represent a potential stressor to unique deep water coral communities. Our goal is to use subtractive proteomic profiling of corals from pristine and oil-stressed sites in order to understand the impacts to these species. To date, the number of proteins, from frozen coral tissue, that are observed in our two color morphs was 44 and 36. The Gene Ontology annotations of the proteins, using blast2go software, indicate that we have isolated several structural proteins, as well as some associated with stress response. Continued studies will validate the observed proteins to enhance our confidence in data gathered from paired GOM coral samples collected during Fall 2012. This work was made possible by a grant (in part) from BP/the Gulf of Mexico Research Initiative to support consortium research entitled "Ecosystem Impacts of Oil and Gas Inputs to the Gulf (ECOGIG)" administered by the University of Mississippi.

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Session: 013 -

Track: Hydrocarbon Distributions, Cycling and Impacts in Blue Water  
Benthic and Pelagic Environments

Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

## Biodegradation of mineral oil components at high pressure

**Presenter:** Ana Gabriela Valladares Juarez – Hamburg University of Technology

**Authors:** Ana Gabriela Valladares Juarez, Hamburg University of Technology; Martina Schedler, Hamburg University of Technology; Giselher Gust, Hamburg University of Technology; Rudolf Muller, Hamburg University of Technology

### Abstract:

Degradation of mineral oil by bacteria in high-pressure environments, like the sea bottom close to the oil source from the DWH, is not well understood.

For this purpose five pressure reactors (160 mL, max. pressure: 400 bar) were adapted for biodegradation experiments, in which the degradation of mineral oil components was studied at pressures up to 200 bar. Bacterial strains known to degrade oil components at ambient pressure could also degrade these mineral oil components at high pressure.

The degradation of oil components by bacterial communities of sediment and water samples from the DWH site will be tested in the high-pressure reactors and in the high-pressure laboratory DL2 (100 L, max. pressure: 550 bar). In the latter, the biodegradation of mineral oil at conditions similar to the deep sea can be studied, such as different shear rates and pressure gradients to simulate rising oil in the water column.

The final objective of the project is to understand and quantify the benthic and pelagic biodegradation of mineral oil at high pressures by natural microbial communities at in-situ conditions.

Session: 013 -

Track: Hydrocarbon Distributions, Cycling and Impacts in Blue Water  
Benthic and Pelagic Environments

Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

## Examining the diversity of petroleum hydrocarbon-degrading genes in Gulf of Mexico deep-sea sediments

**Presenter:** Elizabeth Willis – Haverford College

**Authors:** Elizabeth L. Willis, Haverford College; Helen K. White, Haverford College

### Abstract:

The diversity of microbial functional genes involved in the aerobic degradation of petroleum hydrocarbons has been examined in Gulf of Mexico (GoM) sediments exposed to oil from the Deepwater Horizon disaster and/or natural seepage. This research aims to enhance our understanding of the potential for resident microbes to metabolize oil. Amplification of the well-characterized *alkB* and *PAH-RHD* genes was performed to target the degradation of alkanes and polycyclic aromatic hydrocarbons (PAHs) respectively. The majority of *alkB* protein sequences derived from clone libraries clustered in either the proteobacteria or Actinobacteria groups and were related to other environmental sequences identified from hydrocarbon seep sediments (75-97% similarity). The *PAH-RHD* protein sequences, however, were considerably more diverse and had a maximum of 85% similarity to proteins previously identified. Future work to quantify these functional genes in GoM sediments will provide important insight into the role that these communities play in influencing the fate of oil in the environment.

Session: 013 -

Track: Hydrocarbon Distributions, Cycling and Impacts in Blue Water  
Benthic and Pelagic Environments

Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

## Fingerprinting hydrocarbons from natural seeps and oil spill-impacted areas in GOM

**Presenter:** Beizhan Yan – Lamont-Doherty Earth Observatory

**Authors:** Beizhan Yan, LDEO; Masha Pitiranggon, LDEO; Nigel D'souza, LDEO; Andrew, Juhl, LDEO; Ajit Subramaniam, LDEO

### Abstract:

Water samples from different depths and surface sediment samples were collected from two sites with natural seeps, one site close to Macondo Well, one site previously used for shallow water oil production, and one control site without obvious seep. Various biomarkers (alkanes, aromatics, sterols, and hopanoids, etc) were measured by GC/MS, comprehensive two-dimensional GC, and/or Fourier transform ion cyclotron resonance mass spectrometry in order to characterize hydrocarbon molecular distributions from different natural seep sites, weathered oil after the spill, and natural background in GOM. Results so far show these sources can be separated based on pattern of hopanoid compounds. Ongoing research is focusing on the transformation of hydrocarbons in the water column.

# Science Abstracts

## Session: 014 Oil Droplets and Particles—Physical Processes Affecting the Breakup and Transport of Micro Oil Droplets and Biophysical interactions of Plankton Bacteria at Oil-water Interfaces

Session: 014 - 1

Track: Oil Droplets and Particles—Physical Processes Affecting the Breakup and Transport of Micro Oil Droplets and Biophysical interactions of Plankton Bacteria at Oil-water Interfaces

Date: Wednesday, January 23 10:30 AM  
Type: Oral Presentation

### Evapo-sinking: The sinking of surface spilled oil due to evaporation

**Presenter:** Louis Thibodeaux – Louisiana State U.

**Authors:** Louis J. Thibodeaux, Louisiana State University; Christopher Stevens, Louisiana State University; Edward B. Overton, Louisiana State University

#### Abstract:

Evaporation is the dominant initial weathering process of slick forming, surface spilled oil. Lighter, volatile components will evaporate more quickly than its heavier, nonvolatile counterparts. Considering oil as consisting of these two pseudo-components, the loss of the lighter portions into the atmosphere will result in a concentration gradient in the slick with the heavier component favored at the bottom. This buildup of “heavies” will eventually lead to the sinking of oil drops from the surface slick. A novel theoretical equation for estimating the time required for a drop of oil to fall was developed and will be presented. Experimental data and evidence were collected on a laboratory-scale oil-spill microcosm. Trials were run using “model” oil and data was collected for the time required for the drops to fall. Up to three droplets were observed to form on the underside of each surface slick during the evaporation process. Being heavier than water these sank to the bottom. A chemical analysis of bottom droplet confirmed the high densities and compositions. This presentation will cover experimental procedure, data collection, and analysis to compare the actual data with the predictive model.

Session: 014 - 2

Track: Oil Droplets and Particles—Physical Processes Affecting the Breakup and Transport of Micro Oil Droplets and Biophysical interactions of Plankton Bacteria at Oil-water Interfaces

Date: Wednesday, January 23 10:45 AM  
Type: Oral Presentation

### The Fate and Transport of Subsurface Oil Released in a Wave Tank Facility

**Presenter:** Brian Robinson – Centre for Offshore Oil, Gas and Energy Research (COOGER)

**Authors:** Brian Robinson, Centre for Offshore Oil, Gas and Energy Research; Thomas King, Centre for Offshore Oil, Gas and Energy Research; Kenneth Lee, Centre for Offshore Oil, Gas and Energy Research

#### Abstract:

The wave tank facility was operated in a flow-through mode under breaking wave conditions to evaluate the fate and horizontal transport of a subsurface release of chemically dispersed Heidrum oil in the presence and absence of suspended particles (kaolin). Studies were conducted with dispersant to suspended mineral fines to oil ratios (DMOR) of 0:0:1, 25:0:1, 0:1:1, and 25:1:1 at temperatures between 7 and 13 °C and salinity levels between 24 and 29 ppt. In-situ LISST particle size analysis revealed that the addition of oil dispersants enhanced the production of small oil droplets (<50 µm), whereas without dispersant the median oil droplet size was 157 µm. As expected, the addition of mineral fines to the tank increased the small particle concentrations, since the LISST measures all particles in the water column, including mineral fines and oil droplets. The particle distribution for oil and dispersant in the presence of mineral fines shows that compared to the experiment with no minerals, there was a large increase in very small oil droplets (<5 µm). These small oil droplets would be neutrally buoyant and would remain in the water column, explaining why the subsurface plume was detected travelling over time downstream of the tank in the experiments with oil, dispersant and minerals. The movement of the plume over time was also apparent upon observation of the interface tension and hydrocarbon data. These results could indicate that the presence of suspended mineral fines may help to stabilize small oil droplets so that they cannot coalesce and rise to the surface, and instead they remain in the water column where they are subject to processes such as dilution and biodegradation. Without dispersant treatment large droplets of oil (<100 µm) are formed and rise to the seawater surface and did not form OMA in the wave tank.



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Session: 014 - 3

Track: Oil Droplets and Particles—Physical Processes Affecting the Breakup and Transport of Micro Oil Droplets and Biophysical interactions of Plankton Bacteria at Oil-water Interfaces

Date: Wednesday, January 23 11:00 AM  
Type: Oral Presentation

## Bubble and drop formation under deep sea conditions

**Presenter:** Katrin Laqua – Hamburg University of Technology

**Authors:** Michael Schlueter, Hamburg University of Technology; Katrin Laqua, Hamburg University of Technology; Karen Malone, Hamburg University of Technology; Ralf Seemann, Hamburg University of Technology; Andreas Meyer, Hamburg University of Technology; Dieter Krause, Hamburg University of Technology; Giselher Gust, Hamburg University of Technology; Philipp Jaeger, Eurotechnica GmbH

### Abstract:

The DWH spill 2010 contains oil and seawater (liquid), methane (gas) and forms methane hydrate with seawater (solid). To investigate, model and simulate the distribution of the oil and methane in jet and environment, the bubble and drop size distributions and the velocity, as well as the hydrate formation rates in the jet and near field have to be known. A high pressure laboratory has been adapted for multiphase flows under deep sea conditions. The paramount influence of pressure is revealed in first experiments on surface tension between oil and methane, decreasing by 50 % from 1 to 150 bar (at 35 °C).

This causes different diameter distributions of droplets and bubbles with depth and consequently a height-dependent dynamic jet behavior in comparison to an assumed constant surface tension. The mechanical engineering design of the pressure laboratory for jet-relevant deep sea experiments will be presented as well as first results on the influence of temperature and pressure on local bubbles and drops of a multiphase jet and hydrate formation.

Refs: Bigalke et al., 2008, Gust et al., 2012

Session: 014 - 4

Track: Oil Droplets and Particles—Physical Processes Affecting the Breakup and Transport of Micro Oil Droplets and Biophysical interactions of Plankton Bacteria at Oil-water Interfaces

Date: Wednesday, January 23 11:15 AM  
Type: Oral Presentation

## Settling and Diffusion of Droplets and Particles in Turbulent Flows

**Presenter:** Joseph Katz – Johns Hopkins University

**Authors:** Joseph Katz, Johns Hopkins University; Balaji Gopalan, National Energy Technology Laboratory

### Abstract:

The presentation summarizes the present state of knowledge on the settling speed and diffusion of particles in turbulent flows, with emphasize on slightly buoyant droplets. Due to a series of processes, e.g. trajectory biasing and preferential positioning, turbulence enhances the settling velocity of heavy particles and suppresses the rise velocity of bubbles. Yet, high levels of turbulence, as characterized by the ratio of rms velocity fluctuations to the quiescent rise rate of the droplets, enhance the mean rise velocity of slightly buoyant oil droplets well beyond the quiescent rate. Causes and mechanisms, which involve buoyant slip combined with the droplet inertia, will be discussed. Considerable effort has already been invested in modeling of scalar and particle diffusion in turbulent flows. For oil droplets, our measurements show that buoyancy induced slip at low to intermediate turbulence levels causes anisotropic turbulent diffusion, with higher levels in the horizontal direction. At low turbulence levels, the droplet diffusion is lower than that of the surrounding fluid (neutrally buoyant particles). However, at intermediate levels, the droplets diffusion coefficient can be 20% higher than that of the surrounding fluid. The mechanisms involved will be elucidated. Sponsored by CRRC and GoMRI

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Track: Oil Droplets and Particles—Physical Processes Affecting the Breakup and Transport of Micro Oil Droplets and Biophysical interactions of Plankton Bacteria at Oil-water Interfaces

Date: Wednesday, January 23 11:30 AM  
Type: Oral Presentation

## Single-camera 3D droplet tracking in color

**Presenter:** Evan Variano – University of California Berkeley

**Authors:** Evan A Variano, University of California; Ian C Tse, University of California

### Abstract:

Recording droplet trajectories in 3D allows for the calculation of the eddy diffusivity of droplet plumes. We present a field-deployable stereoscopic



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camera that can capture such trajectories. We implement this in a simple single-camera setup using a multi-iris optical filter. Similar capabilities have been demonstrated using holography, by the research group of Joseph Katz. The key advantage of our method relative to holography is that it uses broad-spectrum illumination and a color camera. The color information in images provides an additional dimension of data that can be used for identifying the droplets of interest (e.g. oil) in the field.

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## Session: 014 - 6

Track: Oil Droplets and Particles—Physical Processes Affecting the Breakup and Transport of Micro Oil Droplets and Biophysical interactions of Plankton Bacteria at Oil-water Interfaces

Date: Wednesday, January 23 11:45 AM  
Type: Oral Presentation

### **Towards new phenomenological models of subgrid scale flux of oil droplet for next-generation large eddy simulation of oil plume-turbulence interaction**

**Presenter:** Marcelo Chamecki – Penn State University

**Authors:** Marcelo Chamecki, Penn State University; J. Christos Vassilicos, Imperial College; Charles Meneveau, Johns Hopkins University

#### **Abstract:**

Deep-water blowouts generate plumes of oil droplets and gas bubbles that rise through, and interact with, various layers of the ocean. An important part of the process occurs towards the latter stages, when plumes reach the ocean mixed layer, where plume-turbulence interactions determine further rates of dilution and bio-degradation. Small-scale turbulence motions that cannot be resolved in numerical models play an important role in this interaction, and must be represented by subgrid scale (SGS) models. This work is a first step in the development of such models. Dispersion of heavy particles in 2D homogeneous isotropic turbulence is studied as a simple model scenario to investigate the basic characteristics of SGS fluxes. The SGS flux has two parts that represent different physical processes and must be modeled separately: mixing due to SGS turbulence and clustering due to particle inertial response to SGS acceleration. Phenomenological models are proposed for the latter. Similarities and differences between the simple model scenarios and dispersion of oil droplets and gas bubbles in the ocean mixed layer will be discussed. Future extension of such models to 3D turbulence and applications in Large Eddy Simulations of oil plume-turbulence interactions will be outlined.

## Session: 014 - 7

Track: Oil Droplets and Particles—Physical Processes Affecting the Breakup and Transport of Micro Oil Droplets and Biophysical interactions of Plankton Bacteria at Oil-water Interfaces

Date: Wednesday, January 23 12:00 PM  
Type: Oral Presentation

### **Microparticle assembly at fluid interfaces**

**Presenter:** Kathleen Stebe – University of Pennsylvania

**Authors:** Kathleen Stebe, University of Pennsylvania; Marcello Cavallaro, University of Pennsylvania; Lu Yao, University of Pennsylvania; Lorenzo Botto, Imperial College

#### **Abstract:**

Microparticles at fluid–fluid interfaces can self-assemble to form aggregates that impart new mechanics to the interfaces. Spherical particles at interfaces have been well studied. However, the behavior of anisotropic particles – whether the anisotropy originates from shape or chemical heterogeneity – has been considered only very recently. In this talk, we review recent advances in the field of anisotropic microparticles at fluid interfaces. Our experiments on capillary adsorption, orientation, migration, and self-assembly on planar and curved interfaces are briefly reviewed, as is recent work on near field capillary repulsion. The potential relevance of this field in the context of the oil spill in the Gulf of Mexico is discussed.

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## Session: 014 - 8

Track: Oil Droplets and Particles—Physical Processes Affecting the Breakup and Transport of Micro Oil Droplets and Biophysical interactions of Plankton Bacteria at Oil-water Interfaces

Date: Wednesday, January 23 12:15 PM  
Type: Oral Presentation

### **Surfactant-Particle Interactions in Pickering Emulsions**

**Presenter:** Arijit Bose – University of Rhode Island

**Authors:** Hari Katepalli, University of Rhode Island; Vijay John, Tulane University; Arijit Bose, University of Rhode Island

#### **Abstract:**

We studied the effect of different surfactants on the stability of octane in water emulsions stabilized by carbon black particles and their ability to desorb the carbon black particles from the emulsion droplet interfaces. The particle stabilized emulsions showed distinct morphological changes when exposed to surfactants depending on their ionic nature and interfacial activity. We observed that the colloidal particles from the oil droplet interfaces are released as jets of single particles or as aggregates depending on the nature and concentration of the exposed surfactants. The interfacial properties of the surfactant molecules play a major role in

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determining emulsion stability and disassembly of colloidal particles for the oil droplet interfaces. By changing the nature, concentration and interfacial properties of the surfactant molecules the emulsion stability and particle release kinetics from the oil droplet interfaces can be tuned effectively.

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## Session: 014 - 9

Track: Oil Droplets and Particles—Physical Processes Affecting the Breakup and Transport of Micro Oil Droplets and Biophysical interactions of Plankton Bacteria at Oil-water Interfaces

Date: Wednesday, January 23 2:00 PM  
Type: Oral Presentation

### Relating Interfacial Mechanics and Coalescence Behavior of Irreversibly Adsorbed Tween 80 Layers at Oil/Water Interfaces

**Presenter:** Matthew Reichart – Carnegie Mellon University

**Authors:** Matthew D. Reichert, Carnegie Mellon University; Shelley L. Anna, Carnegie Mellon University; Lynn M. Walker, Carnegie Mellon University

#### Abstract:

Interfacial mechanics and rheology have been observed to impact coalescence rates between dispersed air bubbles or oil droplets in an aqueous phase. However, most theoretical descriptions of film drainage and coalescence that include film elasticity demonstrate that even small levels of elasticity will render a film tangentially immobile, and do not impact the film drainage or coalescence rate aside from setting this limit in the mobility of the film. The fundamental disjunction between these theoretical treatments and experiments are the geometries over which both are performed. Elasticity measurements are typically done on a pendant-drop device, which is millimeters in radius, while coalescence studies, film drainage studies, and theoretical descriptions utilize microscale systems.

This study connects the elasticity and coalescence rates of droplets for a model oil-aqueous-dispersant system (squalane, simulated sea water or DI water, and Tween 80) using a recently developed microtensiometer. The microtensiometer allows the elasticity and coalescence rates to be measured on the same droplet interfaces, avoiding, for the first time, this disconnect between measurement of interfacial mechanics and coalescence behavior. We observe a critical interfacial tension, below which, coalescence rates are slowed beyond what is predicted for simple theoretical descriptions. We also demonstrate a strong dependence of coalescence rate with elasticity, suggesting that the interfacial elasticity is indicative of surface phenomena that resist coalescence and film drainage. This work demonstrates a new technique that can be used to

further the design of reliable dispersants, as well as raises important questions about the nature of elastic, surfactant-coated interfaces.

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## Session: 014 - 10

Track: Oil Droplets and Particles—Physical Processes Affecting the Breakup and Transport of Micro Oil Droplets and Biophysical interactions of Plankton Bacteria at Oil-water Interfaces

Date: Wednesday, January 23 2:15 PM  
Type: Oral Presentation

### Effect of a natural biomaterial on the droplet size of crude oil dispersed in water

**Presenter:** Daniela De Lima Stebbins – University of South Florida

**Authors:** Daniela Stebbins, University of South Florida; Maria Celis, Universidad de Los Andes; Xanel Bello, Universidad de Vigo; Norma Alcantar, University of South Florida

#### Abstract:

Chemical dispersants are considered to be an effective response to treat oil pollution in water. However, the toxicity of the dispersants and dispersed oil is an environmental concern. The purpose of this study is to assess the non-toxic cactus plant-based mucilage to disperse oil stick in water. The mucilage is extracted from a cactus plant and it has been used to clean contaminated water. The droplet size of oil in water emulsions will be evaluated by transmission electron microscopy and response surface methodology will be used with an incomplete factorial design. The concentration of the mucilage (0.5 to 2000 mg/L), concentration of the crude oil (0.5 to 50 g/L) and concentration of salt (3 to 4%) will be evaluated as independent variables to define the optimal dispersion conditions.

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## Session: 014 - 11

Track: Oil Droplets and Particles—Physical Processes Affecting the Breakup and Transport of Micro Oil Droplets and Biophysical interactions of Plankton Bacteria at Oil-water Interfaces

Date: Wednesday, January 23 2:30 PM  
Type: Oral Presentation

### Oil droplet-Ambient Particle Aggregation in Marine Environments

**Presenter:** Christopher Fuller – Clarkson University

**Authors:** Manogna Billuri, Clarkson University; James S. Bonner, Clarkson University; Christopher B. Fuller, Clarkson University

#### Abstract:

The transport of dispersed oil is influenced by oil droplet interactions with the ambient marine particles that may include suspended sediments, phyto- and zoo-plankton, and bacteria. Using an in-situ particle size analyzer and flow cytometry, oil-particle aggregation was studied as a

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function of mixing shear and salinity. Particle collision efficiencies were estimated using a parameter estimation algorithm. In both homogeneous (i.e. oil only) and heterogeneous (i.e. oil and ambient particle) suspensions, mean velocity gradient affected aggregate size with no impact on the collision efficiency. Variable salinity did not affect aggregate size or collision efficiency. Results suggest that particle chemistry (i.e. surface charge) influences aggregate formation in both homogeneous and heterogeneous suspensions. These results are directly related to the aggregate settling velocity. Considering that these processes also affect aggregation with microbial and planktonic species, implies their importance in the ultimate mineralization of dispersed oil.

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## Session: 014 - 12

Track: Oil Droplets and Particles—Physical Processes Affecting the Breakup and Transport of Micro Oil Droplets and Biophysical Interactions of Plankton Bacteria at Oil-water Interfaces

Date: Wednesday, January 23 2:45 PM  
Type: Oral Presentation

### The Effects of Mineral fines on Oil Dispersion, Fate and Transport

**Presenter:** Tom King – Centre for Offshore Oil, Gas and Energy Research (COOGER)

**Authors:** Thomas King, Centre for Offshore Oil, Gas and Energy Research; Brian Robinson, Centre for Offshore Oil, Gas and Energy Research; Kenneth Lee, Centre for Offshore Oil, Gas and Energy Research

#### Abstract:

The interaction of dispersed oil with mineral fines under regular non-breaking and breaking waves at low temperatures (<80°C) were tested in a flow-through wave tank facility. Fine mineral particles of kaolin were evaluated for their potential to form Oil Mineral Aggregates (OMA) at three different mineral to oil ratios (MORs): 0, 1:10 and 1:5. The test oils included weathered Arabian light (ALC), Alaskan North Slope (ANS), and IFO-40 fuel oil. In all tests, Corexit 9500 was applied at a DOR of 1:25. The dispersed oil concentration, dispersed particle size distribution, and the interfacial tension were measured to track the performance of dispersant in the presence and absence of mineral fines, and to evaluate the overall oil dispersion efficiency under the different mixing energy conditions. Experimental data showed that all of the tested oils could be dispersed in cold water conditions (<80°C) given sufficient mixing energy levels. Real-time LISST-100X particle size analysis of ALC crude oil distribution within the wave tank showed that the application of minerals under regular wave conditions stimulated oil-mineral aggregation formation. The findings of these experiments indicate that for denser oils such as IFO-40, mineral dosage and wave energy play key roles in the effectiveness of OMA formation and crude oil dispersion. The dynamic

dispersant effectiveness (DDE) data indicated that dispersion of ANS and ALC was relatively effective in both regular and breaking waves. In regular waves, the high dose (50 g) of mineral fines slightly increased the total concentration of dispersed oil remaining in the water column. From these data it appears that to achieve a high rate of DDE, adding mineral fines is probably not necessary under the high mixing energy of breaking waves, because the chemical dispersant on its own leads to good dispersion efficiency.

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## Session: 014 - 13

Track: Oil Droplets and Particles—Physical Processes Affecting the Breakup and Transport of Micro Oil Droplets and Biophysical Interactions of Plankton Bacteria at Oil-water Interfaces

Date: Wednesday, January 23 3:00 PM  
Type: Oral Presentation

### Aggregation between Suspended Droplets of South Louisiana Crude Oil and Suspended Sediment Fines from the Mississippi River Delta

**Presenter:** Ali Khelifa – Emergencies Science and Technology Section / Environment Canada

**Authors:** Ali Khelifa, Environment Canada

#### Abstract:

Aggregation between suspended oil droplets and suspended particulate matter (SPM), which leads to the formation of oil-SPM aggregates (OSAs), is recognized as an important process affecting the fate of spilled oil in fresh and marine water systems. It affects oil sedimentation and, thus, contamination of bottom sediments during oil spill events. This paper presents new laboratory results obtained with South Louisiana crude oil and natural sediment collected from the Mississippi River Delta. Oil sedimentation caused by negatively buoyant OSAs varied from 0.7 to 65 %. The highest percentage of oil sedimentation was obtained when chemical dispersant (Corexit 9500) was applied. The size of OSAs varied from 25 to 750 µm. The effective density and settling velocity varied between 15 and 500 g/L and 0.35 and 5.5 mm/s, respectively. The study showed that sediment grain size and concentration have strong influence on OSA formation. For a relatively low sediment concentration of 100 mg/L, OSA formation can lead to significant enhancement of oil sedimentation.

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Session: 014 - 14

Track: Oil Droplets and Particles—Physical Processes Affecting the Breakup and Transport of Micro Oil Droplets and Biophysical Interactions of Plankton Bacteria at Oil-water Interfaces

Date: Wednesday, January 23 3:15 PM  
Type: Oral Presentation

## Biofilms at Oil-Water Interfaces and their Mechanical Consequences

**Presenter:** Liana Vaccari – University of Pennsylvania

**Authors:** Liana Vaccari, University of Pennsylvania; Wen Shieh, University of Pennsylvania; Jian Sheng, Texas Tech University; Miriam Wattenbarger, University of Pennsylvania; Kathleen Stebe, University of Pennsylvania

### Abstract:

We study biofilms of *Pseudomonas* sp. ATCC 27259 on pendant drops of hexadecane formed in a suspension of the bacteria in synthetic sea water. The biofilms are elastic, and impede drop coalescence. Film tension varies as the drop is expanded and retracted by changing the drop volume. At some critical compression, wrinkles appear near the neck of the pendant drop with some characteristic wavelength that may be used to characterize film bending moduli. Significant amounts of liquid can be withdrawn from the drop, which becomes a slack, wrinkled “bag”. The “bag” can be re-inflated. During this process, the mechanics of the biofilm can be interrogated by pendant drop tensiometry. Biofilms exhibit hysteresis with greater tensions for a given surface area upon re-expansion. Such robust biofilms may affect the fate of oil drops formed in the Gulf of Mexico. In ongoing work, we will expand this study to include species recently identified in oil mousse in the Gulf of Mexico. The response of biofilms to dispersant will also be studied.

Session: 014 - 15

Track: Oil Droplets and Particles—Physical Processes Affecting the Breakup and Transport of Micro Oil Droplets and Biophysical Interactions of Plankton Bacteria at Oil-water Interfaces

Date: Wednesday, January 23 3:30 PM  
Type: Oral Presentation

## Bacterial motility near the sheared complex boundaries using DHM + microfluidics platform

**Presenter:** Jian Sheng – Texas Tech University

**Authors:** Maryam Jalali-Mousavi, Texas Tech University; Mehdi Molaei, Texas Tech University; Liana Vaccari, U. Penn; Kate Stebe, U. Penn; Jian Sheng, Texas Tech University

### Abstract:

Bacterial motilities near a boundary are known to be modified by the presence of flow shear. To elucidate bacteria kinematics and subsequent

contact rate to oil-water boundaries under flow shear, these processes involving bio-degradation of oil spill must be investigated and understood. Here, we present a new micro-scale experimental platform, digital holographic microscopy (DHM) and microfluidics, to investigate these interactions near a complex boundary. DHM allows us to capture 3D swimming patterns of bacteria, meanwhile microfluidics provide exquisite control over generating complex boundaries and imposing chemical and hydrodynamic environment. We expose oil-degrading bacteria to a chemically patterned solid surface and an oil-water interfaces at different flow shear. Three-dimensional locations and orientations of bacterial are extracted to illustrate swimming characteristics. These characteristics, including swimming velocity, tumbling frequencies, cellular attachment, and suspension dispersion, will be used to elucidate the interactions and fundamental physics. Results on several bacteria species will be provided in the talk.

Session: 014 - 16

Track: Oil Droplets and Particles—Physical Processes Affecting the Breakup and Transport of Micro Oil Droplets and Biophysical Interactions of Plankton Bacteria at Oil-water Interfaces

Date: Wednesday, January 23 3:45 PM  
Type: Oral Presentation

## Steritaxis: Confinement-Imposed Biased Movement of Non-Chemotactic Bacteria

**Presenter:** Kyriakos Papadopoulos – Tulane University

**Authors:** Kyriakos Papadopoulos, Tulane University; Qing Wang, Tulane University; Yuly A. Jaimes-Lizcano, Tulane University

### Abstract:

It is well established that oil-spill oil that washes to the shore or otherwise gets entrapped in porous media like sands, soils and sediments, can persist for decades. One key reason may be that entrapped oil is protected from the oil-eating action of bacteria that may have difficulty in accessing it. Therefore, to understand how bacteria can access porous-media-trapped oil, the swimming behavior of non-chemotactic flagellated bacteria, in tapered glass capillaries and in transparent random porous media, were studied through optical microscopy. A bacterial-swimming phenomenon, termed steritaxis, will be presented and discussed so as to provide insights to bacterial transport during bioremediation of crude-oil contaminated beaches, marshes and sediments.

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## Session: 014 - 17

Track: Oil Droplets and Particles—Physical Processes Affecting the Breakup and Transport of Micro Oil Droplets and Biophysical interactions of Plankton Bacteria at Oil-water Interfaces

Date: Wednesday, January 23 4:00 PM  
Type: Oral Presentation

### Bacteria near a surface patterned with hydrophilic and hydrophobic regions

**Presenter:** Jian Sheng – Texas Tech University

**Authors:** Mehdi Molaei, Texas Tech University; Maryam Jalali-Mousavi, Texas Tech University; Jian Sheng, Texas Tech University

#### Abstract:

Microbial activity has been speculated to be a key mechanism for rapid dissipation of oil spills in the Gulf of Mexico. However, data concerning bacteria interactions with (model) oil-water interfaces are lacking. Here, using 3D digital holographic microscopy and microfluidics, we investigate the dynamic interactions between bacteria and a surface which presents both hydrophilic and hydrophobic regions. The surface is chemically patterned by soft lithography to present alternating hydrophilic and hydrophobic regions with characteristic sizes ranging from 10-100µm and placed in contact with a bacterial suspension in artificial sea water. Bacteria interactions with this surface, including attachment and detachment, are evaluated in-situ. The growth rates of biofilm are quantified by measuring the structures of bacterial colony. To elucidate hydrodynamic mechanisms involved, bacteria swimming characteristics, such as swimming velocity, angle, tumbling frequency and dispersion, are measured. Comparative studies on various oil degrading bacteria will also be presented.

## Session: 014 - 18

Track: Oil Droplets and Particles—Physical Processes Affecting the Breakup and Transport of Micro Oil Droplets and Biophysical interactions of Plankton Bacteria at Oil-water Interfaces

Date: Wednesday, January 23 4:15 PM  
Type: Oral Presentation

### Does a higher ambient pressure matter? Oil-zooplankter interactions in the Deep-Water-Simulator

**Presenter:** J. Rudi Strickler – University of Wisconsin-Milwaukee

**Authors:** J Rudi Strickler, University of Wisconsin Milwaukee; Thomas Consi, University of Wisconsin Milwaukee; Woo-Jin Chang, University of Wisconsin Milwaukee; Kara Kunz, University of Wisconsin Milwaukee; Jeff Motschman, University of Wisconsin Milwaukee; Shawn Bona, University of Wisconsin Milwaukee; Ai Nihongi, University of Wisconsin Milwaukee; Amatzia Genin, The Hebrew University of Jerusalem

#### Abstract:

Digital high-speed holographic recordings allowed us to observe encounters between oil droplets and planktonic copepods over an ambient pressure range equivalent to 0 to 200 m depths. Over this range the buoyancy of the animal changes as well as the characteristics of their feeding currents. Similarly, the feeding behaviors (e.g., rate of capture, selection, food handling) differ from the ones at 0 m depth. These first results show that, in general, results on copepod-particle interactions from laboratory experiments cannot necessarily be extrapolated to events at greater depths. Videos will demonstrate our results.

## Session: 014 -

Track: Oil Droplets and Particles—Physical Processes Affecting the Breakup and Transport of Micro Oil Droplets and Biophysical interactions of Plankton Bacteria at Oil-water Interfaces

Date: Wednesday, January 23 8:30 - 10:30  
Type: Poster

### Effects of crude oil exposure on zooplankton: lethal effects and accumulation of petroleum hydrocarbons in mesozooplankton communities

**Presenter:** Rodrigo Almeda – University of Texas at Austin

**Authors:** Rodrigo Almeda, The University of Texas at Austin; Zoe Wambaugh, Humbolt State University; Zucheng Wang, East China Normal University; Cammie Hyatt, The University of Texas at Austin; Zhanfei Liu, The University of Texas at Austin; Edward Buskey, The University of Texas at Austin

#### Abstract:

Information concerning the effects of crude oil on zooplankton is essential for our understanding of the impact of oil spills in marine environments because of their role in transfer of organic matter to higher trophic levels. We determined the effects of crude oil exposure on survival and bioaccumulation of polycyclic aromatic hydrocarbons (PAHs) in natural mesozooplankton assemblages from the North Gulf of Mexico. Experiments consisted of short term (16h) on-board incubations of zooplankton assemblages (>150 µm) exposed to crude oil concentrations ranging from 10 to 100 µl L<sup>-1</sup>. Control treatments (without oil added) were run simultaneously. High mortality rates (ca. 90%) were observed at crude oil concentrations ≥ 50 µl L<sup>-1</sup>. Mortality due to crude oil exposure was lower than 10% at concentrations of 10 µl L<sup>-1</sup> in all studied zooplankton communities. However, crude oil concentrations of 10 µl L<sup>-1</sup> had high narcotic effects (> 50%) on coastal zooplankton community dominated by the copepod *Acartia tonsa*. Data on the bioaccumulation of PAH by metazooplankton will also be presented.



# Science Abstracts

Session: 014 -

Track: Oil Droplets and Particles—Physical Processes Affecting the Breakup and Transport of Micro Oil Droplets and Biophysical interactions of Plankton Bacteria at Oil-water Interfaces

Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

## Effects of crude oil on survival, growth rates and swimming behavior of barnacle nauplii (*Balanus* spp)

**Presenter:** Shawn Bona – University of Wisconsin, Milwaukee

**Authors:** Shawn Bona, University of Wisconsin Milwaukee; Rodrigo Almeda, University of Texas at Austin; J. Rudi Strickler, University of Wisconsin Milwaukee; Edward Buskey, University of Texas at Austin

### Abstract:

Barnacle nauplii are common invertebrate larvae that feed on small suspended particles, and may ingest dispersed oil along with their food. We examined the effects of crude oil on survival, growth and swimming behavior of barnacle nauplii and the combined effects of solar radiation and oil exposure. Barnacle nauplii were exposed to crude oil concentrations ranging from 1 to 25  $\mu\text{L L}^{-1}$  for 3 days in dim light. Survival of nauplii decreased from ca. 70% at 1  $\mu\text{L L}^{-1}$  to 10% at 25  $\mu\text{L L}^{-1}$  after 72 h, with a median lethal dose (LD<sub>50</sub>) of 2.5  $\mu\text{L L}^{-1}$ . Negative effects (mortality + morbidity) were higher than 80% at concentration  $\geq 1 \mu\text{L L}^{-1}$ . No significant differences on growth rates were observed. Data on the sublethal effects of crude oil exposure on swimming behavior of barnacle nauplii will also be presented. A second experiment was conducted under full sunlight exposure to test the combined effects of crude oil and solar radiation. Sunlight exposure increased the toxicity of crude oil in nauplii, with high mortality rates (30-85%) after only 14 h incubation.

Session: 014 -

Track: Oil Droplets and Particles—Physical Processes Affecting the Breakup and Transport of Micro Oil Droplets and Biophysical interactions of Plankton Bacteria at Oil-water Interfaces

Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

## Manufacturing micro-oil droplets of different sizes and compositions to test oil-animal interactions

**Presenter:** Jeffrey Motschman – University of Wisconsin-Milwaukee

**Authors:** Jeffrey Motschman, University of Wisconsin Milwaukee; Kara Kunz, University of Wisconsin Milwaukee; Woo-Jin, Chang, University of Wisconsin Milwaukee; J. Rudi, Strickler, University of Wisconsin Milwaukee

### Abstract:

We present a cost-effective, user-friendly microfluidic solution to produce monodispersed micro-oil droplets of different sizes and compositions with the goal of harvesting arrays with small tolerances. This 'complete system' requires minimal user time investment and is ideal for novice microfluidic users, while maintaining exceptional droplet resolution and results. Producing these assemblages, we are capable in our toxicity tests to investigate the affects of size and composition specific droplets on zooplankton. We used mineral oil as a baseline and proceeded to hexane and heptane mixtures of these hydrocarbons. Our results will show the important engineering design parameters in creating and storing droplets for further experimentation and possibility of shipment to other laboratories.

Session: 014 -

Track: Oil Droplets and Particles—Physical Processes Affecting the Breakup and Transport of Micro Oil Droplets and Biophysical interactions of Plankton Bacteria at Oil-water Interfaces

Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

## Investigation of physical role of the marine plants (Mangroves) in oil content transport toward the coastal zones

**Presenter:** Sadegh Partani – Louisiana State University

**Authors:** Sadegh Partani, University of Tehran; Reza Ghiassi, University of Tehran; Ahmad Khodadadi D, University of Tarbiat Modares; Chunyan Li, Louisiana State University; Mohsen Saeedi, Iran University of Science and Technology

### Abstract:

In this paper some of the marine species have been investigated just for their physical role whiten the first hoarse while the oil slick arrive to them and continue its movement toward the coastal zone. This research has been done based on some observed data and some assumed data. In this research 4 times of modeling lead the results to compare them to figure out the physical effects of marine vegetation as the stagnation point in the oil slick stream path which caused by hydraulic and hydrodynamic forces of ocean currents.

The experimental design has been done though the statistic techniques which led the research method to finding the experiment unit and sampling unit and treatment analysis using model instead of real field sampling. Two models include the marine forests and two models without the marine forests have been run as two main blocks and in each block there is one treatment with two levels, with oil slick and without oil slick consideration.



# Science Abstracts

## Session: 014 -

Track: Oil Droplets and Particles—Physical Processes Affecting the Breakup and Transport of Micro Oil Droplets and Biophysical Interactions of Plankton Bacteria at Oil-water Interfaces

Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

### Numerical modeling of methane hydration and droplet transport for deepwater oil spill

**Presenter:** Yohei Takagi – Osaka University

**Authors:** Youhei Takagi, Osaka University; Takahiko Ban, Osaka University; Yasunori Okano, Osaka University; Satoru Kunikane, Osaka University; Sho Kawahara, Osaka University; Naomi Kato, Osaka University; Kazunari Ohgaki, Osaka University

#### Abstract:

As the fundamental study for development of autonomous tracking system of spilled plumes of oil and gas from seabed by an underwater buoy robot, the effect of methane gas hydration and oil/gas droplet size on the spilled region was numerically investigated. The trajectory of spilled oil/gas was calculated by the hybrid scheme which consists of Lagrangian control volume method and Lagrangian particle tracking method, depending on the buoyancy depth level of spill plume. Input data for numerical simulation were extracted from the marine conditions of the “DeepSpill” experiment (Norwegian Sea) and the “Deepwater Horizon” accident (Gulf of Mexico). Numerical results showed that increase of hydrate growth rate induced early termination of jet/plume near the blowout point and large-scaled spreading on a horizontal plane due to increase of advection/diffusion phase. Furthermore, it was shown that the region including smaller bubbles/droplets is widely spread out under strong current condition.

## Session: 014 -

Track: Oil Droplets and Particles—Physical Processes Affecting the Breakup and Transport of Micro Oil Droplets and Biophysical Interactions of Plankton Bacteria at Oil-water Interfaces

Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

### Bioaccumulation of petroleum hydrocarbons by the calanoid copepod *Acartia tonsa*

**Presenter:** Zoe Wambaugh – Humboldt State University

**Authors:** Zoe Wambaugh, Humboldt State University; Rodrigo Almeda, University of Texas at Austin; Zucheng Wang, East China Normal University; Cammie Hyatt, University of Texas at Austin; Zhanfei Liu, University of Texas at Austin; Edward Buskey, University of Texas at Austin

#### Abstract:

Information concerning accumulation and biodegradation of crude oil by copepods is essential for understanding the fate of oil spills in the ocean.

We estimated short-term bioaccumulation of polycyclic aromatic hydrocarbons (PAHs) by copepods and assessed the role of protozoa in the biomagnification of PAHs. Adult stages of the copepod *Acartia tonsa* were exposed to 5  $\mu\text{L L}^{-1}$  of crude oil. Two treatments were conducted, *Acartia tonsa* fed the phytoplankton *Rhodomonas salina*, and those fed both *Rhodomonas salina* and the protozoan *Oxyrrhis marina*. Our results showed that the presence of protozoa caused less accumulation of PAHs in copepods, suggesting that protozoa may be important in mitigating the transfer of PAHs to higher trophic levels. We observed significant uptake of both chrysene and benzo[b]fluoranthene by copepods, but only chrysene was bioaccumulated in copepods tissues and eggs/nauplii. This study showed that interactions of copepods and protozoa are important in controlling the flow of PAHs in the food web, and that copepods selectively bioaccumulate PAHs.

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## Session: 015 Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-Omics and Biogeochemistry Approaches

Session: 015 - 1

Track: Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-Omics and Biogeochemistry Approaches

Date: Tuesday, January 22 8:30 AM

Type: Oral Presentation

### Omics reveals microbial community response to Macondo Oil Deep Plume

**Presenter:** Terry Hazen – University of Tennessee/ORNL

**Authors:** Terry C. Hazen, University of Tennessee

#### Abstract:

Deepwater Horizon drilling rig resulted in oil and gas rising to the surface and the oil coming ashore in many parts of the Gulf, it also resulted in an immense oil plume 4,000 feet below the surface of the water. Despite spanning more than 600 feet in the water column and extending more than 10 miles from the wellhead, the dispersed oil plume was gone within weeks after the wellhead was capped – degraded and diluted to undetectable levels. Furthermore, this degradation took place without significant oxygen depletion. Ecogenomics enabled discovery of new and unclassified species of oil-eating bacteria that apparently lives in the deep Gulf where oil seeps are common. Using 16S microarrays, functional gene arrays, clone libraries, lipid analysis and a variety of hydrocarbon and micronutrient analyses we were able to characterize the oil degraders. Metagenomic sequence data and single cells were sorted and sequenced for the some of the most dominant bacteria that were represented in the oil plume; namely uncultivated representatives of *Colwellia* and *Oceanospirillum*. In addition, we performed laboratory microcosm experiments using uncontaminated water collected from The Gulf at the depth of the oil plume to which we added oil and COREXIT.

Session: 015 - 2

Track: Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-Omics and Biogeochemistry Approaches

Date: Tuesday, January 22 9:00 AM

Type: Oral Presentation

### Response of functional microbial communities to the Deepwater Horizon oil spill and chemical dispersant exposure

**Presenter:** Jizhong Zhou – University of Oklahoma

**Authors:** Jizhong Zhou, University of Oklahoma; Joy D. Van Nostrand, University of Oklahoma; Martin Maxwell, Louisiana State University; Zhenmei Lu, Zhejiang University and University of Oklahoma; Ye Deng, University of Oklahoma; Zhili He, University of Oklahoma; Terry C. Hazen, University of Tennessee at Knoxville; Aixin Hou, Louisiana State University

#### Abstract:

A record amount of oil and chemical dispersant were released during the Gulf of Mexico Deepwater Horizon oil spill. The impact of oil and dispersant on marine ecosystems is largely unknown. Using GeoChip, a comprehensive functional gene array, we examined the effects of the oil spill on the marine microbial community in situ and of dispersant in microcosms. Results in situ indicated a variety of metabolic genes involved in both aerobic and anaerobic hydrocarbon degradation were highly enriched in the plume compared with outside the plume, indicating a great potential for intrinsic bioremediation or natural attenuation in the deep sea. Results of the microcosm study indicated significant changes in the microbial community structure with dispersant and a variety of metabolic genes for hydrocarbon degradation were significantly reduced in samples with dispersant. These results suggest that the indigenous marine microbial communities could have a significant role in biodegradation of oil spills in the deep-sea and that dispersant may reduce the negative effects of oil spills.

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Session: 015 - 3

Track: Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-Omics and Biogeochemistry Approaches

Date: Tuesday, January 22 9:15 AM  
Type: Oral Presentation

## Creating a Predictive Model of Microbially Mediated Carbon Remediation in the Gulf of Mexico

**Presenter:** Jack Gilbert – University of Chicago

**Authors:** Jack A Gilbert, University of Chicago; Sean Gibbons, University of Chicago; Peter Larsen, ANL; Tanya Woyke, JGI; Rex Malmstrom, JGI; Tony Gutierrez, Heriot-Watt University; Tingting Yang, University of North Carolina; Lisa Nigro, University of North Carolina; Mandy Joye, University of Georgia; Andreas Teske, University of North Carolina

### Abstract:

The Macondo oil leak stimulated microbial community. We present analysis of >700 samples of Gulf of Mexico marine bottom sediments with natural seepage and Macondo wellhead sediments and water column samples with and without anthropogenic oil contamination. We present: (A) 16S rRNA V4 sequencing of all 700 samples to capture community succession to create an artificial neural network model to predict changes in community structure. (B) Shotgun metagenomic sequencing of 100 samples representative of different stages of community succession to explore the functional response using metabolic translation through the Predictive Relative Metabolic Turnover algorithm. (C) Single cell genomics from oil-amended sediment enrichments. D) Pure cultures from sediments Selected for by alkanes and aromatic compounds as carbon sources. Here we will present comparative analysis of microbial community structure for 192 sediment samples from natural hydrocarbon seeps and the Macondo wellhead, including a preliminary model of microbial structure resulting from hydrocarbon contamination.

Session: 015 - 4

Track: Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-Omics and Biogeochemistry Approaches

Date: Tuesday, January 22 9:45 AM  
Type: Oral Presentation

## Bacterial 16S rRNA Pyrosequencing analysis of the Gulf of Mexico water column and initial sediment survey results

**Presenter:** Tingting Yang – UNC-Chapel Hill

**Authors:** Tingting Yang, UNC Chapel Hill; Andreas Teske, UNC Chapel Hill; Lisa Nigro, UNC Chapel Hill; Tony Gutierrez, Heriot-Watt University

### Abstract:

The bacterial community structure of the water column and the deep hydrocarbon plume during and after the oil leak was evaluated by high-throughput pyrosequencing of 300bp 16S rRNA gene amplicons. Against similar dominant groups as in previous 16S rRNA clone libraries, the higher resolution afforded by pyrosequencing detected minority groups. Specifically, sequences of DWH Oceanospirillales, and of cultured oil-degrading genera (Alkanivorax, Oleiphilus, Marinobacter, Cycloclasticus) occurred in small numbers post-plume, indicating either a persistent imprint of hydrocarbon pollution, or reservoir populations that persist in the water column. Our ongoing bacterial community survey of surficial sediments near the Macondo wellhead shows conspicuous populations of sulfate-reducing deltaproteobacteria and Firmicutes, including genera that specialize in the complete oxidation of aromatic compounds. These sulfate-reducing bacteria do not appear in non-polluted surface sediments, and differ from the sulfate reducers commonly found at natural hydrocarbon seeps in the Gulf of Mexico.

Session: 015 - 5

Track: Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-Omics and Biogeochemistry Approaches

Date: Tuesday, January 22 10:00 AM  
Type: Oral Presentation

## Stable Isotope Probing to Identify Hydrocarbon-Oxidizing Bacteria in Deep Water Plumes After the Deepwater Horizon Oil Spill

**Presenter:** Molly Redmond – UC Santa Barbara

**Authors:** Molly Redmond, UC Santa Barbara; David Valentine, UC Santa Barbara

### Abstract:

The unprecedented depth of the Deepwater Horizon blowout led to formation of deep water plumes of natural gas and dissolved or dispersed oil. 16S rRNA gene sequencing showed that the microbial communities in the plumes were initially dominated by an uncultivated Oceanospirillales, Colwellia, and Cycloclasticus, and then succeeded by Methylococcaceae. 16S rRNA gene sequences provided relatively little information about metabolic function of these bacteria, so we used stable isotope probing to identify the organisms consuming specific hydrocarbon compounds that were abundant in the plumes. Methylococcaceae were the major methane oxidizers. Ethane and propane were consumed predominately by Colwellia, while benzene was consumed by Colwellia and an uncultivated group of Actinobacteria. These results suggest that the high natural gas content of this spill favored bacteria capable of consuming these compounds, though they likely consumed other hydrocarbons also. Single

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cell amplified genomes from these organisms will provide additional insight into their metabolic functions.

Session: 015 - 6

Track: Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-Omics and Biogeochemistry Approaches

Date: Tuesday, January 22 10:15 AM  
Type: Oral Presentation

## **‘Omics’ Analyses of the Deep-Sea Microbial Community Response to the Deepwater Horizon Oil Spill**

**Presenter:** Olivia Mason – Florida State University

**Authors:** Olivia U. Mason, Florida State University

### **Abstract:**

The Deepwater Horizon oil spill in the Gulf of Mexico resulted in a deep-sea hydrocarbon plume that caused a bloom of uncultured, uncharacterized members of the Oceanospirillales. Given the recalcitrant nature of Oceanospirillales to cultivation efforts, a variety of ‘omics’ techniques (metagenomics, metatranscriptomics, and single cell genomics) were used to examine the role of this clade, as well as that of the microbial community at large, in oil disposition. Shotgun metagenomic and metatranscriptomic sequencing revealed that Oceanospirillales was abundant and active. These analyses also demonstrated that genes coding for motility, chemotaxis and aliphatic hydrocarbon degradation were significantly enriched and expressed in the hydrocarbon plume samples compared with uncontaminated seawater. Genomic analysis of Oceanospirillales single cells obtained from the plume validated our metagenome and metatranscriptome derived findings in that the single cell genome encoded aliphatic hydrocarbon degradation. Additionally, the single cell draft genome revealed a suite of nutrient acquisition strategies and possessed genes for chemotaxis and motility.

Session: 015 - 7

Track: Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-Omics and Biogeochemistry Approaches

Date: Tuesday, January 22 11:00 AM  
Type: Oral Presentation

## **Microbial Community Composition and Functions in the Gulf of Mexico One Year After the Deepwater Horizon Accident**

**Presenter:** Charles Greer – National Research Council

**Authors:** Charles W. Greer, National Research Council Canada; Etienne Yergeau, National Research Council Canada and McGill University; Christine Maynard, National Research Council Canada; Sylvie Sanschagrin, National Research Council Canada; Julie Champagne, National Research Council Canada; David Juck, National Research Council Canada; Kenneth Lee, Fisheries and Oceans Canada; Marie T. BenKinney, Exponent Health & Environmental; Arden Ahnell, British Petroleum

### **Abstract:**

Microbial degradation and dispersant use have reduced residual hydrocarbon concentrations from the Deepwater Horizon accident to undetectable levels and several studies have assessed the effects of the released oil on microbes, either during or immediately after the accident. This study examined the longer term effects on microbial community dynamics and ecosystem recovery using metagenomics, metatranscriptomics and microcosm experiments on samples from four stations located in close proximity to, or distant from the Deepwater Horizon wellhead. At the wellhead station, at depths corresponding to the previously detected plume (1100-1200m), hexadecane mineralization was the greatest and microbial communities were enriched in organisms (obligate hydrocarbonoclastic and methane degrading bacteria) and functional genes (aromatics and methane degradation) known to be associated with hydrocarbon degradation. This was not observed at other stations that were further away from the wellhead (reference station and inshore sites). These results show that ecosystem recovery in the Gulf continues.

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Session: 015 - 8

Track: Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-Omics and Biogeochemistry Approaches

Date: Tuesday, January 22 11:15 AM  
Type: Oral Presentation

## Marine snow and associated microbial processes as drivers for oil transformation in surface Gulf of Mexico waters

**Presenter:** Kai Ziervogel – University of North Carolina - Chapel Hill

**Authors:** Kai Ziervogel, University of North Carolina at Chapel Hill; Uta Passow, University of California Santa Barbara; Julia Sweet, University of California Santa Barbara; Nigel D'souza, Columbia University; Carol Arnosti, University of North Carolina at Chapel Hill

### Abstract:

Marine snow plays a crucial role in oceanic carbon fluxes. The extent of the marine snow formation event shortly after the Deepwater Horizon oil spill in the Gulf of Mexico (GoM) suggest that marine snow also plays a key role in the fate of crude oil and petroleum-derived carbon in the ocean. We conducted laboratory incubations to measure heterotrophic bacterial abundance and rates of carbon transformation (enzyme activities) in marine snow formed in oil-contaminated GoM surface during the spill in 2010, and in surface waters from an oil seep site in 2012. We found a complex cascade of microbial responses that reshaped the dynamics of heterotrophic carbon degradation and the turnover of oil-derived dissolved organic carbon in oil-contaminated waters. Our data show that marine snow aggregates of oily particulate matter are hotspots for bacterial activities. Their formation may be driven by expolymeric substances such as TEP that are produced by microbes to facilitate access to oil.

Session: 015 - 9

Track: Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-Omics and Biogeochemistry Approaches

Date: Tuesday, January 22 11:30 AM  
Type: Oral Presentation

## The response of bacterial communities on oil addition to waters from different depths at the Deepwater Horizon site

**Presenter:** Jiqing Liu – The University of Texas at Austin Marine Science Institute

**Authors:** Jiqing Liu, The University of Texas at Austin; Zhanfei Liu, The University of Texas at Austin; Deana Erdner, The University of Texas at Austin

### Abstract:

Biodegradation is one key process for the oil removal in marine environments. Little is known about how bacterial communities from

different depths in a water column respond to the addition of crude oil. In the May 2012 cruise, we conducted an on-deck incubation of DWH oil using water from the depths of 1500, 700 and 1m at the DWH site. Five hundred mL glass bottles were used for the incubation with a final oil concentration of 0.5%, and samples were taken at 0, 7, 14, 35, 56, and 91d. Petroleum hydrocarbons to be analyzed include n-alkanes, polycyclic aromatic hydrocarbons (PAHs), and alkylated PAHs. Total bacterial abundance will also be examined using flow cytometry, and the abundance of hydrocarbon-degrading bacteria will be measured using the most probable number technique (MPN) with microtiter plates. The microbial community structure will be analyzed by 454 pyrosequencing analysis. These results will shed light on how the oil degradation rates and microbial community structure change with depth at the DWH site.

Session: 015 - 10

Track: Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-Omics and Biogeochemistry Approaches

Date: Tuesday, January 22 11:45 AM  
Type: Oral Presentation

## Corexit 9500 substantially increases the biodegradation of otherwise undispersed oil

**Presenter:** Roger C. Prince – ExxonMobil Biomedical Sciences, Inc.

**Authors:** Roger C. Prince, ExxonMobil Biomedical Sciences, Inc.; Josh D. Butler, ExxonMobil Biomedical Sciences, Inc.

### Abstract:

Dispersants are an important tool for responding to major oil spills. They are essentially a bioremediation tool, allowing oil to disperse into tiny droplets (<70um) that diffuse apart from each other so that they cannot (re-)agglomerate to (re-)form a floating slick. The energy for the dispersion usually comes from surface waves, but can also come from turbulence if oil is released at depth. The tiny droplets are so small that they become entrained in the water column, and the dramatically increased surface area allows microbial access to much more of the oil. Furthermore, diffusion and dilution lead to oil concentrations where natural background levels of biologically available oxygen, nitrogen and phosphorus are sufficient for microbial growth. Dispersants are typically only used on substantial spills in relatively deep water (usually >30m), which are impossible to replicate in the laboratory. Laboratory experiments aimed at following the biodegradation of dispersed oil usually show minimal stimulation of the rate of biodegradation, but this can be attributed to the fact that small quantities of oil disperse quite well even in the absence of chemical dispersant. We show here that when the experiments are conducted so that the comparison is between a slick and a dispersed oil, the rate of biodegradation is dramatically stimulated by effective application of the dispersant Corexit 9500.

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Session: 015 - 11

Track: Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-Omics and Biogeochemistry Approaches

Date: Tuesday, January 22 12:00 PM  
Type: Oral Presentation

## Changes in the redox state in pore water and marine sediments following the 2010 BP blowout

**Presenter:** David Hastings – Eckerd College

**Authors:** Eckerd College: D. Hastings, G. Brooks, T. Bartlett, S. Hammaker, A. Hogan, T. Roeder; University of South Florida: D. J. Hollander, R. Larson, I. Romero; Franklin and Marshall College: J. Morford

### Abstract:

We collected multi-core sediment cores from over 50 sites along the NE Gulf of Mexico continental slope following the event. We present geochemical results from four sites collected between August 2010 and August 2012. Cores were extruded at 2 mm intervals; sediments were analyzed for TOC,  $^{13}\text{C}$ , carbonate, short-lived radioisotopes and grain size. Cores reveal a well-defined, internally stratified dark brown layer in the top 1-6 cm. Interstitial pore waters were sampled at 1 cm intervals in August 2012.

Sediment samples were digested at high temperature and pressure in concentrated  $\text{HNO}_3$  to dissolve the oil and authigenic fractions, but not the detrital component. Samples were subsequently analyzed by ICP-MS. Although Macondo crude oil is slightly enriched in Ni, V, and Co, with concentrations of 2.8, 0.9, and 0.08ppm, respectively, no significant enrichment of these metals is observed in these sediments.

High sedimentation rates, depleted  $^{13}\text{C}$  values and lack of bioturbation on the surface of the deep sediments studied supports the hypothesis of a large sea-snow-like blizzard event during and following the event. Organic and inorganic carbon deposition rates are elevated one to two orders of magnitude in the 2010 and Feb 2011 cores.

Bacterially mediated oxidation of organic matter is reflected in a well-established sequence of oxidation-reduction reactions. We exploit redox sensitive trace elements (Mn, Fe, Re, U, Mo, and V) in sediments and interstitial pore water and changes in pore water nutrients to infer changes in the redox state of sediments following this large pulse of organic matter to the seafloor.

Session: 015 - 12

Track: Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-Omics and Biogeochemistry Approaches

Date: Tuesday, January 22 12:15 PM  
Type: Oral Presentation

## Title: New Approach to Detection of Surfactant-Producing Bacteria in the Sea Surface Microlayer

**Presenter:** Naoko Kurata – NSU Oceanographic Center

**Authors:** Naoko Kurata, Nova Southeastern University; Kate Vella, Nova Southeastern University; Aurelien Tartar, Nova Southeastern University; Silvia Matt, Nova Southeastern University; Mahmood Shivji, Nova Southeastern University; Alexander Soloviev, Nova Southeastern University

### Abstract:

The sea surface microlayer is the biogenic thin layer contained within the uppermost 1 mm of the sea surface. The composition of bacterioneuston community within the microlayer and its functional importance are still understudied due to sampling complexities. In this study, we focus on detection of surfactant-producing bacterioneuston in order to investigate their role in hydrocarbon emulsion through biosurfactants. Biosurfactants reduce surface and interfacial tensions to emulsify petroleum hydrocarbons, and some of which have industrial applications for production of bioemulsifiers. The sea surface microlayer sampling method was designed to reduce the probability of sample contamination from the vessel and subsurface water. A 47 mm polycarbonate membrane filter was utilized at each sampling site to obtain a snapshot of the bacterioneuston community structure at a specific space and time. A high-throughput sequencing technology was employed to compensate for the small sample size. The results revealed the presence of industrially important surfactant-producing marine bacteria: “*Acinetobacter*”, “*Bacillus*”, “*Corynebacterium*” and “*Pseudomonas*”. This new approach is expected to have applications in monitoring biological properties of the sea surface.



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Session: 015 - 13

Track: Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-Omics and Biogeochemistry Approaches

Date: Tuesday, January 22 2:00 PM  
Type: Oral Presentation

## Resistance and alteration of high molecular weight NSO components of crude oils to long term environmental exposure in the water or sediment column

**Presenter:** Thomas Oldenburg – University of Calgary

**Authors:** Thomas Oldenburg, University of Calgary; Ken Chanthamontri, University of Calgary; Melisa Brown, University of Calgary; Andrew Stopford, University of Calgary; Steve Larter, University of Calgary

### Abstract:

High molecular weight NSO compounds highly resistant to biodegradation are key for understanding the fate of spilled oil. These compounds are only detectable with ultra-high resolution mass spectrometric methods and such compounds may be a major contributor to oceanic DOM as demonstrated by recent studies. These unambiguously thermogenic compounds were found homogeneously distributed in the deep sea, but depleted at the sea surface. The structure of these high molecular weight compounds was found to be similar to petroleum asphaltene. With injection of oil into cold deep high pressure marine water it is possible that in addition to aerobic degradation routes, slower anaerobic processes may contribute to oil assimilation and resistant high molecular weight heteroatomic moieties (HMWHM) with multiple heteroatoms per molecule may accumulate.

In this study, the compositional changes of fossil fuels during biodegradation in lab experiments and in natural reservoir profiles under aerobic and anaerobic conditions will be shown as well as indicators of microbiological activity.

Session: 015 - 14

Track: Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-Omics and Biogeochemistry Approaches

Date: Tuesday, January 22 2:15 PM  
Type: Oral Presentation

## The distribution and cold active character of putative hydrocarbon degradation genes among the genomes of cold tolerant microbes

**Presenter:** Jeff Bowman – University of Washington

**Authors:** Jeff S. Bowman, University of Washington; Jody W. Deming, University of Washington

### Abstract:

At both high and low latitudes oil can be released into waters well below the optimal growth temperature of mesophilic bacteria, motivating a search for cold active hydrocarbon degradation genes (HDG). We used a hidden Markov model approach to assign hypothetical proteins to families with hydrocarbon degrading function in a re-annotation of 50 cold tolerant prokaryotic genomes. By conducting a similar analysis on genomes of 38 known hydrocarbon degraders and a random set of 20 genomes, we were able to perform a statistical analysis of the distribution of hypothetical HDG. In a distance biplot of gene family distribution most cold tolerant, random, and known hydrocarbon degraders were co-located in mixed clusters. Mesophilic metabolic “powerhouses” such as *Rhodococcus jostii* and *Burkholderia xenovorans*, however, were located far from these clusters suggesting that limited metabolic “space” is covered by genes contained in the cold tolerant genomes. Further analysis of these results includes a statistical analysis of the cold active character of these hypothetical HDG products.

Session: 015 - 15

Track: Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-Omics and Biogeochemistry Approaches

Date: Tuesday, January 22 2:30 PM  
Type: Oral Presentation

## A Petroleomic Approach to Environmental Analytical Chemistry

**Presenter:** Ryan Rodgers – National High Magnetic Field Lab

**Authors:** Ryan P. Rodgers, Florida State University; Leonard Nyadong, Florida State University; Vladislav V. Lobodin, Florida State University; Brian M. Ruddy, Florida State University; Yuri Eberlim Corilo, Florida State University; David C. Podgorski, Florida State University; Amy M. McKenna, Florida State University; Alan G. Marshall, Florida State University; Robert K. Nelson, Woods Hole Oceanographic Institution; Christopher M. Reddy, Woods Hole Oceanographic Institution

### Abstract:

Petroleomics, the comprehensive characterization of petroleum, employs a wide range of analytical techniques to enable non-linear gains in production and refining efforts. Although most frequently applied to heavy petroleum, the underlying techniques and methods are easily transferable to environmental analyses. Recent advances in GCxGC and ultra-high resolution mass spectrometry combined with over a decade method development has revealed both chemistry specific (acidic, basic and nonpolar) and isomeric molecular-level information previously unobtainable. Here, we exploit the latest GCxGC and Fourier Transform Ion Cyclotron Resonance Mass Spectrometry platforms and methods to provide insight into the composition of the Macondo well oil (MWO), tarballs, contaminated sediments and biotic and abiotic degradation

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products. Preparatory chromatographic techniques that facilitate biodegradation product analyses will also be discussed. [Work supported by NSF DMR-06-54118, the Florida State University Future Fuels Institute, BP/The Gulf of Mexico Research Initiative, and the State of Florida]

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## Session: 015 - 16

Track: Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-Omics and Biogeochemistry Approaches

Date: Tuesday, January 22 2:45 PM  
Type: Oral Presentation

### The use of -omics to detect environmental stress in the Cnidaria

**Presenter:** Iliana Baums – Penn State University

**Authors:** Iliana Baums, Pennsylvania State University; Dannise Ruiz-Ramos, Pennsylvania State University

#### Abstract:

Sessile Cnidarians, including corals and sea anemones, are foundation species of marine ecosystems. However, they exhibit few measurable sub-lethal phenotypes when exposed to stress because growth is typically slow and reproduction occurs rarely. Additionally, many Cnidarians enter into symbioses with eukaryotic and prokaryotic microbes and thus scoring of phenotypes typically assesses the performance of the partners in symbiosis rather than allowing for attribution of performance measures to each partner individually. Recent development of affordable high-throughput molecular methods such as next-generation sequencing and metabolomics methods now enable scoring of thousands of molecular phenotypes that are specific to each symbiotic partner. Here, we develop high-throughput molecular methods to measure the performance of a deep-sea black coral, *Leiopathes glaberrima* and its prokaryotic associates to exposure of oil and dispersants.

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## Session: 015 - 17

Track: Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-Omics and Biogeochemistry Approaches

Date: Tuesday, January 22 3:00 PM  
Type: Oral Presentation

### Impact of hydrocarbon/dispersant exposure on deep-water corals: the transcriptome of *Leiopathes glaberrima*

**Presenter:** Dannise Ruiz Ramos – Pennsylvania State University

**Authors:** Dannise Ruiz Ramos, The Pennsylvania State University; Iliana Baums, The Pennsylvania State University

#### Abstract:

Deep-water corals form vibrant communities in the deep Gulf of Mexico. Here, we aim to assess the mostly unknown impact of hydrocarbon/dispersant exposure on deep-water corals, focusing on the antipatharian *Leiopathes glaberrima*. *L. glaberrima* is one of the most common corals along the upper Louisiana slope and a foundation species. Reference transcriptomes were generated for *Leiopathes* as the first step to understand how crude oil and dispersant alter gene expression. A total of 20 RNA samples were barcoded by color (red and white) and collection site (GC140 and VK906) and sequenced using Illumina RNAseq. Samples included colonies preserved in-situ and onboard the ship, and colonies treated with oil, dispersant and an oil-dispersant mixture. The resulting transcriptomes will enable the development of genetic markers to understand cnidarian physiological response to hydrocarbon/dispersant stress.

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## Session: 015 - 18

Track: Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-Omics and Biogeochemistry Approaches

Date: Tuesday, January 22 3:15 PM  
Type: Oral Presentation

### Synergistic Effects of Crude Oil and Corexit Dispersant on a Sponge Holobiont System

**Presenter:** Jose Lopez – Nova Southeastern University

**Authors:** Jose Lopez, Nova Southeastern University; Marie Cuvelier, Florida International University; Jack A. Gilbert, University of Chicago; Peter Larsen, Argonne National Laboratory; David Willoughby, Ocean Ridge Biosciences; Yonggan Wu, Ocean Ridge Biosciences; Patricia Blackwelder, Nova Southeastern University; Peter McCarthy, Harbor Branch Oceanographic Institution at Florida Atlantic University; Emily Smith, Nova Southeastern University; Rebecca Vega Thurber, Oregon State University

#### Abstract:

Macondo crude oil from the Deepwater Horizon spill and Corexit 9500 dispersant were applied in experimental dosing of the common reef sponge, *Cinachyrella alloclada*, found in both the GOM and many Caribbean reefs. Physiological monitoring included baseline descriptions of a) tissue ultrastructure by electron microscopy, b) profiling the sponge “microbiome” and c) preliminary RNA-sequencing of the host transcriptome. SEM revealed novel (embryo-like) structures. Under closed aquaculture conditions, *C. alloclada* individuals ( $n > 75$ ) were dosed with sublethal amounts of oil or 10:1 oil/Corexit mixtures for 1, 24 and 48 hours. Unexpectedly, microbial communities of the same sponge host diverge into two distinct 16S rRNA clades after PCA analysis. Additionally, over 8000 sponge transcriptome sequences were identified; with oil and/or Corexit dosed samples having increased expression of

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protein transport and breakdown, cytochrome P450, and DNA repair responses. Predicted metabolite turnover demonstrated differential metabolism of sulfur-containing and phenolic compounds.

Session: 015 - 19

Track: Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-Omics and Biogeochemistry Approaches

Date: Tuesday, January 22 3:30 PM  
Type: Oral Presentation

## Molecular diagnostics of coral exposed to oil and dispersants

**Presenter:** Sara Edge – Florida Atlantic University at Harbor Branch Oceanographic Institute

**Authors:** Sara Edge, Harbor Branch Oceanographic Institute at Florida Atlantic University; Joshua Voss, Harbor Branch Oceanographic Institute at Florida Atlantic University; Richard Ruzicka, Fish and Wildlife Research Institute; Kathleen Semo, Fish and Wildlife Research Institute

### Abstract:

Coral reefs face a variety of stressors with potentially synergistic effects. Understanding the dynamics of these interactions and their impacts on coral health is critical. The Deepwater Horizon (DWH) event in 2010 highlights the need to understand the biological impacts of oil and dispersants in coral ecosystems. The combination of oil and dispersants creates a complex mixture of toxic contaminants with different modes of action on marine organisms through multiple routes of exposure and induces molecular and biochemical processes that can serve as biomarkers of the exposure. Such sublethal, molecular quantifications can identify the impacts of oil and dispersant toxicity on coral health. This study examined the effects and interactions of DWH oil, dispersant (Corexit 9500A), and black band disease (BBD) on the coral *Montastraea faveolata*. Variable susceptibility to BBD and dispersant was observed. Dispersant and BBD exposures had greater effects on zooxanthellae density and chlorophyll content than oil exposure. In addition, dispersant had a significantly negative effect on BBD severity. Both microarray-based gene expression profiling and bacterial community profiling were used to determine changes in coral health resulting from the treatment stressors and for monitoring potential exposure in the field. Ongoing work will identify specific genotypic traits that may contribute to coral resiliency following oil and dispersant exposures.

Session: 015 - 20

Track: Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-Omics and Biogeochemistry Approaches

Date: Tuesday, January 22 3:45 PM  
Type: Oral Presentation

## Direct Exposure to Deepwater Horizon Crude Oil Emulsions Elicits Morphology and Gene Expression Changes in Zebrafish Embryos

**Presenter:** Frances Xin – University of Pennsylvania

**Authors:** Frances Xin, University of Pennsylvania; Allen Bui, Louisiana State University School of Medicine; Rui Xiao, LSU SVM; Zakia Perveen, LSU SVM; Louis Thibodeaux, LSU; Kevin Kleinow, LSU SVM; Arthur Penn, LSU SVM

### Abstract:

**Rationale:** The 2010 Deepwater Horizon (DH) blowout damaged marine habitats and halted commercial fishing in much of the Gulf of Mexico. As the spill continued, polynuclear aromatic hydrocarbon-rich emulsions washed up along the Gulf shoreline. Zebrafish embryos (ZFE), a well-established model for vertebrate development, are very sensitive to a variety of environmental pollutants. **Methods:** We assessed short-term developmental responses of ZFE that were exposed directly (from 0-48; 24-72; or, 48-96 hours post-fertilization) to DH-derived emulsions collected from 4 sites along the Gulf (in MS, AL and FL). ZFE were examined for morphological and behavioral changes; Affymetrix ZF arrays were used to assess gene expression changes in emulsion-exposed ZFEs from each site at each time point; and qRT-PCR was used to confirm fold-change values of selected genes. **Results:** Similar morphological changes (axial malformations, pericardial and yolk sac edema), altered swimming patterns and enhanced levels of gene expression were observed in samples from all the sites. Phase I biotransformation-related genes (*cyp1a*, *1b1*, *1c1*, *3a65*; plus *ahrr* and *sult6b1*) displayed greater levels of up-regulation compared to oxidative stress genes (*nqo1*, *prdx1*, *hmx1* and *pgrmc1*) at earlier stages of ZFE development. Phase I gene expression levels dropped rapidly after ZFE were removed from the emulsions. Up-regulation of oxidative stress genes persisted even after ZFE were washed and placed in emulsion-free media. The collection site of the emulsions did not appreciably affect gene expression response patterns. **Conclusions:** DH spill products from a 200-mile stretch across the Gulf were persistently embryotoxic.

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Session: 015 - 21

Track: Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-Omics and Biogeochemistry Approaches

Date: Wednesday, January 23 2:00 PM  
Type: Oral Presentation

## Biodegradation of Emulsified MC 252 Oil in Coastal Salt Marshes

**Presenter:** John Pardue – Louisiana State University

**Authors:** John Pardue, Louisiana State University; Vijai Elango, Louisiana State University

### Abstract:

Biodegradation of emulsified MC252 was investigated in greenhouse experiments conducted in salt marsh cores immediately after the spill. Presence of oil in emulsified form dramatically decreased the biodegradability of PAH crude oil components in these environments when compared with previous published research in our laboratory. Biodegradation rates of lower molecular weight PAHs, in particular, declined when emulsified oil was used in experiments. Normal degradation patterns were observed when the emulsion broke into water and oil components during incubation, suggesting that bioavailability of crude oil components to degrading consortia play a key role in emulsion persistence in these environments. A review of emulsion stability in natural systems will be presented to identify data gaps in our understanding of stable emulsions. A permanent oiled marsh field site located adjacent to Fourchon Beach in Lafourche Parish, LA is being studied using multiple techniques to understand whether emulsion stability contributes to persistence at the field scale. Data from that site will also be presented for comparison with lab and greenhouse results. Results support the hypothesis that formation of emulsions in this spill decreased the predictability of biodegradation as a weathering process on the shoreline.

Session: 015 - 22

Track: Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-Omics and Biogeochemistry Approaches

Date: Wednesday, January 23 2:15 PM  
Type: Oral Presentation

## The Response of Sedimentary Microbial Communities to the Deposition of Oil Hydrocarbons from the Deepwater Horizon (DH) Oil Spill

**Presenter:** Will Overholt – Georgia Institute of Technology

**Authors:** Will A Overholt, Georgia Institute of Technology; Andy Canion, Florida State University; Luis M. Rodriguez, Georgia Institute of Technology; Chris Hagan, Florida State University; John Kaba, Florida State University; Brian Wells, Florida State University; Kostas Konstantinidis, Georgia Institute of Technology; Markus Huettel, Florida State University; Joel E. Kostka, Georgia Institute of Technology

### Abstract:

A large amount of oil from the DH oil spill was transported to and subsequently buried in sedimentary environments from the deepsea to beaches of the Gulf coast. The objective of this research is to characterize the in situ response of bacterial communities to oil contamination as oil transits from the deepsea to the coast and to identify the predominant oil degrading taxa. A bloom of overall bacteria along with members of the Gammaproteobacteria, including known oil degraders (*Alcanivorax* spp.), was observed in parallel with the degradation of oil compounds in the first 4 months after oil came ashore in beach sands. In addition, oiling resulted in a pronounced shift in bacterial community composition that included uncharacterized members of the Proteobacteria and gram positive groups. We conclude that hydrocarbon contamination has a substantial impact on the abundance and composition of indigenous microbial communities and the Gammaproteobacteria play a key role in mediating oil degradation.

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Session: 015 - 23

Track: Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-Omics and Biogeochemistry Approaches

Date: Wednesday, January 23 2:30 PM  
Type: Oral Presentation

## The weathering of oil from the sea surface, salt marshes, and sediments in the northern Gulf of Mexico after the Deepwater Horizon oil spill

**Presenter:** Zhanfei Liu – The University of Texas at Austin

**Authors:** Zhanfei Liu, The University of Texas at Austin; Jiqing Liu, The University of Texas at Austin; Qingzhi Zhu, Stony Brook University; Wei Wu, The University of Southern Mississippi

### Abstract:

Understanding how composition and concentrations of the oil were altered by weathering is essential to evaluating the oil toxicity and impact on the ecosystem in the northern Gulf of Mexico after the Deepwater Horizon oil spill. We examined petroleum hydrocarbons in oil mousse collected from the sea surface and salt marshes, and in oil deposited in sediments adjacent to the wellhead after the oil spill. Our results showed that the oil mounds were weathered moderately by evaporation, with clear losses of low-molecular-weight compounds. The weathering degree became more intensive on the oil mousse along its movement from accident sites to the salt marsh. Contents of trace metals, particularly Al, Fe and Mn, increased significantly with the weathering, suggesting that clay minerals and dissolved metals were aggregated along the mousse movement. The oil deposited in sediments underwent only light to moderate degradation one year after the oil spill, mostly by biological degradation and dissolution. Bacterial community structures in these oil samples will also be presented.

Session: 015 - 24

Track: Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-Omics and Biogeochemistry Approaches

Date: Wednesday, January 23 2:45 PM  
Type: Oral Presentation

## Assessing the Impact of the Deepwater Horizon Oil Spill on Indigenous Bacterial Communities: A Biogeochemical and Molecular Approach

**Presenter:** Tiffany Baskerville – Florida A&M University

**Authors:** Tiffany Baskerville, Florida A&M University; Judith Sarkodee-Adoo, Florida A&M University; Wade Jeffrey, University of West Florida; Ashvini Chauhan, Florida A&M University; Jeff Canton, Florida State University; Jennifer Cherrier, Florida A&M University

### Abstract:

One year after the Deepwater Horizon oil spill, samples were collected from Barataria Bay LA (BB, impacted) and Apalachicola Bay FL (AB, unimpacted) to evaluate spill effects on indigenous bacterial communities. Natural Delta C-14 and  $\delta$  C-13 abundances were used to trace in situ bacterial hydrocarbon remineralization to dissolved inorganic carbon (DIC). BB DIC samples were significantly depleted in Delta C-14 (-109.98‰ to +12.48‰) relative to that for AB (+36.31‰) indicating hydrocarbon remineralization at the BB site. Using dual isotope three endmember mixing models we estimate that between 1- 12% of the respired DIC at BB can be attributed to hydrocarbon remineralization. Bacterial abundances were an order of magnitude higher in BB than in AB and distinct differences in bacterial community clusters were observed between sites. Clone libraries are currently being sequenced to determine if these differences are due to the presence of oil degrading bacteria.

Session: 015 - 25

Track: Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-Omics and Biogeochemistry Approaches

Date: Wednesday, January 23 3:00 PM  
Type: Oral Presentation

## Louisiana brackish and salt marsh nitrification potential and microbial diversity following the Deepwater Horizon oil spill

**Presenter:** John Marton – LUMCON

**Authors:** John Marton, Louisiana Universities Marine Consortium; Brian Roberts, Louisiana Universities Marine Consortium; Anne Giblin, Marine Biological Laboratory; Anne Bernhard, Connecticut College

### Abstract:

We quantified the effects of the Deepwater Horizon oil spill on nitrification potential and microbial diversity in 13 brackish and salt marshes (6 unoiled, 7 oiled) from three regions across the Louisiana coast (Terrebonne and eastern and western Barataria Bays). We evaluated spatial variability by sampling along a transect of increasing distance from the marsh edge at each site. Samples were collected monthly from Terrebonne from May through September 2012 and in July and September from Barataria. Nitrification potential exhibited high variability ranging from 0 to 5,500 nM NO<sub>3</sub>-N/dry g/day. In Terrebonne soils, potentials peaked in July and consistently increased with distance from the marsh edge. Across all sites, nitrification was positively related to soil organic matter quantity and quality (%C, %N, C:N). Rates were significantly greater in July than September, though no difference was found between regions within either month. We found no effects of oil on nitrification rates two years post-exposure. We predict that variation in



# Science Abstracts

nitrification will be further explained by the abundance of ammonia-oxidizing bacteria.

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Session: 015 - 26

Track: Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-Omics and Biogeochemistry Approaches

Date: Wednesday, January 23 3:15 PM  
Type: Oral Presentation

## **In situ seasonal and annual changes in microbial communities of a Gulf of Mexico coastal salt marsh affected by the Deepwater Horizon oil spill**

**Presenter:** Melanie Beazley – University of Alabama

**Authors:** Melanie Beazley, University of Alabama; Patricia Sobecky, University of Alabama

### **Abstract:**

The microbial communities of a coastal Alabama marsh ecosystem affected by the Deepwater Horizon oil spill have been monitored since June 2010. The goals of this study were to determine how microbial populations changed during oil contamination and ascertain the long-term metastable microbial community structure. Microarray analyses of marsh sediment microbial populations demonstrated a significant increase after oil exposure and were dominated by the phyla Proteobacteria and Firmicutes. In addition, members of Vibrionales and Clostridiales significantly increased in abundance during oiling when compared to the following two years, suggesting a community structure shift due to oil exposure. Several members of these taxa are pathogenic and further analysis is currently being conducted to determine if strains isolated from the oil-impacted marsh contain virulence genes. These long-term data sets will identify bacteria metastable populations that will aid in assessing the impact of future perturbations to this sensitive ecosystem.

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Session: 015 - 27

Track: Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-Omics and Biogeochemistry Approaches

Date: Wednesday, January 23 3:30 PM  
Type: Oral Presentation

## **Anaerobic biodegradation of benzene in salt marsh sediment of the Louisiana Gulf coast**

**Presenter:** Kewei Yu – Troy University

**Authors:** Kewei Yu, Troy University; Jiou Yu, Loveless Academic Magnet Program High School; Rui Tao, Troy University

### **Abstract:**

The 2010 BP oil spill became the worst environmental disaster in US history with unprecedented damages to the environment. In this study benzene was selected as a representative of petroleum hydrocarbons to assess its anaerobic biodegradation potential in salt marsh sediment from the Louisiana Gulf coast. The experiment was conducted in two separate phases of incubation of the sediment slurries to determine the benzene biodegradation kinetics (phase-1), and to determine if any stimulation of benzene degradation occurred after benzene exposure (phase-2). Benzene biodegradation was assumed to follow Michaelis-Menten kinetics, and the Vmax was determined to be 1.66 mg g<sup>-1</sup> week<sup>-1</sup> and the Km to be 1.17 mg g<sup>-1</sup>. According to this model, it would take 11 weeks for 1 m<sup>2</sup> of the salt marsh to degrade 1 L of benzene. Benzene degradation rates were found to have a minimum increase after the sediment had been exposed to benzene for 4 weeks, which suggests that the sediment has almost reached its natural maximum biodegradation potential.

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Session: 015 - 28

Track: Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-Omics and Biogeochemistry Approaches

Date: Wednesday, January 23 3:45 PM  
Type: Oral Presentation

## **Mesocosm design for long term degradation of petroleum polycyclic aromatic hydrocarbons in emerged and submerged coastal sediments**

**Presenter:** Doorce Batubara – Louisiana State University

**Authors:** Doorce Batubara, Louisiana State University; Ronal F. Malone, Louisiana State University; Donald D. Adrian, Louisiana State University

### **Abstract:**

Oil spilled in the Gulf of Mexico may accumulate although mobility, biological uptake, and degradation processes take place. Crude oils contain abundant polycyclic aromatic hydrocarbons (PAHs) which can be toxic to many marine species in coastal environments.

Organic substances in crude oil are broken down by microbes in the coastal environment. One approach to study experimentally the biodegradation of contaminants of concern in crude oil is to develop mesocosms that can provide replicated looks at different scenarios. Mesocosm designs may have features essential for studies long term effects and degradation. Wave and tidal actions are believed to play roles in degrading polycyclic aromatic hydrocarbons in coastal water and sediment. Wave and tidal actions and topographical conditions govern whether wetland sediment will be submerged all the time or subject to periodic exposure to the atmosphere as it is emerged.



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## Abstract:

The objective of the study was to determine the mineralization rates and extents of naphthalene, a model polycyclic aromatic hydrocarbon (PAH) compound, in Alabama marsh sediments impacted by MC252 oil. Biometer flasks containing sediments and  $^{14}\text{C}$ -labeled and non-labeled naphthalene were incubated under saturated conditions at  $19\pm 1^\circ\text{C}$ . Sorption of naphthalene by sediments was  $43.7\pm 1.1\%$ . Biodegradation of naphthalene followed first-order kinetics. Mineralization of naphthalene ( $0.8\text{ mg/Kg}$  of dry sediment) by indigenous microorganisms in the sediments was  $7.5\pm 1.9\%$  after 33 days of incubation;  $^{14}\text{CO}_2$  production reached a plateau after 14 days. After inoculation of the sediments with an enrichment culture obtained from sediments collected from a heavily contaminated site, mineralization of  $^{14}\text{C}$ -naphthalene increased to  $36.2\pm 1.6\%$ . Naphthalene is the smallest and most readily biodegradable member of the PAH family. Its limited mineralization in Alabama coastal marsh sediments suggests that PAHs sorbed by marsh sediments are not readily available for biodegradation and prevailing anaerobic conditions may further limit biodegradation.

## Session: 015 -

Track: Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-Omics and Biogeochemistry Approaches

Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

### Anaerobic Degradation of Petroleum Hydrocarbon in the Sediments of Barataria-Terrebonne Estuary

**Presenter:** Raj Boopathy – Nicholls State University

**Authors:** Raj Boopathy, Nicholls State University

#### Abstract:

Enhanced biodegradation was attained under mixed electron acceptor conditions, where various electron-accepting anaerobes co-existed and aided in degrading complex petroleum hydrocarbon components of marsh sediments in the coastal Louisiana.

## Session: 015 -

Track: Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-Omics and Biogeochemistry Approaches

Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

### Biodegradation of naphthalene in marsh sediments of the Gulf of Mexico

**Presenter:** Yucheng Feng – Auburn University

**Authors:** Yucheng Feng, Auburn University; Reji Mathew, Auburn University

## Session: 015 -

Track: Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-Omics and Biogeochemistry Approaches

Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

### The effect of Deep Water Horizon oil on oxygen consumption and dissolved inorganic carbon production in north Florida beaches

**Presenter:** John Kaba – Florida State University - Oceanography

**Authors:** John Kaba, Florida State University; Stacia Dudley, Florida State University; Chris Hagan, Florida State University; Brian Wells, Florida State University; Markus Huettel, Florida State University

#### Abstract:

In June 2010, large amounts of Deep Water Horizon oil was washed up onto Pensacola beaches and buried as deep as 70 cm in the sediment. Our project investigates the fate of the embedded oil and its impact on sediment biogeochemistry. Cores of sand were taken monthly from Pensacola beach, Florida, and analyzed for oxygen consumption/DIC production. Sediment layers with oil showed potential oxygen consumption rates increased up to 7 times the consumption rates of clean layers in the same core. The clean layers immediately above and below the oiled layer showed oxygen consumption rates similar to clean layers further removed from the oil layer, indicated a localized impact of the concentrated oil and a lack of movement once the layer was embedded within the sediment. The correlation of DIC and oxygen consumption

# Science Abstracts

suggests complete aerobic mineralization of some of the buried oil compounds. Incubations of sand tar mixtures in seawater show that the oil increases oxygen consumption up to a certain concentration of oil, after which it decreases and DIC production remains relatively steady.

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## Session: 015 -

Track: Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-Omics and Biogeochemistry Approaches

Date: Wednesday, January 23 8:30 - 10:30  
Type: Poster

### **Effect of biosurfactant and nitrogen interaction on gas emission, oil hydrocarbons degradation and microbial community in a saline marsh soil**

**Presenter:** Chang Liu – Louisiana State University

**Authors:** Chang Liu, Louisiana State University Agricultural Center; Jim Wang, Louisiana State University Agricultural Center; Syam Dodla, Louisiana State University Agricultural Center

#### **Abstract:**

Decontamination of spill oils from marsh soils requires a delicate approach. Coastal marsh has been considered as one of the most dynamic systems that have complicated microbial diversity. Since the 2010 Deepwater Horizon Oil Spill happened, the impact of oil contamination to the marsh system was uncertain. Much of science relating the fate and impact of oil hydrocarbons is not well known. The objective of this study was to investigate the impact of biosurfactant and nutrient interaction on petroleum hydrocarbon degradation as well as the impacts of petroleum hydrocarbons to the environment and ecosystem, especially microbial community. Rhamnolipid was chosen as the biosurfactant in this research.

A microcosm experiment containing eight different treatments was established to evaluate the interaction of rhamnolipid biosurfactant and nitrogen nutrient on the degradation of crude oil in a saline marsh soil collected from Leeville, Louisiana. Respiring carbon gases and N<sub>2</sub>O from incubation jars along with total petroleum hydrocarbons remained in the marsh soil was monitored periodically throughout the microcosm experiment. Concentrations of carbon gases and N<sub>2</sub>O from incubation jars were determined using gas chromatography. In addition, replicates of each treatment were terminated at designated intervals and used for characterizing the microbial community. Our initial results showed that rhamnolipid biosurfactant treatment had much higher CO<sub>2</sub> and CH<sub>4</sub> emission rate than the other treatments without the biosurfactant. Nitrogen had a less effect on CO<sub>2</sub> and CH<sub>4</sub> emission but strong impact on N<sub>2</sub>O generation. Crude oil, on the other hand, appeared to inhibit N<sub>2</sub>O production. It was concluded that the use of rhamnolipid biosurfactant

and nitrogen leads to a different microbial diversity than the original marsh soil that could facilitate faster degradation of petroleum hydrocarbons in the marsh soil.

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## Session: 015 -

Track: Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-Omics and Biogeochemistry Approaches

Date: Wednesday, January 23 8:30 - 10:30  
Type: Poster

### **Biogeochemical controls on MC252 biodegradation on a coastal headland beach**

**Presenter:** John Pardue – Louisiana State University

**Authors:** John Pardue, Louisiana State University; Vijai Elango, Louisiana State University; Kendall R. Lemelle, Louisiana State University; Marilany Urbano, Louisiana State University

#### **Abstract:**

Biogeochemical conditions impacting the biodegradation of residual oil on a coastal headland beach in Louisiana were investigated. Studies described below investigated biodegradability of stable emulsified oil:sand aggregates, termed surface residue balls or SRBs, which represent the primary form of residual oil remaining on the beach environment. SRB aggregates were sampled across transects perpendicular to the beach from the intertidal to the supratidal from 2010-2012. Areas in the supratidal that were sampled were set aside for research purposes and not altered by any clean-up activities. Chemical and physical characteristics of SRBs were measured including concentrations of n-alkanes, PAHs, hopanes, nutrients, and electron acceptor concentrations (including O<sub>2</sub> microprofiles). Microbial characterization of SRBs was also conducted using DGGE and sequencing. Results focused on comparing and contrasting impacts of biogeochemistry on biodegradation of oil stranded in 3 beach microenvironments; supratidal surface; subtidal subsurface (permanently inundated) and intertidal subsurface samples (intermittently inundated). Supratidal samples were depleted in n-alkanes and lower-molecular weight PAHs. Changes in the PAH concentrations were followed in the field as compounds weathered within SRBs on the beach. Geochemically, aggregates located in these environments had low salinities (1.3-1.5 ppt), O<sub>2</sub> at near saturation throughout the aggregates and nutrient concentrations (N and P) significantly lower than SRBs deposited in the intertidal and subtidal. Intertidal and subtidal subsurface oil samples were characterized by elevated nutrient concentrations and salinities consistent with regular seawater inundation. Complete inundation leads to O<sub>2</sub> consumption in the aggregates after several days. Despite the presence of elevated nutrients, PAHs and n-alkanes were comparatively unweathered in the subtidal samples consistent with O<sub>2</sub> limitations.

# Science Abstracts

Sequences of known PAH degraders were isolated from the supratidal and intertidal aggregates but not those from the subtidal. The results support the hypothesis that SRBs deposited at different locations on the beach have different biogeochemical characteristics that strongly influence weathering patterns through biodegradation.

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## Session: 015 -

Track: Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-Omics and Biogeochemistry Approaches

Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

### **Metabolic activity of anaerobic microbial communities in salt marsh sediments impacted by the Deepwater Horizon oil spill.**

**Presenter:** Verlin Perry – Department of Biology, Georgia State University

**Authors:** V. Ryan Perry, Georgia State University; Michael S. Sanderson, Georgia State University; Nicholas A. Sutton, Georgia State University; Neem J. Patel, Georgia State University; Daniel M. Deocampo, Georgia State University; Kuk-Jeong Chin, Georgia State University

#### **Abstract:**

Sulfate- and Fe(III)-reducing, and methanogenic prokaryotes (SRP, FRP, MGP) play an important role in petroleum bioremediation by coupling terminal electron acceptor (TEA) reduction to anaerobic petroleum hydrocarbon (PHC) oxidation. Monitoring the metabolic activity of these groups in environments has been limited by a lack of quantitative tools. In this study, we monitored seasonal metabolic activity of SRP, FRP and MGP, and identified active microbial communities using molecular methods targeting mRNA transcript levels of key genes involved in anaerobic PHC oxidation and respiration in Deepwater Horizon oil spill-impacted estuarine salt marsh sediments in Bay Jimmy, LA. Montmorillonite clay was added to experimental sites to test whether its application accelerates PHC degradation. RNA and mRNA were isolated from contaminated surface sediments to a maximum depth of 15 cm in control and clay-amended sites. Primers targeting dissimilatory (bi)sulfite reductase (*dsrAB*), citrate synthase (*glcA*), methyl coenzyme M reductase (*mcrA*), and benzyl succinate synthase (*bssA*) genes were developed and amplified using RT-PCR and quantitative real time PCR (qPCR). Phylogenetic analyses of *glcA* and *bssA* mRNA clone sequences demonstrated that members of the aromatic hydrocarbon-degrading Geobacteraceae are metabolically active in control and clay-amended surface sediments. Phylogenetic analyses of SRP-specific 16S rRNA, and *dsrAB* and *mcrA* mRNA clone sequences revealed metabolically active SRP and MGP communities at both control and clay-amended sites dominated by *Desulfovibrio*, uncultured SRP groups, and

Methanosarcinales, respectively. qPCR analyses compiled over a year-long period revealed significant seasonal variation in SRP, FRP, MGP activities with *dsrA* transcript levels peaking in summer and *glcA*, *bssA* and *mcrA* peaking in winter. *BssA* and *glcA* transcript levels followed an identical trend, suggesting that anaerobic aromatic hydrocarbon degradation is dominated by the Geobacteraceae. The results of qPCR demonstrated ca.two-fold increase in transcript level for all genes in clay-amended sites compared to control sites. GC/MS analyses showed that the signature is consistent with expected compositions, namely dominance of n-alkane components of PHCs in situ.

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## Session: 015 -

Track: Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-Omics and Biogeochemistry Approaches

Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

### **Biochemical Oxygen Demand (BOD) in oil-polluted seawater samples treated with cactus plant-based mucilage**

**Presenter:** Deni-Maire Smith – University of South Florida

**Authors:** Deni-Maire Smith, University of South Florida; Daniela Stebbins, University of South Florida; Jose Leon, University of South Florida; Ryan Toomey, University of South Florida; Norma Alcantar, University of South Florida

#### **Abstract:**

Bioremediation can be an effective, environmentally friendly treatment for contaminated shorelines areas from marine oil spill disasters. The purpose of this study is to assess the non-toxic plant-based mucilage to help increase the natural biodegradation of the crude oil in seawater. The mucilage is natural biomaterial that has up to 55 sugars, mainly arabinose, galactose, rhamnose, xylose, glucose, and uronic acids and it has been proposed as natural oil dispersant. Preliminary studies show that mucilage can also increase biodegradation of the crude oil in seawater samples by adding a readily available source of carbohydrates to the system. BOD has been assessed in seawater samples with crude oil (0.5 to 50 g/L) using concentrations of mucilage (natural dispersant) ranging from 0.5 to 2000 mg/L, and comparing it to the effect with its similar Corexit 9500. These measurements have allowed us to the optimal biodegradation conditions as a function of dispersant concentration.

**Keywords:** oil spill, bioremediation, biostimulation, emulsification, Biochemical Oxygen Demand, Corexit, nopal, natural dispersant

# Science Abstracts

## Session: 016 Time Series Studies of the Impacts of Oil and Gas Releases in Northern Gulf of Mexico

Session: 016 - 1

Track: Time Series Studies of the Impacts of Oil and Gas Releases in Northern Gulf of Mexico

Date: Monday, January 21 10:30 AM  
Type: Oral Presentation

### Impact to deepwater corals from the Deep Water Horizon disaster

**Presenter:** Charles Fisher – The Pennsylvania State University

**Authors:** Charles Fisher, Pennsylvania State University; Pen-Yuan Hsing, Penn State; Bo Fu, Penn State; Carl Kaiser, WHOI; Dana Yoerger, WHOI; Erik Cordes, Temple; Harry Roberts, LSU; William Shedd, BOEM; Tim Shank, WHOI; Walter Cho, Point Loma Nazarene; Elizabeth Larcom, Penn State; Miles Saunders, Penn State; Jim Brooks, TDI Brooks Int.

#### Abstract:

During ongoing studies supported by BOEM and NOAA OER, repeat visits to 10 known deep-water coral sites in October 2010, 6 months after the beginning of the spill, found no apparent acute impact to corals at any of the sites >20 km from the Macondo well. However, a site discovered 11 km away from the well in late 2010 exhibited widespread signs of recent deleterious impact. Furthermore, brown floc removed from one coral contained hydrocarbons with fingerprints that matched oil from Macondo (White et al., 2012). Continued monitoring of this site has documented signs of recovery in some corals, however extensive tissue death and subsequent colonization of numerous other corals by hydroids was also observed. Additional exploration in the area around Macondo resulted in the discovery of 6 additional sites with colonial coral communities. Some of these sites did not exhibit obvious and widespread signs of stress or impact. However, at least one site, 6.5 km from the Macondo well and 13 km to the east of the other heavily impacted site, did exhibit widespread signs of stress and impact.

Session: 016 - 2

Track: Time Series Studies of the Impacts of Oil and Gas Releases in Northern Gulf of Mexico

Date: Monday, January 21 10:45 AM  
Type: Oral Presentation

### Time-series Monitoring the Subsurface Oil Plume released from Deepwater Horizon MC252 in the Gulf of Mexico

**Presenter:** Kenneth Lee – Centre for Offshore Oil, Gas and Energy Research (COOGER)

**Authors:** Kenneth Lee, Centre for Offshore Oil, Gas and Energy Research; Scott Ryan, Centre for Offshore Oil, Gas and Energy Research; Paul Kepkay, Centre for Offshore Oil, Gas and Energy Research; Zhengkai Li, Centre for Offshore Oil, Gas and Energy Research

#### Abstract:

The Deepwater Horizon MC252 wellhead, located in the Gulf of Mexico, released methane gas and oil under pressure at 1500m depth. During spill response operations, the decision was made to inject chemical oil dispersants directly into the wellhead in order to reduce the impact of the surface oil reaching sensitive coastal environments. Small oil droplets (<70 microns in diameter) resulting from both physical and chemical dispersion can remain entrained in the water column for months.

To comply with US EPA directives the R/V Brooks McCall and the R/V Ocean Veritas were tasked to monitor the efficacy and potential detrimental effects of subsurface dispersant additions. These vessels were equipped with in situ conductivity temperature and depth (CTD), Colored Dissolved Organic Matter (CDOM), and dissolved oxygen (DO<sub>2</sub>) sensors. During the study period, 193 station locations (4-5/day) were sampled between 0.5 and 185 km from the wellhead. Based on real-time data recovered during the CTD, CDOM, and DO<sub>2</sub> down-cast, sample depths were selected for the recovery of water to be used during analyses of Laser In Situ Scattering and Transmissometry (LISST) particle size, BTEX hydrocarbons (benzene, toluene, ethylbenzene, and xylene), and UV fluorescence (excitation: 280 nm emission: 340 nm).

Results of these data show a subsurface oil plume (generally between 1000m and 1300m) originating at the wellhead with low oil concentrations throughout the remainder of the water column. The strongest signals were observed near the wellhead during oil release and ambient levels decreased rapidly with distance in the direction of ocean currents along regional isobaths. Over four months, the dispersion and biological degradation of the oil on the ocean surface and subsurface plume was monitored to the “method detection limits” of our analytical protocols.

# Science Abstracts

Session: 016 - 3

Track: Time Series Studies of the Impacts of Oil and Gas Releases in Northern Gulf of Mexico

Date: Monday, January 21 11:00 AM  
Type: Oral Presentation

## Large-scale tracking of oil-derived hydrocarbons in the water column of the Gulf of Mexico after the Deepwater Horizon blowout

**Presenter:** Kathleen Watson – University of South Florida

**Authors:** Kathleen Watson, University of South Florida; Isabel C. Romero, University of South Florida; Steve Murawski, University of South Florida; David Hollander, University of South Florida

### Abstract:

Tracking the spatial and temporal distribution of petroleum released into the water column during the Deepwater Horizon blowout is critical to advancing our understanding of deep-water oil-well blowouts and their impacts. Using data from 16,467 water column samples collected and analyzed by NOAA and the US EPA, we developed spatial and temporal maps documenting the depth-distribution of polycyclic aromatic hydrocarbons (PAHs), BTEX (benzene, toluene, ethylbenzene, xylene), and n-alkanes (C<sub>5</sub>-C<sub>40</sub>). A sub-surface intrusion at 1000-1300 m depth occupied an estimated area of 4500 km<sup>2</sup> (or 1500 km<sup>3</sup>), with samples 10 km southwest of the wellhead containing a 400-fold increase in PAHs and BTEX compared to baseline concentrations from non-impacted sites. In coastal samples, concentrations of PAHs and BTEX were up to 150 times above baseline across 1200 km of coastline from Louisiana to Alabama. The results from this study will define areas of chemical exposure that have potential biological impacts and will provide empirical data for the validation of models of oil transport and fate.

Session: 016 - 4

Track: Time Series Studies of the Impacts of Oil and Gas Releases in Northern Gulf of Mexico

Date: Monday, January 21 11:15 AM  
Type: Oral Presentation

## Testing the Mechanisms of Sedimentary Oil Deposition in the Deep-Sea

**Presenter:** David Hollander – College of Marine Science, USF

**Authors:** University of South Florida: David Hollander, Isabel Romero, Patrick Schwing, Rebecca Larson, Kathleen Watson, Nicola Zinzola, Steven Murawski; Eckerd College: Gregg Brooks, David Hasting; Florida State University: Jeff Chanton; Georgia Tech: Joel Kostka

### Abstract:

Sediment cores from the DeSoto Canyon and in the area to the southwest of the Deepwater Horizon (DwH) blowout site indicate that petroleum interacted with and accumulated in the deep-sea sediments. Hypotheses that account for sedimentary oil deposition include, 1) direct contact between the sediments and the subsurface oil plumes (“toxic bath-tub ring”) 2), intense aggregation and sinking of oil-associated surface particles (the “dirty blizzard”), 3) transformation and selective sinking of pyrogenic petroleum components, and 4) flushing of terrestrial-derived components associated with the opening of river flood gates. Each mechanism defines a change in physical sedimentological conditions, is predicted by unique chemical indicators and results in distinct biological impacts and consequences. This study integrates high-resolution physical sedimentology, chronology, radio- and stable-isotopes, metal and redox-chemistry, molecular organic geochemistry, macro-faunal and microbial ecology in the regional analyses of pre- and post-DwH blowout sediments. Within the blowout region, coherent spatial and temporal patterns of changing sediment accumulation rates, sediment texture, benthic faunal abundance and diversity and organic matter sources emerge to document the mechanism(s) responsible for and the geographic and depth-related constraints on sedimentary oil deposition and its associated biological impacts.

Session: 016 - 5

Track: Time Series Studies of the Impacts of Oil and Gas Releases in Northern Gulf of Mexico

Date: Monday, January 21 11:30 AM  
Type: Oral Presentation

## In situ, time series measurements of benthic boundary layer water chemistry in the northern Gulf of Mexico using the Chimney Sampler Array (CSA)

**Presenter:** Christopher Martens – UNC-Chapel Hill

**Authors:** Christopher S. Martens, UNC Chapel Hill; Howard Mendlovitz, UNC Chapel Hill; Laura Lapham, UMCES

### Abstract:

Benthic landers equipped with Chimney Sampler Arrays (CSA) and light hydrocarbon monitoring sensors designed to measure in situ chemical and physical parameters at two minute intervals during six months monitoring experiments within the benthic boundary layer were deployed using ROVs at three upper slope sites in the northern Gulf of Mexico: MC118 (at 883m depth, 28° 51.28440'N, 88° 29.39421'W) featuring nearby gas hydrates, GC600 (1226 m, 27° 21.89061'N, 90° 33.84861'W) featuring natural hydrocarbon seeps and OC26 (1617m, 28° 42.45000'N, 88° 21.71800'W), providing background data. Landers at the latter two



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sites will surface in November 2012. The CSA on each lander includes two 30 cm diameter by 90 cm length cylinders (Chimneys) that seal against the sediment with lead pellet beanbags; within each chimney are optode, temperature, conductivity and methane sensors. External ambient instrumentation on the lander and Chimney exterior includes optodes, conductivity, temperature, pressure and turbidity sensors along with a single point acoustic Doppler current meter to measure temporal variation in ambient current velocity and direction at approximately one m above bottom. Chimney washout rates deduced from ambient current velocities multiplied by internal chimney O<sub>2</sub> minus ambient O<sub>2</sub> concentrations allow for calculations of net O<sub>2</sub> sediment-water fluxes. Over a six month period at MC118, ambient O<sub>2</sub> concentrations within a meter of the sediment surface ranged from 120 to 180  $\mu\text{M}$ . Chimney dissolved O<sub>2</sub> concentrations controlled by sediment demand ranged from ambient to near zero  $\mu\text{M}$  and were linked to variability in near bottom current velocities that ranged from near zero to over 25 cm/s. A systematically variable tidal range of 10 to 90 cm was observed throughout the deployment. Near ambient atmospheric saturation methane concentrations were observed over a three week period.

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## Session: 016 - 6

Track: Time Series Studies of the Impacts of Oil and Gas Releases in Northern Gulf of Mexico

Date: Monday, January 21 11:45 AM  
Type: Oral Presentation

### Deep-water sediment biogeochemical time-series data from MIMOSA (Microbial Methane Observatory for Seafloor Analysis)

**Presenter:** Laura Lapham – University of Maryland Chesapeake Biological Laboratory

**Authors:** Laura Lapham, University of Maryland Center for Environmental Sciences; Beth Orcutt, Bigelow Laboratory for Ocean Sciences; Peter Girguis, Harvard University; Geoff Wheat, University of Alaska at Fairbanks

#### Abstract:

An anomalously large amount of oil and dispersant was deposited on sediments surrounding the Macondo well following the Deepwater Horizon blowout. Sedimentary bacteria and archaea are known to breakdown natural and human-supplied oil and gas; however, it is not known how natural communities respond to such significant loading as occurred during this event. How did this oil impact deep-sea, in situ microbial biogeochemical processes? To address this question, we deployed the Microbial Methane Observatory for Seafloor Analysis (MIMOSA) for 7 months at a Macondo oil impacted site and a natural oil seep site. MIMOSA collects continuous, co-registered samples of methane, pore-water and fluids for microbial community genomic

analysis. Alongside other time-series measurements of seafloor physical (e.g. current direction and speed, temperature, and pressure) and chemical (e.g. oxygen, pH, methane) conditions, these experiments will provide unique temporally- and spatially-resolved records of benthic microbial distribution, composition, and activity.

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## Session: 016 - 7

Track: Time Series Studies of the Impacts of Oil and Gas Releases in Northern Gulf of Mexico

Date: Monday, January 21 12:00 PM  
Type: Oral Presentation

### Organic carbon remineralization stoichiometry – a useful indicator for detecting oil degradation in water column

**Presenter:** Xinping Hu – Texas A&M University - Corpus Christi

**Authors:** Xinping Hu, Texas A&M University Corpus Christi; Wei-Jun Cai, University of Georgia; Nancy N. Rabalais; Louisiana Universities Marine Consortium

#### Abstract:

Due to different carbon valents in different marine organic molecules (i.e., zero to slightly negative in surface produced organic matter and -4 in methane), it is expected that aerobic respiration utilizing these molecules will lead to different reaction stoichiometries, therefore the signal of hydrocarbon remineralization in the water column can be differentiated from that of marine produced organic matter remineralization. This hypothesis was tested in stratified shelf bottom waters in the northern Gulf of Mexico using multiple datasets collected in the summer. By comparing bottom water dissolved inorganic carbon and dissolved oxygen data, we found that after the Deep Water Horizon oil spill in July 2010, the bottom water DIC-O<sub>2</sub> relationship showed clear deviation from what have been observed in the previous years and the year 2011. Stable carbon isotope data from 2011 also appear to suggest that oil degradation was not detected one year after the spill. In addition, we also participated in the 2012 Summer Hypoxia Cruise and will provide an update on the findings for this year.



# Science Abstracts

Session: 016 - 8

Track: Time Series Studies of the Impacts of Oil and Gas Releases in Northern Gulf of Mexico

Date: Monday, January 21 12:15 PM  
Type: Oral Presentation

## Pre-and post-spill porewater DIC concentrations and d13C signatures of Gulf of Mexico sediments

**Presenter:** Andreas Teske – University of North Carolina at Chapel Hill

**Authors:** Luke McKay, University of North Carolina at Chapel Hill; Kelly Speare, University of North Carolina at Chapel Hill; Howard Mendlovitz, University of North Carolina at Chapel Hill; Andrea Hale, University of North Carolina at Chapel Hill; Tingting Yang, University of North Carolina at Chapel Hill; Lisa M. Nigro, University of North Carolina at Chapel Hill; Samantha B. Joye, University of Georgia; Christopher S. Martens, University of North Carolina at Chapel Hill; Andreas Teske, University of North Carolina at Chapel Hill

### Abstract:

We are comparing DIC porewater concentrations and d13C signatures of sediments on the Gulf of Mexico continental slope before and after the oil-derived sedimentation pulse. In early May 2010, surficial sediments near the Macondo wellhead showed consistent DIC concentrations (3 to 4 mM) and d13C signatures (– 3 to – 4 ‰) for moderately oligotrophic sediments from the continental margin. Sediments recovered in October 2010 from near the Macondo wellhead showed higher DIC concentrations (11 to 12 mM) that were indicative of recent C import and in-situ bioremineralization; however, d13C signatures (– 5 ‰) were only very slightly depleted compared to pre-spill levels. Duplicate cores taken in May and October that were not in the vicinity of probable oil deposition demonstrate consistent DIC concentrations and isotopic values. We are working on linking the DIC porewater dataset to microbial community composition, to gain insight into the microbial pathways of carbon remineralization after the arrival of the oil-derived sedimentation pulse of the seafloor near the DWH site.

Session: 016 - 9

Track: Time Series Studies of the Impacts of Oil and Gas Releases in Northern Gulf of Mexico

Date: Monday, January 21 2:00 PM  
Type: Oral Presentation

## Total Scanning Fluorescence (TSF) determination of Petroleum in the Water Column in the Vicinity of the Deepwater Horizon Spill

**Presenter:** Terry Wade – Texas A&M University

**Authors:** Terry Wade, Texas A&M University; Stephen Sweet, Texas A&M University; Jose Sericano, Texas A&M University; Dawei Shi, Texas A&M University; Norman Guinasso, Texas A&M University

### Abstract:

Sources of hydrocarbons in the water column include spills, natural seepage, oil production activities, ship activities, coastal run-off and atmospheric deposition. Total scanning fluorescence (TSF) is an effective screening tool to detect the presence of aromatic compounds derived from petroleum in environmental samples. TSF analyses of over 300 discreet water samples collected at various depths throughout the water column during and soon after the Deepwater Horizon (DWH) Spill detected aromatic hydrocarbons (Wade et.al, 2011 a,b) in some samples. Selected samples analyzed for polycyclic aromatic hydrocarbons (PAH) confirmed the presence of petroleum in samples with elevated TSF. Additional water samples (337) were collected through out the water column in July 2012 on the R/V Pelican in the vicinity of the DWH and extracted for TSF analysis. Larger water volumes (2 to 4 L) were collected to at selected depths to provide lower detection limit to better characterize low concentrations. The presence and spatial extent of petroleum two years following the spill will be presented.

Session: 016 - 10

Track: Time Series Studies of the Impacts of Oil and Gas Releases in Northern Gulf of Mexico

Date: Monday, January 21 2:15 PM  
Type: Oral Presentation

## Laboratory Degradation of Oil-derived Hydrocarbons in Coastal Sediments

**Presenter:** Daniel Fields – University of Alabama

**Authors:** Daniel Fields, University of Alabama; Yuehan Lu, University of Alabama

### Abstract:

To better understand the impact of the BP Deepwater Horizon and future oil spills on the Gulf of Mexico coast this study assesses the biodegradation of alkanes and polycyclic aromatic hydrocarbons (PAH) in

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coastal sediments. Sediment from Bayou La Batre, Alabama was spiked with 500ppm Macondo oil for a time series experiment with sampling points at 0, 6, 12, 24, 48, 168, and 336 hours. We characterized the composition and concentrations of alkanes and PAHs, and the concentrations of nutrients (nitrate, nitrite, ammonium, phosphate). Results show approximately 68% alkane degradation after six hours with a degradation rate of 49 ppm/hour, and 75% degradation after 14 days. Low molecular weight ( $\leq C_{17}$ ) alkanes were preferentially degraded over high molecular weight ( $> C_{17}$ ) alkanes during the first 24 hours, and normal alkanes were not preferentially degraded over isoprenoid alkanes. Total PAHs decreased approximately 27% within the first six hours and did not show apparent decreases afterwards. Phosphate was actively utilized, decreasing by 86%, whereas nitrogen species concentrations remained relatively constant throughout the experiment.

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**Session: 016 - 11**

Track: Time Series Studies of the Impacts of Oil and Gas Releases in Northern Gulf of Mexico

Date: Monday, January 21 2:30 PM  
Type: Oral Presentation

## **Experimental Time Series Studies of the Impacts of Oil and Dispersant Contamination on Salt Marsh Sediment Geochemistry**

**Presenter:** Rona Donahoe – The University of Alabama

**Authors:** Rona J. Donahoe, University of Alabama

### **Abstract:**

Two sets of time series experiments were conducted to examine the impacts of oil and dispersant contamination on the geochemistry of seawater/sediment microcosms. Coastal sediment and seawater were collected from a salt marsh near Bayou la Batre, Alabama, which was not severely impacted by the BP Deepwater Horizon accident of April 2010. Sediment/seawater microcosms were constructed in 500 ml glass jars pre-combusted for 5 hours at 450 degrees C. Non-sterile microcosms spiked with 500 ppm of MC-252 oil or with 500 ppm of COREXIT 9500 dispersant were sacrificed in duplicate at various time intervals over a 21 day period to establish data time series for each contaminant. Sterile controls with and without oil/dispersant and a non-sterile control without oil/dispersant were sacrificed in duplicate for comparison with the time series microcosms. Solid and aqueous phases were separated by centrifugation and prepared for analysis. Sediment mineralogy was determined using X-ray diffraction and nitric acid-extractable sediment chemistry was determined using EPA Method 3051A and ICP-OES analysis. The aqueous phase major, minor and trace element

concentrations were determined by ICP-OES, ICP-MS and ion chromatography.

The mineralogy of the salt marsh sediment is predominantly quartz, but includes reactive phases such as clays (smectite, illite), feldspar, and iron oxide. Iron-bearing clays and iron oxides can serve as electron acceptors for the growth of Fe(III)-reducing bacteria. Microwave digestions of the microcosm substrate samples were performed in triplicate and show no significant variation in major element chemistry over the course of the three week experiment, suggesting that observed temporal trends in aqueous geochemistry may be due to ion exchange processes, rather than mineral dissolution reactions. Microcosm substrate trace element data which indicate possible changes with time are being analyzed for statistical significance.

Analysis of aqueous solution geochemistry revealed some interesting temporal trends. Iron and manganese were released to solution after 2 days, suggesting the presence of facultative anaerobic bacteria which utilize iron-bearing minerals in the sediment as electron receptors. The presence of oil-degrading and iron-reducing bacteria in the salt marsh sediment and microcosm substrates was confirmed in a separate microbiological study.

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**Session: 016 - 12**

Track: Time Series Studies of the Impacts of Oil and Gas Releases in Northern Gulf of Mexico

Date: Monday, January 21 2:45 PM  
Type: Oral Presentation

## **In situ characterization of distributions of dissolved gases and light hydrocarbons using underwater membrane introduction mass spectrometry**

**Presenter:** Tim Short – SRI International

**Authors:** R. Timothy Short, SRI International; Strawn K. Toler, SRI International

### **Abstract:**

Versatile in situ analyzers are needed to locate, quantify, map, and monitor chemical compounds in underwater environments for basic scientific and environmental analysis reasons. A mass spectrometer is a versatile analyzer with capabilities that far exceed traditional in situ underwater chemical sensing techniques with respect to dynamic range, sensitivity, and selectivity to a broad range of analytes. The ability to perform in situ mass spectrometry greatly enhances both spatial and temporal densities for environmental chemical analysis. Real-time chemical measurements also allow rapid decision making and lead to the possibility of adaptive sampling strategies. SRI International's in situ

# Science Abstracts

membrane introduction mass spectrometry (MIMS) instruments can quantitatively detect light hydrocarbons in water at trace levels, while simultaneously monitoring the concentrations of all light, stable dissolved gases to a depth of 2000 meters. Recent deployments of the MIMS systems in the Gulf of Mexico will be discussed.

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Session: 016 - 13

Track: Time Series Studies of the Impacts of Oil and Gas Releases in Northern Gulf of Mexico

Date: Monday, January 21 3:00 PM  
Type: Oral Presentation

## A Technique for Qualitative Observation of Hydrocarbon Seeps Location and Movement Over Varying Temporal and Spatial Scales

**Presenter:** Kevin Martin – University of Southern Mississippi

**Authors:** Kevin M. Martin, University of Southern Mississippi; Vernon Asper, University of Southern Mississippi; James Davis IV, University of Southern Mississippi

### Abstract:

All over the world hydrocarbon seeps have been observed using various techniques over the years. The most recent technique is the use of acoustics to map seep sites and to quantify the seepage amounts. However, repeated measurements at some sites have noticed that seeps either are no longer there or appear to have moved. In an attempt to better understand hydrocarbon seeps movement, a small, easy to deploy, low cost, low powered system was developed to monitor hydrocarbon seeps over extended periods of time. This experiment uses an Imagenex Sector Scanning Sonar, with the capability to scan 360 degree with varying range (0-200m), frequency (175kHz to 1.1MHz), gain (0-40db) and spatial resolution (0.3-2.40/ping) to observe hydrocarbon seeps. This sonar uses less than 5W at 24v and can be controlled by a low power computer. The system was deployed ~3.5m above the sea-floor in ~850m of water at the Gulf of Mexico Gas Hydrates Sea-floor Observatory, site MC118 on the Mineral Management Resources Institute mobile observatory lander. A high resolution data set was collected over three weeks at this site, during which time, a one day continuous scanning with varying frequencies (175, 310 and 675kHz) and gain (10-40db) were recovered over 5-200m range increments, to identify the optimal settings for range. Furthermore, eight one-hour, scans per day were conducted at predetermined settings with varying ranges from 5-200m. CTD data were simultaneously collected to help identify environmental factors that may lead to seep movement.

Session: 016 - 14

Track: Time Series Studies of the Impacts of Oil and Gas Releases in Northern Gulf of Mexico

Date: Monday, January 21 3:15 PM  
Type: Oral Presentation

## Multi-phase Partitioning Behaviour of Xenobiotic Compounds in Crude Oil/Natural Gas/Seawater Systems

**Presenter:** Andrew Stopford – University of Calgary

**Authors:** Andrew Stopford, University of Calgary; Thomas Oldenburg, University of Calgary; Steve Larter, University of Calgary

### Abstract:

Xenobiotic compounds are exogenous chemical species, not normally synthesised by a host organism, which have the potential to induce acute/chronic toxicity symptoms or cause death in extreme cases. Fossil fuels have been identified as a major source of such compounds and their release into the environment typically follows anthropogenic use or accidental spillage. Significant interest in the environmental fate of crude oil components in marine environments followed the release of large quantities of oil from the Macondo well during 2010. Here we describe a novel device that will allow the measurement of partition coefficients for low molecular weight compounds, including BTEX and alkylated phenols, under conditions that simulate the high pressure/low temperature environment at the site of deep submarine oil and gas releases. This approach will provide key information required by near- and far-field distribution models for the accurate prediction of environmental fate and crude oil component distribution along with their potential for interaction with various trophic groups.

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Session: 016 - 15

Track: Time Series Studies of the Impacts of Oil and Gas Releases in Northern Gulf of Mexico

Date: Monday, January 21 3:30 PM  
Type: Oral Presentation

## Ensemble Dynamics and Bred Vectors

**Presenter:** Nusret Balci – University of Arizona

**Authors:** Nusret Balci, University of Arizona; Anna Mazzucato, Penn State; Juan Restrepo, University of Arizona; George Sell, University of Minnesota

### Abstract:

We present recent work on the the dynamics of ensembles and a modified bred vector methodology.

The goals of the new method include better robustness and filtering spurious outcomes associated with the similar technologies while keeping some of the better qualities and nonlinear nature. Case studies on a few

# Science Abstracts

examples are also provided. Joint work with Anna Mazzucato, Juan Restrepo, and George Sell.

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**Session: 016 - 16**

Track: Time Series Studies of the Impacts of Oil and Gas Releases in Northern Gulf of Mexico

Date: Monday, January 21 3:45 PM  
Type: Oral Presentation

## **Developmental Impacts of Macondo-252 crude and Corexit-9500 on the embryogenesis of the Gulf killifish, *Fundulus grandis***

**Presenter:** Charles Brown – Louisiana State University

**Authors:** Charles Brown, Louisiana State University; Chris Green, Louisiana State University AgCenter; Adam Kuhl, Louisiana State University AgCenter; Fernando Galvez, Louisiana State University

### **Abstract:**

The use of dispersants to remediate the effects of the Deepwater Horizon oil spill is controversial due to the possible synergistic effects of weathered oil and dispersant on coastal biota. The interactive effects of weathered oil and dispersant on the embryogenesis of the Gulf killifish (*Fundulus grandis*) were tested using laboratory mesocosms that were constructed using sediment and water spiked with oil, dispersant, or in combination. Sediment and water were collected from these mesocosms at 1, 4, or 16 weeks, and then used in exposures to Gulf killifish embryos. Treatment water exposed to both oil and dispersant appears to be the most toxic, with toxicity declining as weathering time increases. When exposed to water fractions from the mesocosms weathered for 1 week, pre-hatch embryonic heart rate was significantly lower in combined oil-dispersant exposure, compared to those exposed to the other treatments across weathering time. On-going experiments are studying the effects of mesocosm sediments on Gulf killifish embryos.

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**Session: 016 - 17**

Track: Time Series Studies of the Impacts of Oil and Gas Releases in Northern Gulf of Mexico

Date: Monday, January 21 4:00 PM  
Type: Oral Presentation

## **A Local Non-parametric Technique for the Calculation of Trends in Multiscale Time Series**

**Presenter:** Darin Comeau – University of Arizona

**Authors:** Darin Comeau, University of Arizona; Juan Restrepo, University of Arizona; Hermann Flaschka, University of Arizona

### **Abstract:**

The challenge involved in de-trending signals typical of shelf flows and oil dynamics is that they are strongly affected by remote conditions. This means that when using conventional de-trending methodologies, it becomes important to include information at spatial and temporal scales that are many times larger than the area of interest. In real world systems, this data is not always available. We propose a methodology for producing a trend or tendency of a data set that does not make use of any parametric or statistical framework, and is defined in precise mathematical terms. The highly local nature of our methodology can be exploited in these cases, reducing the need for information external to the area and times of interest.

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**Session: 016 -**

Track: Time Series Studies of the Impacts of Oil and Gas Releases in Northern Gulf of Mexico

Date: Monday, January 21 16:30 - 18:30  
Type: Poster

## **Absolute nannofossil abundances in the De Soto Canyon pre- and post-spill sediments**

**Presenter:** Aisha Agbali – Florida State University

**Authors:** Aisha Agbali, Florida State University; Benjamin Flower, University of South Florida; Susan Foley, Florida State University; Nicholas Myers, Florida State University; Sherwood Wise, Florida State University

### **Abstract:**

Calcareous nannoplankton are important phytoplankton and one of the major primary producers in the Gulf of Mexico (GOM). Variations in their abundance in the underlying sediments through time and space indicate a response to changes in the physical and nutrient conditions of the water. Hence, calculation of absolute nannofossil abundances in the De Soto canyon sediments is valuable for stratigraphic evaluation of post-spill effects on the assemblages. In addition, it provides a tool to examine possible causes of the high sedimentation rate recorded in the GOM in some sediment cores.

We report here the results of quantitative estimates of nannofossil fluxes in the De Soto Canyon sediments using the filtration technique and present the variations in their accumulation rates before, during and after the 2010 Macondo oil spill.

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Session: 016 -

Track: Time Series Studies of the Impacts of Oil and Gas Releases in Northern Gulf of Mexico

Date: Monday, January 21 16:30 - 18:30  
Type: Poster

## Polycyclic aromatic hydrocarbon concentrations across the Florida Panhandle Bight Shelf after the BP MC 252 well failure

**Presenter:** Richard Snyder – CEDB-University of West Florida

**Authors:** Richard Snyder, University of West Florida; Wade Jeffrey, University of West Florida; Melissa Ederington Hagy, University of West Florida; Frederick Hileman, University of West Florida; Joseph Moss, University of West Florida; Lauren Amick, University of West Florida; Rebecca Carruth, University of West Florida; Marie Gaona, University of West Florida; Joel Marks, University of West Florida

### Abstract:

The continental shelf of the West Florida Panhandle Bight in northeastern Gulf of Mexico on was sampled monthly for 1.5 years to determine the presence and fate of midwater dispersed oil upwelling out of DeSoto Canyon onto the shelf, shallower dispersed oil coming up onto the shelf, and sinking oil from floating patches that covered the shelf. Three transects were established due south of Pensacola and Destin and running SSW from Panama City. Triplicate Shipek® grab samples of sediments were taken with surface layers collected as composite samples. Sediments were extracted using standard techniques, and selected indicator polycyclic aromatic hydrocarbons (PAHs) were quantified as Naphthalenes, Phenanthrenes, and Chrysenes by GCMS using <sup>13</sup>C standards. Samples from June 2010 during the spill showed 10-165 PPB PAHs, with higher concentrations mid-shelf. Subsequent cruises have yielded variable, decreasing, and trace amounts of PAHs, suggest the residual hydrocarbons from the BP MC252 well failure have degraded to background in the Gulf of Mexico

Session: 016 -

Track: Time Series Studies of the Impacts of Oil and Gas Releases in Northern Gulf of Mexico

Date: Monday, January 21 16:30 - 18:30  
Type: Poster

## Coquina (Donax spp.) as an indicator of oil spill impact to sandy beach shorelines

**Presenter:** Richard Snyder – CEDB-University of West Florida

**Authors:** Richard Snyder, University of West Florida; Alexandra Vestal, University of West Florida; Christina Welch, University of West Florida; Gracie Barnes, University of West Florida; Robert Pelot, University of West Florida; Melissa Ederington Hagy, University of West Florida; Frederick Hileman, University of West Florida

### Abstract:

The Mussel Watch status and trends monitoring program provides estimates of bioavailable pollutants by using filter-feeding bivalves as indicators. Along the Gulf of Mexico Coastline, These stations are situated in estuaries utilizing oysters as sentinels. The BP MC252 well failure April 2010 highlighted the lack of indicator species along the sandy beaches to monitor contamination of the coastal environment. We began monthly collections of Coquina clams (*Donax* spp.) from the surf zone of Florida Panhandle bight beaches to monitor PAH contamination from the well failure. These clams concentrated PAHs relative to water and sand collected from the surf zone, and allowed us to continue to monitor PAH levels after water and sand levels became non-detect. The Coquina tissues indicated that the PAHs from the oil spill had cycled through the system one year after oil landed on panhandle beaches. Our work suggests these surf zone molluscs may be effectively used as biomonitors of pollutants along high energy sandy beach shorelines.

Session: 016 -

Track: Time Series Studies of the Impacts of Oil and Gas Releases in Northern Gulf of Mexico

Date: Monday, January 21 16:30 - 18:30  
Type: Poster

## Increase in Nickel and Vanadium Concentrations in Sea Bottom Sediment Collected from the Continental Shelf off of Western Florida after the Deepwater

**Presenter:** David Steffy – Jacksonville State University

**Authors:** David Steffy, Jacksonville State University; Al Nichols, Jacksonville State University; Joe Morgan, Jacksonville State University; Billy Bonner, Jacksonville State University; Rachael Gibbs, Jacksonville State University

### Abstract:

Forty-five (45) sea-bottom sediment samples were collected over a three year period from the carbonate continental shelf off of western Florida. This three year period includes and brackets the BP Deepwater Horizon Oil Spill of 2010. The samples were analyzed for trace metals including nickel (Ni) and vanadium (V). A comparative analysis of the trace metal concentrations indicates that there is a statistically significant increase in Ni and V concentrations in sea-bottom sediment after the oil spill, and the V-Ni ratio ( $V / (V + Ni)$ ) increased as well. Crude oil is known to contain Ni and V, and the ratio has been used as a fingerprint for the crude oil source. We propose this change in Ni and V concentrations is related to the oil spill and the use of dispersants (which also contain trace metals) to alleviate the spill effects.



# Science Abstracts

## Session: 017 Technological, Environmental and Policy Developments for Improved Research and Operations in the Gulf of Mexico

### Session: 017 - 1

Track: Technological, Environmental and Policy Developments for Improved Research and Operations in the Gulf of Mexico

Date: Monday, January 21 10:30 AM

Type: Oral Presentation

### Summary of EPA's Five-Year Oil Spill Research Strategy

**Presenter:** Albert Venosa – U.S. EPA

**Authors:** Albert D. Venosa, U.S. Environmental Protection Agency

#### Abstract:

EPA's Oil Spill Research Program has been conducting research since 1990. The Deepwater Horizon (DWH) spill highlighted the need for innovative spill response technologies and raised questions relative to the use of dispersants and acute and chronic health effects for responders and communities. Consequently, EPA developed a multi-year research strategy on potential human and environmental risks from oil spills and the application of dispersants, surface washing agents, bioremediation agents, and other mitigation measures. The goal of the research program is to provide environmental managers with the tools, models, and methods needed to mitigate the effects of oil spills in all environments, emphasizing the coastal and inland environments. The proposed research is composed of several themes incorporating research to: (1) develop a better understanding of the impacts of oil spills and dispersants on the environment, (2) develop innovative technologies to mitigate the impact of oil spills, and (3) address the technical needs of the communities impacted by the DWH oil spill.

### Session: 017 - 2

Track: Technological, Environmental and Policy Developments for Improved Research and Operations in the Gulf of Mexico

Date: Monday, January 21 10:45 AM

Type: Oral Presentation

### Post-remediation restoration of heavily oiled Louisiana salt marshes

**Presenter:** Michael Blum – Tulane University

**Authors:** Brittany Bernik, Tulane University; Michael Blum, Tulane University

#### Abstract:

Louisiana marshes that were heavily oiled during the Deepwater Horizon spill have become a test bed for linking shoreline remediation and restoration approaches. In Bay Jimmy, experimental re-vegetation of impacted marshes using *Spartina alterniflora* was carried out to evaluate strategies to minimize damages from oiling and treatment. Trials made use of plants from multiple genetic lines to evaluate the impact of genotype selection on shoreline recovery. Prefabricated propagation technologies also were designed and assessed as a potential tool for rapid deployment and to stimulate new growth with minimal labor and shoreline impact. Results indicate that survival significantly varies across genotypes used for restoration, particularly following storm events. The test treatments also demonstrated that genotypes exhibit variation in functional traits that influence shoreline stability, which suggests that the trajectory of marsh recovery following oil exposure and treatment is determined by the genetic identity of plants that naturally reestablish or that are chosen for restoration.

### Session: 017 - 3

Track: Technological, Environmental and Policy Developments for Improved Research and Operations in the Gulf of Mexico

Date: Monday, January 21 11:00 AM

Type: Oral Presentation

### Gulf of Mexico Research Priorities Identified Based on Input from Thousands

**Presenter:** Stephen Sempier – Mississippi-Alabama Sea Grant Consortium

**Authors:** Stephen H. Sempier, Mississippi-Alabama Sea Grant Consortium; LaDon Swann, Mississippi-Alabama Sea Grant Consortium and Auburn University

#### Abstract:

The Gulf of Mexico Research Plan (GMRP) was developed based on input from more than 1,200 people from diverse disciplines and organizations across the Gulf of Mexico. The GMRP was released just months before the Deepwater Horizon (DWH) oil spill and has been used to inform strategic plans from organizations and agencies across the region. In addition, organizations have funded tens of millions of dollars of worth of research based on the priorities identified in the GMRP. The amount of new resources that have already been committed and additional funds still to be devoted to research in the Gulf of Mexico over the next decade is unprecedented. This provides an opportunity for more research to be conducted and increases the demand to ensure that highest priorities needs are met in a coordinated manner. In response to the DWH oil spill, the GMRP is being updated. The update is based on input collected through three surveys and at least eight workshops reports that occurred

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Session: 017 - 5

Track: Technological, Environmental and Policy Developments for Improved Research and Operations in the Gulf of Mexico

Date: Monday, January 21 11:30 AM  
Type: Oral Presentation

## Affinity-based hydrocyclone filter for oil-water separation and oil spill cleanup

**Presenter:** Volodymyr Tarabara – Michigan State University

**Authors:** Volodymyr Tarabara, Michigan State University; Seth Hogg, Michigan State University; Abdul Motin, Michigan State University; Emily Tummons, Michigan State University; Pengyu Ji, Michigan State University; Wenqian Shan, Michigan State University; Andre Benard, Michigan State University; Merlin Bruening, Michigan State University

### Abstract:

Teh project aims to combine oleophilic and hydrophilic membranes with rotating, hydrocyclonic flow to create a technology that rapidly separates oil-water mixtures, such as those from oil spills, into dewatered and deoiled streams. The hypothesis of the work is that the rotational flow will force oil droplets toward the central oleophilic membrane to reduce fouling of the outer hydrophilic membrane and enhance the purity of both the oil whickered by the central oleophilic membrane and the water exiting the outer membrane. The work includes development of superoleophilic membranes to continuously whicker oil, creation of hydrophilic, regenerable coatings to mitigate fouling, predictive and diagnostic modeling of hydrocyclone flow for performance optimization, and design of pilot scale devices.

A series of meetings with Louisiana and Michigan residents affected by recent oil spills (BP's Gulf of Mexico spill and Enbridge's Kalamazoo River spill) is planned to engage and connect these communities. Presentations will demonstrate this research, which is devoted to rapid oil-spill response as well as potential reclamation of water used by the oil industry. The outreach will demonstrate that communities have a stake in research projects aimed at addressing the significant human health and environmental risks posed by oil spills.

The combination of hydrocyclonic separation and affinity-based selectivity of membranes should yield a water stream that meets standards for discharge into the environment and an oil stream sufficiently dewatered for energy use. This technology can reduce the risk of delays in treating large and small oil spills, and reassure communities that there will be a deployable technology that enables a rapid response to contamination of water with oil.

shortly after the DWH oil spill to present. Results are being analyzed from the GMRP oil spill related survey with 1,000 responses, the White House Subcommittee on Science and Technology oil spill conferences, Gulf of Mexico Alliance input sessions, Gulf Coast Ecosystem Restoration Task Force Science Plan and many other resources. In addition, a matrix has been developed that identifies commonly occurring priorities across the multitude of post-oil spill meetings and workshops compared to the original GMRP priorities. This presentation will highlight the approach that is being used to update the GMRP, results to date, and methods for people to become engaged in the process, including a questionnaire offered at the presentation. Finally, there will be a brief discussion regarding opportunities for sponsors of research in the region to work collaboratively to find opportunities to make efficient use of resources and explore strategies to jointly contribute to large-scale research efforts.

Session: 017 - 4

Track: Technological, Environmental and Policy Developments for Improved Research and Operations in the Gulf of Mexico

Date: Monday, January 21 11:15 AM  
Type: Oral Presentation

## Advanced Oil-Water Separation Technology for Oil Spill Cleanup and other Oil & Gas Remediation Problems

**Presenter:** Eric Hoek – UCLA Civil & Environmental Engineering

**Authors:** Eric M. V. Hoek, UCLA; Subir Bhattacharjee, University of Alberta

### Abstract:

Over the years, we have explored an array of oil-water emulsion breaking and separation processes including: coagulation/flotation, electro-coagulation, hydrocyclones and centrifugation as well as media and membrane filtration. These basic studies gave rise to some new approaches to oil-water separation, some of which were employed in the oil spill cleanup in the Gulf of Mexico. This talk will begin with a review of our oil-water separations research focusing on how it informed and enabled our work in the Gulf of Mexico, which will also be described. Finally, we will present our current research focused on next-generation solutions for water treatment and remediation problems the oil and gas industry will face in the 21st century. This includes topics as diverse as oil spill cleanup, oil sands tailing ponds cleanup and produced water treatment – the latter shaping up as the central environmental aspect of oil and gas E&P with significant implications on technology, economics, water footprint, and energy intensity of these operations.

# Science Abstracts

Session: 017 - 6

Track: Technological, Environmental and Policy Developments for Improved Research and Operations in the Gulf of Mexico

Date: Monday, January 21 11:45 AM  
Type: Oral Presentation

## Foundations for a Kinetic Model of Weathering Complex Petroleum Products in Natural Waters

**Presenter:** John McIlroy – Michigan State University

**Authors:** John W. McIlroy, Michigan State University; Victoria L. McGuffin, Michigan State University; A. Daniel Jones, Michigan State University

### Abstract:

In order to guide effective responses to spills of petroleum products, improved understanding of the rates of dispersion is needed. The development of predictive models for transport and weathering of individual petroleum constituents is central to decision-making. In the current study, a diesel/water microcosm has served as a model fuel spill, and temporal changes in diesel composition have been assessed during evaporation and weathering using gas chromatography-mass spectrometry (GC-MS). Kinetic rate constants were calculated for known and putatively annotated constituents. Rate constant models were then developed based on temperature and structure-retention relationships for different compound classes, including aliphatic and aromatic classes. The models were validated by interpolation and extrapolation of rate constants for structurally related compounds. Models based on GC-MS structure-retention relationships will allow for rapid assessment and decision-making during petroleum spills. Partial funding was provided by the U. S. Environmental Protection Agency.

Session: 017 - 7

Track: Technological, Environmental and Policy Developments for Improved Research and Operations in the Gulf of Mexico

Date: Monday, January 21 12:00 PM  
Type: Oral Presentation

## Cleanup of Heavily Oiled Salt Marsh during the Deepwater Horizon Oil Spill: I. Adaptive Field Testing and Operational Treatments

**Presenter:** Scott Zengel – Atkins

**Authors:** Scott Zengel, Atkins; Eric Schneider, Atkins; Jacqueline Michel, RPI

### Abstract:

The Deepwater Horizon oil spill resulted in heavy persistent oiling conditions in the salt marshes of Northern Barataria Bay, Louisiana, more so than elsewhere in the Gulf of Mexico. Due to the degree and nature of

oiling, traditional marsh cleanup methods were not effective. There was concern that marsh recovery in this area could be at risk without further intervention. The competing concern was that aggressive cleanup could cause further marsh damage, delaying or limiting recovery, as has been observed following many spills. Due to these factors, an adaptive marsh treatment testing program was developed. The goal was to identify treatments that would remove and/or reduce detrimental oiling conditions and enhance marsh recovery without causing further marsh damage. Treatment methods that showed initial promise were replicated in standardized test plots, for comparison with sets of control and reference plots. Early test results were used to develop an operational-scale treatment plan, applied across roughly 11 km of shoreline. The treatments used in this case would not be appropriate for the majority of oil spills in salt marshes, and in many situations, could result in further damage. Even during this spill, only the most heavily oiled marshes were intensively treated; a small fraction of the nearly 800 km of marsh shorelines oiled across the Gulf. Natural recovery was the recommended approach for the majority of oiled marshes. This presentation will focus on the treatment testing process, the effectiveness and environmental effects of the various test treatments, and adaptive changes to treatments methods applied at the operational scale.

Session: 017 - 8

Track: Technological, Environmental and Policy Developments for Improved Research and Operations in the Gulf of Mexico

Date: Monday, January 21 12:15 PM  
Type: Oral Presentation

## Microbial biosurfactants for potential use in oil-spill remediation

**Presenter:** Andrew Nyman – Louisiana State University

**Authors:** Andy Nyman, LSU AgCenter; B.P. Lamsal, Iowa State University; M.E. Marti, Iowa State University; W.J. Colonna, Iowa State University; P. Patra, Columbia University; C. Green, LSU AgCenter; A.J. Kuhl, LSU AgCenter; K. Jarrell, Modular Genetics, Inc.; P. Somasundaran, Columbia University; C.E. Glatz, Iowa State University

### Abstract:

Biosurfactants are biodegradable, and less toxic and have potential for oil-spill remediation. Lipopeptide Surfactin from *Bacillus subtilis*, and engineered variant, fatty acyl-glutamate (FA-Glu) were produced via fermentation. Isoforms of these biosurfactants will be purified and surface-active properties, and toxicity studied. Glucose-based media had surfactin 15X higher than FA-Glu in foam-enriched fraction. Critical micelle concentration (CMC), and dispersant-to-oil ratio (DOR), indicated that biosurfactants were comparable to conventional surfactants in DI water; at 0.35 ppm saline, CMCs were higher. DOR of

# Science Abstracts

surfactin was 1:96 in DI-water and 1:12 in 0.35 ppm NaCl. DOR of FA-Glu increased from 1:1.15 (DI-water) to 1: 3.5 (0.35 ppm NaCl). Surfactin was 10X toxic than FA-Glu to 7-8 d old Gulf killifish, compared to intermediate toxicity for sodium laurel sulfate. The basic structure-function relationship for these biosurfactants is being investigated so as to design biochemicals for possible oil-spill remediation, with minimal or no adverse environmental effect(s).

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## Session: 017 -

Track: Technological, Environmental and Policy Developments for Improved Research and Operations in the Gulf of Mexico

Date: Monday, January 21 16:30 - 18:30  
Type: Poster

### Reagents for rapid on-site analysis of petrogenic polynuclear aromatic hydrocarbons (PAHs)

**Presenter:** Diane Blake – Tulane Univ, Sch, Medicine

**Authors:** Yue Sun, Tulane University School of Medicine; Bhupal Ban, Tulane University School of Medicine; Shakeel Ansari, University of Texas Medical Branch; Andrew Bradbury, Los Alamos National Laboratories; Leslie Naranjo, Los Alamos National Laboratories; Diane Blake, Tulane University School of Medicine

#### Abstract:

Because PAHs can enter the environment from a variety of sources, our laboratories are focused upon developing antibodies that specifically recognize alkylated PAHs, which are derived almost exclusively from oil spills and seeps. Synthesized carboxy, 2-methylphenanthrene and 2,7-dimethyl phenanthrene were conjugated with bovine serum albumin and used to select single chain phage displayed antibodies (scFvs) from a large naïve human scFv library (>10<sup>10</sup> scFvs). Successive selections were performed with increasing concentrations of soluble phenanthrene. Selected scFv were transferred to a yeast display system and FACS was used to select those clones that bound with high affinity to conjugated 2-methylphenanthrene. These clones were then subjected to FACS in the presence of soluble phenanthrene or 2-methylphenanthrene. A small fraction of the analyzed clones (1/96) appeared to bind preferentially to soluble 2-methylphenanthrene. Further analysis of other scFvs isolated from this library may provide additional antibodies that could be adapted for use in antibody-based sensors.

## Session: 017 -

Track: Technological, Environmental and Policy Developments for Improved Research and Operations in the Gulf of Mexico

Date: Monday, January 21 16:30 - 18:30  
Type: Poster

### Making ergonomic digital holography

**Presenter:** Filippo Ghiglieno – CEBIMar- University of Sao Paolo

**Authors:** Filippo Ghiglieno, University of Sao Paolo; L. Fabiano Baldasso, University of Sao Paolo; J. Rudi Stickler, University of Wisconsin Milwaukee; Rubens Mendes Lopes, University of Sao Paolo

#### Abstract:

Digital in-line holography is a powerful tool for monitoring the concentration of suspended particles in vapor or liquid environments. From the hardware point of view the setup compactness is a major advantage, and several digital cameras with different recording speeds, pixel resolutions and detector sizes are readily available for holographic applications. A second benefit is the expanded depth of focus in comparison with other optical techniques, but the large amount of data generated in hologram digital reconstruction challenges a real-time approach. The time-consuming aspect of hologram reconstruction is the focus of our research. We have developed an interface with an autofocusing algorithm to be applied during reconstruction. Such application will allow an ergonomic approach for non-expert users of holographic systems.

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## Session: 017 -

Track: Technological, Environmental and Policy Developments for Improved Research and Operations in the Gulf of Mexico

Date: Monday, January 21 16:30 - 18:30  
Type: Poster

### Uncertainty estimation in operational oil spill modeling for bays and estuaries

**Presenter:** Ben Hodges – University of Texas at Austin

**Authors:** Ben R. Hodges, University of Texas at Austin; Xianlong Hou, University of Texas at Austin

#### Abstract:

Uncertainty estimation in oil spill transport modeling for bays and estuaries is being developed to improve oil spill response. When a spill occurs at night in heavily trafficked shipping lanes, operational models become the key tool for estimating oil spill motion and deciding the initial equipment positioning as part of the emergency response. However, the present generation of operational models for Texas bays do not have any method of quantifying the uncertainty in spill transport predictions. We are collaborating with the Texas General Land Office and the Texas Water

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Development Board to develop ensemble modeling capabilities that will provide operational managers with better information about the likely path of the spill and the confidence in the underlying numerical models.

Session: 017 -

Track: Technological, Environmental and Policy Developments for Improved Research and Operations in the Gulf of Mexico

Date: Monday, January 21 16:30 - 18:30  
Type: Poster

## Methods for Assessing Effects on Deep-Sea Macrobenthic Communities

**Presenter:** Chien-Yi Hsiang – Harte Research Institute at TAMUCC

**Authors:** Chien-Yi Hsiang, Harte Research Institute for Gulf of Mexico Studies; Paul Montagna, Harte Research Institute for Gulf of Mexico Studies; Rick Kalke, Harte Research Institute for Gulf of Mexico Studies

### Abstract:

Decreases in benthic abundance and diversity can indicate effects on ecological integrity caused by changing environmental conditions resulting from disturbance and/or contamination. However, there is uncertainty about the specific methods needed for assessing effects in the deep-sea, such as those related to the Deepwater Horizon oil spill. This study evaluated the effectiveness of two different mesh sizes (500 and 300  $\mu\text{m}$ ) in retaining macrofaunal species during sieving of benthic samples, and the vertical distribution of benthos within the top 20 cm of sediment. Samples were collected in the northern Gulf of Mexico in fall 2010 with a multiple corer from 10 stations at water depths ranging from 500 m to 2300 m. Up to 97 % of total macrofauna were restricted to the 0-10 cm sediment. The 500  $\mu\text{m}$  sieve retained 56.4 % of total individuals and 93.4 % of total taxa. It is recommended that 300  $\mu\text{m}$  sieves be used to extract the macrofauna, and sampling up to 10 cm sediment depth. Because macrofauna are restricted to the surface sediments they are at risk to exposure of oil from the spill.

Session: 017 -

Track: Technological, Environmental and Policy Developments for Improved Research and Operations in the Gulf of Mexico

Date: Monday, January 21 16:30 - 18:30  
Type: Poster

## Dendritic polymers as biocompatible oil spill dispersants

**Presenter:** David Ladner – Clemson University

**Authors:** David A. Ladner, Clemson University; Nicholas K. Geitner, Clemson University; Muriel M. Steele, Clemson University; Peng Xie, Clemson University; Priyanka Bhattacharya, Pacific Northwestern National Labs; Ran Chen, Clemson University; Andrew Whelton, University of South Alabama; Sean Powers, University of South Alabama; Pu-Chun Ke, Clemson University

### Abstract:

Dendritic polymers have recently been shown to encapsulate polycyclic aromatic hydrocarbons (PAHs) and other hydrophobic materials. We thus hypothesize that crude oil can be dispersed using these materials. Our objective is to gain a fundamental understanding of the interactions of dendritic polymers with crude oil, taking toxicity and biodegradability into consideration. First-phase laboratory results show that poly(amidoamine) dendrimers and hyperbranched poly(ethyleneimine) polymers form complexes with linear (hexadecane) and polyaromatic (phenanthrene) hydrocarbons, increasing the dispersion of these model crude oil components. Ongoing efforts are examining the effects of hydrocarbon-polymer complexes on algal species to determine their biocompatibility. Dendritic polymers will be compared with Corexit 9500A and other conventional dispersants. As a part of this project, community outreach workshops will carry the research knowledge to the public and allow community groups to participate directly in laboratory studies.

Session: 017 -

Track: Technological, Environmental and Policy Developments for Improved Research and Operations in the Gulf of Mexico

Date: Monday, January 21 16:30 - 18:30  
Type: Poster

## Applying lessons learned from DHW to the Pre-Salt Layer deep-sea oil exploration in Brazil

**Presenter:** Fabio Moretzsohn – Harte Research Institute

**Authors:** Fabio Moretzsohn, Harte Research Institute

### Abstract:

The silver lining of the Deepwater Horizon (DWH) oil spill in the Gulf of Mexico in 2010 is that because of its magnitude it has received a lot of



# Science Abstracts

attention from scientists and public at large. Thanks to the unprecedented amount of research funds made available by BP, NSF, NOAA, and other agencies, the disaster is currently being studied in great detail to understand the complex interactions between oil, gas, dispersants, biota and the environment, hopefully in a long time series.

Massive oil fields with a combined volume potentially 1000 times larger than the Macondo Prospect have been discovered since 2007 in the Brazilian Pre-Salt layer in 2 km of water and underneath rock and salt layers about 4-5 km thick. Petrobrás and partners are ramping up for large-scale oil exploration under very challenging conditions. The ongoing research effort in the Gulf of Mexico can be applied to the Brazilian Pre-Salt and other deep-sea oil drilling elsewhere to avoid some of the hard-learned lessons from DWH and be better prepared should an accident occur.

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## Session: 017 -

Track: Technological, Environmental and Policy Developments for Improved Research and Operations in the Gulf of Mexico

Date: Monday, January 21 16:30 - 18:30

Type: Poster

## Incorporating comprehensive species data in ecosystem science and recovery initiatives

**Presenter:** Fabio Moretzsohn – Harte Research Institute

**Authors:** Roger McManus, International Union for Conservation of Nature; B. Polidoro, Arizona State University and IUCN Species Programme; H. Harwell, IUCN Species Programme, Old Dominion University; F. Moretzsohn, Harte Research Institute; T. Lacher, Texas A&M University College Station; M. Comerros-Raynal, IUCN Species Programme, Old Dominion University; K. Carpenter, IUCN Species Programme, Old Dominion University

### Abstract:

The presence of threatened species on the US Endangered Species Act is often used to define conservation priorities and conduct risk assessments in the Gulf of Mexico. However, only 14 Gulf species are afforded federal protection, while at least 53 are currently considered threatened on the IUCN Red List of Threatened Species. Therefore, the identification of conservation priorities in the Gulf is largely conducted in the absence of comprehensive species information. To address this, IUCN, in collaboration with Harte Research Institute, will complete regional-level Red List Assessments for Gulf species (including all marine fishes, mammals, sea turtles, seabirds and selected plants and invertebrates). This comprehensive dataset (including range maps), will help develop a spatial modeling capacity to incorporate into Harte's existing BioGoMx database, improving knowledge of threatened species and allowing for more effective identification of site and species-specific conservation

priorities, risk assessment, disaster preparedness, and recovery of natural resources in the region.

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## Session: 017 -

Track: Technological, Environmental and Policy Developments for Improved Research and Operations in the Gulf of Mexico

Date: Monday, January 21 16:30 - 18:30

Type: Poster

## GULF SAVER® BAG: A SUSTAINABLE APPROACH TO SPARTINA ALTERNIFLORA MARSH RESTORATION

**Presenter:** Margo Moss – Matrix New World Engineering

**Authors:** Lawrence Malizzi, Matrix New World Engineering, Inc.; Leslie Carrere, Restore the Earth Foundation, Inc.; P.J. Marshall, Restore the Earth Foundation, Inc.; Marvin Marshall, Restore the Earth Foundation, Inc.; Alan Parsons, Matrix New World Engineering, Inc.; Margo D. Moss, Matrix New World Engineering, Inc.

### Abstract:

The use of the Gulf Saver® bag (bag) for *Spartina alterniflora* marsh restoration at Popcorn Beach at the Pass a Loutre WMA, Venice, Louisiana demonstrates the effectiveness of this approach for marsh restoration. The bag is a biodegradable, self-contained package of native plants with its own site-specific custom mixed supply of natural nutrients to support, feed, and protect the native vegetation. Each bag contains three, one year old *Spartina* seedling plugs and are the size of a sandbag (45 cm). The bag is a stability kit that jump starts growth and survivability in the face of storm surge, wave action, and rapid erosion. Vegetative restoration of the Gulf Coast marshes is of paramount importance to establish a living, growing barrier in the face of land loss and rising sea levels. In addition, Gulf Coast wetlands provide economic stimulus for coastal communities and the nation as a whole, from commercial fisheries to recreational activities, in the form of critical habitat for fish and wildlife.

As one of the three principal outlets of the Mississippi River, the Pass a Loutre Site is challenging to restore using traditional planting techniques due to the variable tidal range, high wave energy and substantial discharge rates on-site creating an obstacle to *Spartina* plug establishment. In December 2010, 400 bags (1200 plugs) were placed on the north end of Popcorn Beach as a demonstration project. Half of the bags (200 bags) were distributed in cluster formation (2-3 bags) in a checkerboard pattern, in an approximately 22 m by 25 m area adjacent to the beach, with 3 m between bag clusters. The remaining half (200 bags), were deployed as a continuous row along portions of the perimeter in order to enhance sediment capture and to buffer interior bag groupings from high energy tidal forces. In March of 2011, 50 additional bags of

# Science Abstracts

Spartina plugs in cluster formations were deployed to reinforce the perimeter by arraying bags adjacent to the perimeter rows deployed in December 2010. The first monitoring event at the Site was conducted in December of 2011 at pre-surveyed, permanent 1 m by 1 m plots. The average percent cover of the Spartina was 78%, with an average canopy height of 93 cm in the bag area. A second monitoring was conducted at the same plot locations in April of 2012. The average percent cover was 85% and the average canopy height was 119 cm in the bag area. Of importance is the fact that the Spartina had completely filled in the treatment area in a twelve month period. In addition, the initial linear formation of Spartina along the perimeter had expanded outwards to a width of 8 m from the original planting in 17 months. The percent cover, average canopy height, and aerial extent of the Spartina demonstrates the effectiveness of the bags for use in marsh restoration.

hypotheses that the mixture would be effective in water and that it would be more effective in fresh water than salt water.

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## Session: 017 -

Track: Technological, Environmental and Policy Developments for Improved Research and Operations in the Gulf of Mexico

Date: Monday, January 21 16:30 - 18:30

Type: Poster

### **Pop Goes the Diesel: A Linoleic Acid/R. rhodochrous Mixture as a Bioremediation Agent of Diesel Contaminants in Saltwater and Freshwater Environments**

**Presenter:** Morgan Sinko – University of Rochester

**Authors:** Morgan Sinko, University of Rochester

#### **Abstract:**

A novel mixture of Linoleic acid and R. rhodochrous proved to be an effective bioremediation tool for hydrocarbon contamination in a variety of soils. The purpose of this study was to verify and compare the efficacy of the mixture as a bioremediation agent of diesel contaminants in freshwater and saltwater environments.

Four tanks of salt water and four tanks of fresh water were spiked with diesel fuel. One tank of each water type remained untreated as a control; all others were treated with the mixture. Samples were taken from each tank on days 1, 2, 7, 14 and 21 and analyzed in a GC/MS. The levels of Heptadecane 2-6-dimethyl were compared to Heptadecane, which were then compared to the control to find a ratio of change throughout the samples.

The salt water revealed a range of 42-50% remediation by the end of the trial, while freshwater samples remediated at a final range of 64-79%. There was also a decrease in plastics contamination. The data supported

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## Session: 018 Remote Sensing and the Deep Water Horizon Oil Spill

Session: 018 - 1

Track: Remote Sensing and the Deep Water Horizon Oil Spill

Date: Monday, January 21 10:30 AM

Type: Oral Presentation

### UAVSAR response to the Deepwater Horizon oil spill

**Presenter:** Cathleen Jones – Jet Propulsion Laboratory

**Authors:** Cathleen E. Jones, Jet Propulsion Laboratory; Benjamin Holt, Jet Propulsion Laboratory; Brent Minchew, California Institute of Technology

#### Abstract:

The June 2010 deployment of NASA's Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR) in response to the Deepwater Horizon oil spill provided remote sensing data over the open waters of the Gulf of Mexico (GOM) and along beaches, wetlands, and barrier islands from the Florida Keys to Corpus Christi, Texas. Anniversary campaigns in 2011 and 2012 provided a time-series to document impact and recovery along coastal areas in Mississippi, Louisiana, and Texas. Here we discuss the capabilities of UAVSAR for oil spill response and impact studies, presenting new results showing the utility of polarimetric SAR remote sensing for oil spill response, including significantly improved open water oil slick characterization capability, slick mapping in inland waterways, and detection of oil impact to wetland vegetation, all of which were enabled by UAVSAR's excellent signal-to-noise characteristics and full polarization capability. In addition, we show examples of UAVSAR products covering different portions of the GOM to motivate its use in other Gulf ecosystem science studies.

Session: 018 - 2

Track: Remote Sensing and the Deep Water Horizon Oil Spill

Date: Monday, January 21 10:45 AM

Type: Oral Presentation

### Oil Detection and Latent Impact Monitoring in Coastal Marshes with Polarimetric SAR

**Presenter:** Elijah Ramsey – USGS

**Authors:** Elijah Ramsey III, US Geological Survey; Amina Ragoonwala, Five Rivers Services, LLC; Cathleen Jones, NASA JPL-CalTech

#### Abstract:

We discuss remote sensing methods based on NASA's high spatial resolution and fully polarimetric L-band SAR (UAVSAR) sensor system to

detect oil and monitor latent change as exemplified by Deepwater Horizon oil occurrences within the coastal marshes of eastern Louisiana. Oil detection relied on decomposition and classifications of pre-spill 2009 and post-spill 2010 PolSAR single look complex scenes. Freeman-Durden and Cloude-Pottier decompositions found a change in the dominant scatter mechanism associated with oiled shorelines. All decompositions and classifications also identified a spatially extensive class of interior marshes that were associated with changes in backscatter mechanisms dominantly from surface or volume to double or even bounce. A lack of direct observational data prevents confirmation of whether these changes were directly related to oil occurrences. In addition, we describe the spatial expansion of the oil detection to the wider Mississippi Deltaic region, and the temporal comparisons of derived PolSAR products from 2009, 2010, 2011, and 2012 UAVSAR collections.

Session: 018 - 3

Track: Remote Sensing and the Deep Water Horizon Oil Spill

Date: Monday, January 21 11:00 AM

Type: Oral Presentation

### Fine-scale features on the sea surface in SAR satellite imagery

**Presenter:** Alexander Soloviev – Nova SE Univ Oceanographic Center

**Authors:** Alexander Soloviev, Nova Southeastern University Oceanographic Center; Silvia Matt, Nova Southeastern University; Susanne Lehner, German Aerospace Center; Stephan Brusch, German Aerospace Center; Domenico Velotto, German Aerospace Center; William Perrie, Bedford Institute of Oceanography

#### Abstract:

This work is aimed at identifying the origin of fine-scale features on the sea surface in synthetic aperture radar (SAR) imagery with the help of in-situ measurements as well as numerical models. We are interested in natural and artificial features starting from the horizontal scale of the upper ocean mixed layer, around 30-50 m. These features are often associated with three-dimensional upper ocean dynamics. We have conducted a number of studies involving the in-situ observations including controlled oil releases in the Straits of Florida during TerraSAR-X, RADARSAT 2, and COSMO-SkyMed satellite overpasses. The data include examples of sharp frontal interfaces, wakes of surface ships, internal wave signatures, slicks of artificial (oil) and natural origin. Atmospheric processes, such as squall lines and rain cells, produced prominent signatures on the sea surface. This data has allowed us to test an approach for distinguishing between natural and artificial features, including oil spills, and atmospheric influences in SAR images that is based on a co-polarized phase difference filter.

# Science Abstracts

Session: 018 - 4

Track: Remote Sensing and the Deep Water Horizon Oil Spill

Date: Monday, January 21 11:15 AM

Type: Oral Presentation

## Analysis of the BP Oil Spill Deep Water Horizon Extent Using Synthetic Aperture Radar Satellite Imagery.

**Presenter:** Oscar Garcia-Pineda – Florida State University

**Authors:** Oscar Garcia-Pineda, Florida State University; Ian MacDonald, Florida State University

### Abstract:

In this project we present the analysis of the oil spill extent using 217 Synthetic Aperture Radar (SAR) images that were processed using the Textural Classifier Neural Network Algorithm (TCNNA). The TCNNA outputs were then used to compile 81 Daily Composite Footprints (DCF) of the oil spill. In order to quantify the frequency per day in which the oil spill landed in the coast, each of the DCF was then intersected with the shoreline (using a buffer zone of 3km). Additionally, a 5km grid was constructed to map the cumulative presence of oil in different areas of the sea. We estimated that approximately 1900 linear kilometers of the US coast were reached by the DWH oil spill. In this extent, the numbers of counties affected by state are: 4 in Texas, 14 in Louisiana, 2 in Alabama, 1 in Mississippi, and 7 in Florida. The counties with the highest frequency of oil observed were Plaquemines and Lafourche in LA, Jefferson and Terrebonne in Texas. At sea, the total extent of the oil spill covered approximately 139,000 km<sup>2</sup> of surface waters.

Session: 018 - 5

Track: Remote Sensing and the Deep Water Horizon Oil Spill

Date: Monday, January 21 11:30 AM

Type: Oral Presentation

## On the Utility of Remote Sensing Data for Oil Spill Applications

**Presenter:** Chet Pilley – LSU Earth Scan Laboratory

**Authors:** Chet Pilley, LSU Earth Scan Laboratory; Nan Walker; Alaric Haag; Vandana Raghunathan; Jessica Comeaux; Ambrose Bordelon; Jordan Pino

### Abstract:

This paper discusses applications of satellite data towards studies of the Deepwater Horizon Oil Spill (DWHOS) undertaken at the LSU Earth Scan Laboratory (ESL), a real-time satellite data receiving and processing facility using three antennas. Prior to the DWHOS, the remote sensing literature documented the usefulness of both MODIS and SAR data for

surface oil detection allowing for immediate application as the event unfolded. SAR data were fortuitously available from CSTARS, Univ. of Miami. Surface oil distributions over time were measured and base datasets were archived for further analysis in support of several BP-funded research projects. The ESL archive ([www.esl.lsu.edu/oilspill/](http://www.esl.lsu.edu/oilspill/)) has proven useful for assessing the fate of surface oil in the deep Gulf, quantifying coastal fishery impacts, and improving coastal models. Whether one is studying the deep ocean or the coast, spatial measurements derived from satellite observations of surface oil have proven essential for researchers

Session: 018 - 6

Track: Remote Sensing and the Deep Water Horizon Oil Spill

Date: Monday, January 21 11:45 AM

Type: Oral Presentation

## Advancements in Oil Spill Automatic Detection and Early Warning with Radar

**Presenter:** Freda Zifteh – Nortek

**Authors:** Freda Zifteh, Nortek

### Abstract:

SeaDarQ uses radar processing technology to extract hydrographic, oceanographic, and environmental information using X-band marine radar. Using advanced image processing techniques, it detects oil spills, making it possible to conduct real time, continuous surveillance of the water surface from a shipboard or land-based system. Information is extracted from sea clutter resulting from surface disturbances, which have different structures caused by bottom topography, boundary layers, or currents. The oil spill detection module operates on the principle that oil on water reduces the sea surface roughness and backscatter intensity. Analyzing wave crests in radar images provides information on directional spectrum, surface currents, and bottom topography using Fourier analysis. This information is used to predict oil spill trajectory. While the basic principles used date back to the 1980s, engineers and scientists at Nortek have recently advanced the image processing techniques to improve hydrographic measurements and enable automatic oil spill detection, as well as integrated the system with infrared sensors. The presentation will explain principles of operation and latest developments. Existing installations and use in recovery operations will be discussed.

# Science Abstracts

Session: 018 - 7

Track: Remote Sensing and the Deep Water Horizon Oil Spill

Date: Monday, January 21 12:00 PM

Type: Oral Presentation

## Satellite remote sensing of the Deepwater Horizon oil spill: What have we learned with MODIS and MERIS?

**Presenter:** Chuanmin Hu – University of South Florida

**Authors:** Chuanmin Hu, University of South Florida

### Abstract:

Compared with satellite synthetic aperture radar (SAR) observations that are often used to detect and trace oil spills, optical instruments at reduced resolutions provide more synoptic and frequent coverage, thus could be used in a quasi-operational mode to complement other observations. Here, we show how these optical remote sensing data were used during and after the DWH oil spill to quantify the spill's surface coverage and to estimate post-spill ocean changes. MODIS and MERIS data at 250-m and 300-m resolutions, respectively, were obtained in near real-time from NASA GSFC, and processed with computer software developed by NASA and those written in house. The customized imagery, with surface oil coverage delineated and ocean currents implied, were provided online and delivered to several groups in near real-time to track the surface oil and to help management actions. The satellite data products were also used to assess the pre-spill baseline condition and post-spill ocean phytoplankton changes. However, estimating the surface oil thickness is still problematic.

Session: 018 - 8

Track: Remote Sensing and the Deep Water Horizon Oil Spill

Date: Monday, January 21 12:15 PM

Type: Oral Presentation

## Surface oil drift rates estimated from natural seeps

**Presenter:** Ian MacDonald – FLORIDA STATE UNIVERSITY

**Authors:** Ian R. MacDonald, Florida State University; Samira Danishgar Asl, Florida State University; Oscar Garcia-Pineda, Florida State University

### Abstract:

The drift rate and persistence over time of floating oil, as a function of wind speed, surface currents, and sea state, is an important parameter for predicting the transport and fate of oil released by natural and anthropogenic processes. We analyzed SAR images showing curvilinear oil slicks that were generated by small, continuous releases from mostly natural oil seeps. The distances from the ends proximal to known source

locations to the terminal ends of the slicks were measured. In a data set from the GC600 lease block (ECOGIG study site), we analyzed 47 oil slicks observed between 2004 and 2011. These features remain visible until the Their average length was 13.9 km (stdev 11.40); however the distribution of lengths included several very long features (max 49 km). Average wind speed during these image collections was 5.2 m s<sup>-1</sup> (stdev 1.47). Assuming a drift rate of 3% of wind speed, we estimate the time required to form each feature and found a median value of 14.7 h. Ongoing simulation experiments will provide more precise estimates of these processes.

Session: 018 - 9

Track: Remote Sensing and the Deep Water Horizon Oil Spill

Date: Monday, January 21 2:00 PM

Type: Oral Presentation

## Lagrangian predictability in the DWH region from HFR observations and model output

**Presenter:** Max Yaremchuk – NRL

**Authors:** Max Yaremchuk, Naval Research Laboratory; Mozheng Wei, Naval Research Laboratory; Peter Spence, Naval Research Laboratory; Gregg Jacobs, Naval Research Laboratory

### Abstract:

Predictability of surface drifter trajectories in the Deep Water Horizon oil spill region is used as a criterion for optimizing interpolation of local high-frequency radar (HFR) observations, and assessing the potential benefit of assimilating HFR data into regional models. It is shown that penalizing the magnitude and enforcing smoothness of the divergence field significantly increases the Lagrangian predictability at the forecast times of 4-12 days while preserving it at the smaller time scales. Applying preliminary gap-filling technique based on the analysis of spatial correlations of the radial velocities adds an extra 2-4% to the forecast skill. Comparison of the Lagrangian forecast skills provided by the 2d variational (2dVar) interpolation of the HFR data and the data-constrained solutions of the NCOM model demonstrates a better skill of the 2dVar product, indicating potential benefits of assimilating HFR data into regional models.



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Session: 018 - 10

Track: Remote Sensing and the Deep Water Horizon Oil Spill

Date: Monday, January 21 2:15 PM

Type: Oral Presentation

## Integration of Satellite Measurements for the Surveillance of Deepwater Horizon Surface Oil, the Loop Current and its Frontal Eddies

**Presenter:** Nan Walker – Louisiana State University

**Authors:** Nan Walker, Louisiana State University Earth Scan Lab; Chet Pilley, Louisiana State University; Alaric Haag, Louisiana State University; Peter Brickley, Horizon Marine Inc.; Patrice Coholan, Horizon Marine Inc.; Robert Leben, University of Colorado CCAR; Hans Graber, University of Miami CSTARS

### Abstract:

This paper focuses on the use of passive (color, temperature) and active (radar, altimetry) satellite remote sensing for tracking surface oil and Gulf currents in support of response activities and research. The usefulness of MODIS and SAR data for detecting surface oiling is discussed based on real-time acquisitions from two direct broadcast stations, at Louisiana State Univ. and Univ. of Miami. A detailed assessment of the impacts of deepwater currents on oil motion was performed using MODIS and SAR for oil detection and GOES-E sea surface temperature composite images integrated with sea surface height (SSH) data (from Univ. Colorado) to assess circulation of the Loop Current (LC) and associated eddies. The evolution of a 33,000 km<sup>2</sup> surface oil feature in mid-May 2010 is discussed in light of new observations of eddy merging along the LC front. Horizon Marine's in-situ current data (from drifters and ADCP profiles) provided support for the satellite observed circulation patterns.

Session: 018 - 11

Track: Remote Sensing and the Deep Water Horizon Oil Spill

Date: Monday, January 21 2:30 PM

Type: Oral Presentation

## Impact of the Deepwater Horizon Oil Spill on the chlorophyll Concentrations of the Gulf of Mexico- A Remote Sensing Perspective

**Presenter:** Sonia Gallegos – NASA Stennis Space Center

**Authors:** Sonia C. Gallegos, NASA Applied Science Program; Rodolfo H. Iturriaga, NASA; Sean McCarthy, Naval Research Laboratory; Adam Lawson, Naval Research Laboratory; Curtis D. Armstrong, NASA

### Abstract:

Chlorophyll concentrations based on Fluorescence Line Height (FLH), and backscattering coefficients at 531 nm were computed for The

Moderate Resolution Imaging Spectroradiometer (MODIS) data for the Northern Gulf of Mexico from 2006 to 2008. These data were then compared with FLH estimates for 2010 and 2011 in an effort to understand and quantify the impact of the Deepwater Horizon (DWH) oil spill on the phytoplankton health of this area. Results indicate that unusually large chlorophyll concentrations were present in oceanic areas in 2010. In this same year, patchy blooms were also observed off the Southwest Pass, which upon examination show very high concentrations of multi-species phytoplankton, usually found in the Gulf of Mexico. Examination of the 2011 imagery shows patterns and concentrations typical of the surface waters of Gulf of Mexico leading us to believe that the impact of the DWH on the surface phytoplankton was strong but short lived. Further work is necessary to determine the full impact of the spill.

Session: 018 - 12

Track: Remote Sensing and the Deep Water Horizon Oil Spill

Date: Monday, January 21 2:45 PM

Type: Oral Presentation

## Quantifying severity of plant stress induced by oil spill contamination in the Gulf of Mexico using hyperspectral remote sensing

**Presenter:** Shruti Khanna – University of California, Davis

**Authors:** Shruti Khanna, University of California Davis; Alexander Koltunov, University of California Davis; Maria J. Santos, Stanford University; Paul J. Haverkamp, University of California Davis; Mui C. Lay, University of California Davis; Raymond Kokaly, USGS; Susan L. Ustin, University of California Davis

### Abstract:

Saltmarshes of the Gulf of Mexico were differentially impacted by the Macondo Oil Spill in 2010. We used AVIRIS hyperspectral data flown over Bay Jimmy in Barataria Bay during September 2010 and a year later in August 2011 to quantify impact of oil contamination on health of the saltmarsh. In September 2010, oil impact extended 12m inland from the shore. Four plant stress indexes (NDVI, mNDVI, ANIR, ARed) and three water content indices (NDII, WA980, WA1240) each showed that plant stress was significantly higher in the zone closest to oiled shore and decreased with increasing distance from the shore. Indices along oiled shore indicated higher stress than oil-free shore index values in September 2010. A year later, the vegetation had mostly recovered from the impact of oil. Data collected in the field documenting severity of oiling was used to examine whether depth of oil contamination (inland from the shore) was related to recovery, a year after the oil spill. This study marks the contribution of remote sensing in detecting stress and monitoring recovery after an oil spill.

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Session: 018 - 13

Track: Remote Sensing and the Deep Water Horizon Oil Spill

Date: Monday, January 21 3:00 PM

Type: Oral Presentation

## Phytoplankton anomaly in the NEGOM linked to the Mississippi River

**Presenter:** Brendan O'Connor – University of South Florida

**Authors:** Brendan O'Connor, University of South Florida; Frank Muller-Karger, University of South Florida; Woody Nero, National Oceanic and Atmospheric Administration

### Abstract:

An anomalous phytoplankton bloom was observed in the Northeastern Gulf of Mexico during August 2010, in the area bound by 30.0 – 28.0 degrees N and 89.6 – 86.1 degrees W, east of the Mississippi Delta. There has been speculation that this anomaly was related to the Deepwater Horizon (DWH) Oil Spill. The main objective of this research was to test the hypothesis that this anomaly was an outcome of an eastward dispersal of the Mississippi River plume in August 2010, which had not been observed in any month of August in MODIS satellite images collected since the year 2000. We examined a number of relevant datasets including MODIS fluorescence line height images and ship-based surface salinity data. The American Seas – Navy Coastal Ocean Model (AmSeas-NCOM) was used to examine possible particle trajectories released under three scenarios, including seeding around the Mississippi River delta. We present substantial evidence that the August 2010 phytoplankton anomaly was in response to the freshwater discharge from the Mississippi River.

Session: 018 - 15

Track: Remote Sensing and the Deep Water Horizon Oil Spill

Date: Monday, January 21 3:30 PM

Type: Oral Presentation

## Informing Coastal Ecosystem Science with Airborne Coastal Mapping

**Presenter:** Molly Reif – USACE/ERDC-EL

**Authors:** Molly Reif, US Army Engineer Research and Development Center; Jennifer Wozencraft, US Army Engineer Research and Development Center

### Abstract:

In order to improve research and operations in the Gulf of Mexico (GOM), timely technological developments, such as enhanced remote sensing data products, are critical. The U.S. Army Corps of Engineers National Coastal Mapping Program produces regional, high-resolution, high-accuracy, data necessary to implement coastal restoration management and monitoring along the GOM coastlines. A suite of basic

information products, like bathymetric/topographic digital elevation models, air photo mosaics, shoreline contours, and land cover classification images are generated from the NCMP data on a reoccurring basis. This presentation will illustrate new technological advances in hardware to support the development of enhanced mapping products that not only support activities such as regional sediment management, regulatory functions, flood damage reduction, asset management, and emergency operations, but also, support effective environmental restoration and planning that requires short- and long-term monitoring to assess coastal change and health.

Session: 018 - 16

Track: Remote Sensing and the Deep Water Horizon Oil Spill

Date: Monday, January 21 3:45 PM

Type: Oral Presentation

## Data-Based Mechanistic Modeling of Environmental Impacts of Multiple Natural and Anthropogenic Stressors on the Gulf of Mexico

**Presenter:** Olufemi Osidele – Southwest Research Institute

**Authors:** Olufemi Osidele, Southwest Research Institute; Ronald Green, Southwest Research Institute

### Abstract:

The Gulf of Mexico faces multiple stressors such as hurricanes and tropical storms, nutrient enrichment from upstream agricultural river basins, and occasional spills from offshore oil and gas drilling. The Deepwater Horizon oil spill disrupted several marine and coastal ecosystems, adding to existing impacts from sustained oxygen depletion in the northern Gulf waters. Modeling these impacts to inform ecosystem restoration decisions requires integration of diverse data sets on multiple natural and anthropogenic stressors. To address this challenge, we present results of a study based on stochastic, nonstationary time-series methods supporting a data-based, mechanistic modeling approach for identifying linkages between observed stressors and impacts. Proof of concept is demonstrated with a case study integrating meteorology, hydrology, land use practice, and nutrient loading into a decision-support system for the Arroyo Colorado river basin, a predominantly agricultural subwatershed of the Gulf of Mexico in South Texas. Funding for this study was provided by NASA grant NNX09AR63G.

# Science Abstracts

Session: 018 - 17

Track: Remote Sensing and the Deep Water Horizon Oil Spill

Date: Monday, January 21 4:00 PM

Type: Oral Presentation

## DEVELOPMENT OF A LAB-ON-CHIP BASED OIL DETECTION INSTRUMENT

**Presenter:** Wanjun Wang – Louisiana State University

**Authors:** Wanjun Wang, Louisiana State University; Yuxuan Zhou, Louisiana State University

### Abstract:

Real-time monitoring the efficacy of dispersant application is a critical topic for oil spill response. We have been working to develop a lab-on-chip based oil detection technology that can be used for on-site, in-situ detection applications. It consists of two sections: one is the sample extraction/pre-concentration unit based on a liquid-to-liquid (L-L) principle, and the other is an on-chip micro-optic detection unit. The micro L-L is used in the proposed system to extract the oil from the sample water into an organic solvent as the pre-concentrated stage. The micro-optical detection system will have an integrated microlens to boost the signal strength for improved sensitivity.

The whole microfluidic device were fabricated on a disposable PDMS chip. Two optical fibers perpendicular to each other are inserted into the PDMS chip through pre-aligned optical fiber holder. One optical fiber is used to deliver excitation light from a LED light source (360 nm) to the fluid sample and the other one is used to output fluorescence signal (470nm) to a PMT. To enhance the light collection of the fluorescence signal, two three-dimensional (3D) out-of-plane microlenses are directly integrated onto the microfluidic device at the end of each optical fiber. Preliminary tests have produced promising results and proved the feasibility of the system.

Session: 018 - 18

Track: Remote Sensing and the Deep Water Horizon Oil Spill

Date: Monday, January 21 4:15 PM

Type: Oral Presentation

## A Method for the Identification of Hydrocarbon-Transforming Bacteria in the Sea Surface

**Presenter:** Kate Vella – Nova Southeastern University

**Authors:** Kate Vella, Nova Southeastern University; Naoko Kurata, Nova Southeastern University; Alexander Soloviev, Nova Southeastern University; Silvia Matt, Nova Southeastern University; Mahmood Shivji, Nova Southeastern University; Aurelien Tartar, Nova Southeastern University

### Abstract:

The sea surface microlayer (SML) represents the interface between the atmosphere and ocean, serving as a collection point for hydrocarbons and surfactants. This work presents an improved method for the identification of hydrocarbon-transforming bacteria in the SML. Bacterial samples were collected with a new sampling method that minimized sample contamination from the research platform and subsurface water. Microbial composition in the SML was determined using DNA analyses. Surfactants are capable of suppressing ocean surface waves, which affects radar back-scatter. Remote sensing thus may provide additional information on the state of the upper ocean ecosystem. The SML sampling was planned to coincide with satellite overpasses, COSMO SkyMed. Preliminary analysis of bay samples suggested the presence of uncultured gammaproteobacteria, which are known to be involved in hydrocarbon degradation. We are further exploring and quantifying the presence of hydrocarbon-transforming bacteria in the SML using 454 pyrosequencing.

Session: 018 -

Track: Remote Sensing and the Deep Water Horizon Oil Spill

Date: Monday, January 21 16:30 - 18:30

Type: Poster

## Chronic, Anthropogenic Hydrocarbon Releases in the Gulf of Mexico

**Presenter:** Samira Daneshgar Asl – Florida State University

**Authors:** Samira Daneshgar Asl, Florida State University; John Amos, SkyTruth; Paul Woods, SkyTruth; Oscar Garcia-Pineda, Florida State University; Ian R. MacDonald, Florida State University

### Abstract:

We used satellite SAR to quantify chronic hydrocarbon releases reported in the Gulf of Mexico. We compiled NRC reports collected and filtered by SkyTruth from 2001 to 2012 and determined whether the reports

# Science Abstracts

coincided with archived SAR images. In all, 316 of 4,574 reports could be investigated from 64 SAR images over the incident locations. Further analysis found that 104 reports of releases from pipeline, platforms or other anthropogenic sources, and unknown sources could be seen in SAR images. Measurements in GIS indicated that the average measured lengths of the oil slicks visible in SAR are significantly larger than the reported lengths. One source in particular, the Taylor offshore platform, produced oil slicks that were consistently much larger than other anthropogenic releases. Work in progress will use a texture classifying neural network algorithm (TCNNA) to segment oil cover to compare reported volume of the oil and the apparent release volume.

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**Session: 018 -**

Track: Remote Sensing and the Deep Water Horizon Oil Spill

Date: Monday, January 21 16:30 - 18:30

Type: Poster

## **Polarimetric remote sensing of wind-induced surface roughness**

**Presenter:** Nathan Laxague – RSMAS

**Authors:** University of Miami: Nathan Laxague, Brian Haus, Neil Williams, Tamay Ozgokmen, Adrianus Reniers, Josefina Olascoaga, Shuyi Chen; University of Delaware: Bruce Lipphardt; Texas A&M Corpus Christi: Darek Bogucki

### **Abstract:**

Data collection and analysis that targets underlying physical processes is of great interest to the study of ocean surface transport. As such, meteorological and surface roughness data gathered during studies of upper-ocean flow and transport is considerably beneficial. A ship that can serve as a measurement platform during large-scale drifter deployments is an excellent case of this tandem. The Grand Lagrangian Deployment (GLAD) experiment allowed for the release of 300 drifters to be coupled with in-situ air-sea interaction observation. Colocated measurements were made with an infrared camera system and a polarimetric video camera of a region of the surface outside the wake disturbance of the RV Walton Smith while underway. Momentum, moisture and heat fluxes were observed using direct covariance techniques from a mast mounted on the bridge. Here we begin to analyze the effects of wind forcing on surface transport physics with a focus on surface roughness.

**Session: 018 -**

Track: Remote Sensing and the Deep Water Horizon Oil Spill

Date: Monday, January 21 16:30 - 18:30

Type: Poster

## **A Prototype Location-Based Web Content Management System for Engaging Gulf of Mexico Coastal Communities**

**Presenter:** Olufemi Osidele – Southwest Research Institute

**Authors:** Olufemi Osidele, Southwest Research Institute; Alexander Sun, University of Texas at Austin; Ronald Green, Southwest Research Institute

### **Abstract:**

With increasing access to global positioning technologies, use of location-based content is now commonplace. However, the potential for applying such content in targeted delivery of geospatial data to specific end-users has yet to be fully exploited. Response to the Deepwater Horizon oil spill has provided opportunities for direct interaction among researchers, policy makers, and affected communities. Dialog among these parties can be enhanced through web-based content management systems, thus expanding opportunities to improve environmental awareness, outreach, and feedback. Toward this goal, we present a collaborative decision-support system based on Web 2.0 technologies. This system was developed to support implementation of water quality improvement and habitat protection plans for a Gulf coastal river basin in South Texas. Location-based content includes remote-sensing and in-situ data maintained by federal, state, and local agencies. Potential application to areas affected by the Deepwater Horizon oil spill is highlighted. This work was funded by NASA research grant NNX09AR63G.

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**Session: 018 -**

Track: Remote Sensing and the Deep Water Horizon Oil Spill

Date: Monday, January 21 16:30 - 18:30

Type: Poster

## **NASA DEVELOP Students Contribute to Oil Slick/Spill Monitoring and Analysis**

**Presenter:** Ross Reahard – NASA DEVELOP Program - Stennis

**Authors:** Ross Reahard, NASA DEVELOP Program

### **Abstract:**

As a capacity building element of NASA's Applied Sciences Program, the DEVELOP National Program equips students and young professionals with the Earth science resources necessary to improve decision making relating to relevant to public policy and environmental issues One aspect of DEVELOP's project portfolio is oil slick/spill monitoring and analysis and this poster provides an overview of relevant findings. One project

# Science Abstracts

employed 2008 – 2009 MODIS visible imagery to search for natural oil seeps in the Mid-Atlantic Planning Area. To maximize the number of sun glint scenes, data were acquired for March – September in 2008 and 2009. Cloud masks and image contrast enhancements were applied before visual analysis. Although no conclusive indications of natural seeps were detected, a probable ship-produced slick was found. Beyond the realm of slick monitoring, another project utilized Ozone Monitoring Instrument, Tropospheric Emission Spectrometer, and MODIS atmospheric data to assess potentially degraded air quality after the Deepwater Horizon oil spill. Data were analyzed for the presence of VOCs, ozone, and particulate matter, but no conclusively elevated levels were detected. An outreach campaign regarding NASA /federal involvement in oil spill response and recovery was also conducted.

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Session: 018 -

Track: Remote Sensing and the Deep Water Horizon Oil Spill

Date: Monday, January 21 16:30 - 18:30

Type: Poster

## Impact of Natural Oil Seeps on Phytoplankton in the Gulf of Mexico

**Presenter:** Ajit Subramaniam – LDEO/Columbia University

**Authors:** Susan Phan, Columbia University; Ian MacDonald, Florida State University

### Abstract:

Previous studies showed that the effect of oil slicks on phytoplankton productivity can be both stimulating and inhibiting at low concentrations. We examined radar and ocean-color satellite data between 1998 and 2007 to determine the impact of oil slicks from a major seep site in the Gulf of Mexico on surface chlorophyll concentration. Time series of 8-day averaged chlorophyll-a concentrations estimated from SeaWiFS satellite data were extracted for the area around the main test site – which experienced 26 recorded slicks over the decade of study – and 4 control sites, which do not experience slicks. During 8-day periods in which a slick was present, chlorophyll concentration was significantly higher by 0.035 mg/m<sup>3</sup> at the test site than at the 4 slick-free control sites ( $t = 3.40$ ,  $p = 0.001$ ). Larger slicks were associated with greater increases in local chlorophyll concentration. While we do not imply causality, this result points to the need for a better understanding of the effects of degrading hydrocarbons on biogeochemical cycles.



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## Session: 019 Models and Observations Working Together to Understand the Deepwater Horizon Oil Spill

### Session: 019 - 1

Track: Models and Observations Working Together to Understand the Deepwater Horizon Oil Spill

Date: Wednesday, January 23 10:30 AM  
Type: Oral Presentation

### Models are wrong, observations are sparse, what to do?

**Presenter:** Joseph Montoya – Georgia Institute of Technology

**Authors:** Joseph Montoya, Georgia Institute of Technology; Yuley Cardona, Georgia Institute of Technology; Sarah C. Weber, Georgia Institute of Technology; Annalisa Bracco, Georgia Institute of Technology

#### Abstract:

Offshore tropical and subtropical river plumes are often associated with large populations of diazotrophic (N<sub>2</sub>-fixing) organisms, which can support high rates of new production in the plume margins. Here we present direct measurements of N<sub>2</sub>- and CO<sub>2</sub>-fixation associated with populations of free-living diazotrophs and diatom-diazotroph assemblages (DDAs) in and around the offshore plume of the Mississippi and Atchafalaya Rivers during cruises in the summers of 2010, 2011 and 2012. We relate diazotroph abundance and activity to the distributions of nutrients and salinity, and in parallel, we present results from high resolution two-way nested ROMS-Agrif numerical simulations of the Gulf of Mexico that resolve the submesoscale dynamics around the Mississippi plume. Our goal is to use both observations and model simulations to quantify the physical processes responsible for the horizontal and vertical mixing of the nutrient-loaded river waters and their spread in the Gulf while understanding physically mediated biological processes at play along the continental shelf and off-shore.

### Session: 019 - 2

Track: Models and Observations Working Together to Understand the Deepwater Horizon Oil Spill

Date: Wednesday, January 23 11:00 AM  
Type: Oral Presentation

### Hunting for Impacts: A New Deep Sea Oil Spill Model For Highlighting Ecotoxicological Effects

**Presenter:** Sean Anderson – CSU Channel Islands

**Authors:** Sean Anderson, California State University Channel Islands

#### Abstract:

The 2010 Deepwater Horizon blowout posed the unique challenge of two types of oil spill: a familiar spill characterized by buoyant oil, fouling and killing organisms at the sea surface which eventually grounded upon and damaged sensitive shoreline communities, and a novel deepwater spill involving many unknowns. The subsurface retention of oil as finely dispersed droplets and emulsions, wellhead injection of dispersants, and deepwater retention of plumes of natural gas undergoing rapid microbial degradation were unprecedented and demanded the development of a new model for deepwater wellhead blowouts that includes subsurface consequences. Our recently-published new deepwater spill model is a useful tool with which to identify assumptions about the transport, fate and effect of hydrocarbons and dispersants. In particular it has been helpful in highlighting the lack of quantitative information about midwater and deep benthic impacts and presumed tradeoffs associated with dispersants as well as the overall efficacy of subsurface dispersants.

### Session: 019 - 3

Track: Models and Observations Working Together to Understand the Deepwater Horizon Oil Spill

Date: Wednesday, January 23 11:15 AM  
Type: Oral Presentation

### The General NOAA Operational Modeling Environment (GNOME)

**Presenter:** Christopher Barker – NOAA / ORR

**Authors:** Christopher H. Barker, NOAA Emergency Response Division; William Lehr, NOAA; Amy MacFadyen, NOAA; Caitlin O'Connor, NOAA; Jasmine Sandhu, NOAA; Brian Zelenke, NOAA

#### Abstract:

For over 35 years, NOAA's Emergency Response Division has provided scientific support to the US Coast Guard and other responders in the event of oil and chemical spills in the marine environment. During this time the office has developed and maintained series of models for predicting and assessing the fate and transport of oil and chemical spills. ERD's transport model: the General NOAA Operational Modeling Environment (GNOME), and oil weathering model: the Automated Data Inquiry for Oil Spills (ADIOS) have been available for public use, and are broadly used by the oil spill response community. We are currently in the process of developing the second generation of GNOME and the third generation of ADIOS. In these versions, the models are being re-factored into a single framework for oil spill modeling. The new framework is highly modular and scriptable, so that it will be easy for researchers and other users to both use the code and algorithms developed by NOAA, and use the framework in support of their own model development. This will

# Science Abstracts

allow the research community to take advantage of NOAA's operational experience and allow NOAA to better take advantage of new developments in modeling. This paper describes the structure and capability of the oil spill modeling framework, and a number of the key algorithms and capabilities included.

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Session: 019 - 4

Track: Models and Observations Working Together to Understand the Deepwater Horizon Oil Spill

Date: Wednesday, January 23 11:30 AM  
Type: Oral Presentation

## **Coupling glider observations and ocean forecasts for a more effective ocean observing system**

**Presenter:** Charlie Barron – Naval Research Laboratory

**Authors:** Charlie N. Barron, Naval Research Laboratory; Lucy F. Smedstad, Naval Research Laboratory; Germana Peggion, University of New Orleans; Emanuel Coelho, University of New Orleans; Kevin Heaney, OASIS

### **Abstract:**

Glider is slow, energy-efficient autonomous underwater vehicles that can be deployed as a flexible, low-cost, persistent observing system. The effectiveness of such a system is enhanced when glider measurements are linked back into an assimilative forecast system that can quantify the impact of prior and planned glider samples. NRL has developed these capabilities within a Glider Mission Adaptation Strategies (GMAST) system to expand mission planning times and coordinate data flow between mission planning and execution. GMAST develops guidance appropriate for each glider's specified mission type: tactical operations, feature definition, or sustained coverage. GMAST transforms forecasts of the local currents and environment into mission-specific cost functions, which in turn are used by the EMPATH genetic algorithm to identify the most effective set of possible glider trajectories. These are expressed as a set of waypoints and tolerances that is provided as guidance for Navy glider pilots. Application of GMAST is simulated in the north central Gulf of Mexico.

Session: 019 - 5

Track: Models and Observations Working Together to Understand the Deepwater Horizon Oil Spill

Date: Wednesday, January 23 11:45 AM  
Type: Oral Presentation

## **The Grand Lagrangian Drifter Experiment (GLAD): a case study in planning and implementing a large scale model-oriented experiment.**

**Presenter:** Brian Haus – University of Miami

**Authors:** Brian Haus, University of Miami; Bruce L. Lipphardt Jr., Tamay Ozgokmen, Javier Beron-Vera, Shuyi Chen, Emanuel Coelho, Annalisa Griffa, Angelique Haza, Pat Hogan, Helga Huntley, Gregg Jacobs, Mohammed Iskandarani, Denny Kirwan, Arthur Mariano, Arnoldo Valle-Levinson, Guillaume Novelli, Josefina Olascoaga, Andrew Poje, Ad Reniers, Ed Ryan, Mozheng Wei, Conor Smith, Milan Curcic, Matt Gough, Falko Judt, Nathan Laxague, Brett Webb

### **Abstract:**

CARTHE investigators conducted a large-scale experiment to determine the appropriate parameterizations to be used in regional scale and coastal models for the subgridscale variability due to submesoscale fronts, filaments and vortices in the Gulf of Mexico. Based on previous studies, it was determined that O(300) individually tracked Lagrangian drifters with initial spacing ranging from 100 m to 10 km and temporal scales from hours to weeks were required to determine the transport impact. Building, equipping, deploying and simultaneously tracking this large number of drifters presented many challenges even with a robustly supported field program. The design and implementation of this program was conducted with very close coordination between the modeling, data management and experimental groups within CARTHE. The resulting experiment realized multiple, quasi-synoptic drifter deployments with successful transmission of data from 99.7% of the units. The lessons learned from this process and their application to future experiments and future response efforts will be discussed.

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Session: 019 - 6

Track: Models and Observations Working Together to Understand the Deepwater Horizon Oil Spill

Date: Wednesday, January 23 12:00 PM  
Type: Oral Presentation

## Lagrangian Coherent Structures in Observations and Models

**Presenter:** Helga Huntley – University of Delaware

**Authors:** Helga S. Huntley, University of Delaware; B.L. Lipphardt, Jr., University of Delaware; A.D. Kirwan, Jr., University of Delaware; F.J. Beron-Vera, University of Miami; D. Bogucki, TAMU; S. Chen, University of Miami; E. Coelho, NRL Stennis; M. Curcic, University of Miami; M. Gough, University of Miami; A. Griffa, University of Miami; B. Haus, University of Miami; A. Haza, University of Miami; P. Hogan, NRL Stennis; M. Iskandarani, University of Miami; G. Jacobs, NRL Stennis; F. Judt, University of Miami; N. Laxague, University of Miami; A. Mariano, University of Miami; G. Novelli, University of Miami; M.J. Olascoaga, University of Miami; T. Ozgokmen, University of Miami; A. Poje, CUNY Staten Island; A. Reniers, University of Miami; E.H. Ryan, University of Miami; C. Smith, University of Miami; A. Valle-Levinson, University of Florida; M. Wei, NRL Stennis

### Abstract:

A well-established method for determining Lagrangian pathways and associated barriers to transport is by locating ridges in the finite-scale Lyapunov exponent (FSLE) field. It has been argued that the resulting Lagrangian Coherent Structures (LCS) are often more robust to small perturbations and model errors than the individual trajectories that constitute the basis for the calculation. Consequently, LCS are believed to be a valuable tool in transport and mixing forecasts.

Validating the assertion that LCS from model FSLE provide useful forecasts of Lagrangian pathways in the ocean has been challenging due to the scarcity of Lagrangian observational data. The Grand Lagrangian Deployment (GLAD) experiment, which resulted in more than 300 drifters simultaneously in the water within a fairly restricted region, for the first time permits an approximation to a synoptic FSLE map directly from observations. Here we use this data set to assess LCS maps from a state-of-the-art regional ocean model.

Session: 019 - 7

Track: Models and Observations Working Together to Understand the Deepwater Horizon Oil Spill

Date: Wednesday, January 23 12:15 PM  
Type: Oral Presentation

## Ocean Condition Forecasts during the Grand Lagrangian Deployment (GLAD) Experiment

**Presenter:** Gregg Jacobs – Naval Research Laboratory

**Authors:** Gregg Jacobs, Naval Research Laboratory; J. Beron-Vera, RSMAS; S. Chen, RSMAS; E. Coelho, UNO; M. Curcic, RSMAS; A. Griffa, RSMAS; M. Gough, RSMAS; B. Haus, RSMAS; A. Haza, RSMAS; P. Hogan, NRL; H. Huntley, UD; M. Iskandarani, RSMAS; J. Falko, RSMAS; D. Kirwan, UD; N. Laxague, RSMAS; A. Valle Levinson, UF; B. Lipphardt, UD; A. Mariano, RSMAS; G. Novelli, RSMAS; J. Olascoaga, RSMAS; T. Ozgokmen, RSMAS; A. Poje, CUNY; A. Reniers, NPS; E. Ryan, RSMAS; C. Smith, RSMAS; M. Wei, NRL

### Abstract:

GLAD is part of CARTHE and is designed to understand the dispersion of surface materials under the action of ocean surface processes. Ocean model forecasts were aided in the initial deployment of 300 surface drifters in the northeastern coastal Gulf of Mexico during July 2012, and the results provide context for the experiment as it evolves. The main circulation features developing during the GLAD time are discussed, and accuracy of the numerical model is examined through comparison to the independent observations from GLAD.

The Navy Coastal Ocean Model (NCOM) is used covering the Gulf of Mexico at 1km resolution nested into the global NCOM at 1/8 degree resolution. Comparisons to 3km resolution indicate the added energy in the submesoscale processes within the mixed layer. The predictive models are forced by wind stress from COAMPS with forecasts to 72 hours every day. Publicly available data were assimilated into the ocean model daily. The impact of satellite data availability is apparent as prediction accuracy greatly increased when small features were observed.

# Science Abstracts

Session: 019 - 8

Track: Models and Observations Working Together to Understand the Deepwater Horizon Oil Spill

Date: Wednesday, January 23 2:00 PM  
Type: Oral Presentation

## A nested grid based Large Eddy Simulation tool to predict flow, turbulence and transport in the near field

**Presenter:** Dongjin Kim – Georgia Institute of Technology

**Authors:** Dongjin Kim, Georgia Institute of Technology; Mehtap Cakmak, Georgia Institute of Technology; Thorsten Stoesser, Cardiff University

### Abstract:

Understanding and predicting the fundamental near field behaviour of petroleum fluids in the ocean environment is critical to inform far field transport models. The aim of this research is to develop and validate a highly-efficient large-eddy simulation tool that allows very detailed and accurate predictions of the near field of multi-phase plumes. Since this is a multi-scale problem, a local mesh refinement technique has been developed and coupled to a multigrid method to solve the filtered incompressible Navier-Stokes equations on Cartesian grids. The Wall-Adapting Local Eddy Viscosity (WALE) subgrid model is used to predict subgrid scale stresses. In a first step, the new LES tool is verified for a jet in cross-flow and a buoyant plume in cross-flow using experimental data previously reported in the literature. Instantaneous and turbulence statistics are compared to experiments and overall good agreement between measured and computed quantities is found. The details of the turbulence structure in the near field are revealed by visualizations and animations.

Session: 019 - 9

Track: Models and Observations Working Together to Understand the Deepwater Horizon Oil Spill

Date: Wednesday, January 23 2:15 PM  
Type: Oral Presentation

## Simulating the effects of dispersant, droplet size, and flow rate on the subsea far-field biodegrading oil from the Deepwater Horizon spill

**Presenter:** David Lindo-Atichati – University of Miami

**Authors:** David Lindo-Atichati, University of Miami; Claire B. Paris, University of Miami; Matthieu Le Hénaff, University of Miami; Michael Schlüter, Hamburg University of Technology; Katrin, Laqua, Hamburg University of Technology; Rudolf Muller, Hamburg University of Technology; Ana Gabriela Valladares, Hamburg University of Technology

### Abstract:

During the Deepwater Horizon oil spill, crude oil and natural gas flowed into the Gulf of Mexico from 1520 m underwater. A multi-scale numerical framework, the Connectivity Modeling System, nested the highest Resolution Ocean Predictions Systems available for the region, and incorporated an oil-fate stochastic module to simulate the surface and subsurface oil behavior. The validated model provided a baseline for further assessment of the transport and fate of oil products. Here we incorporate degradation rates and initial droplet sizes distribution estimated from lab experiments, and variable flow rate. By carrying sensitivity analyses on the effects of dispersants on oil droplet sizes, we obtain time series of the three major depth stratifications of the oil which are linked to thresholds of particle size in the model and to temporal evolution of the circulation. The deeper plume formed initially translating to the SW, while the shallower plumes transported oil products to the NE and SE, respectively. This 3D model provides valuable insights to further assessment of the spill impacts on key ecosystem components, and offers a greater analytic capability to forecast impacts of future threats.

Session: 019 - 10

Track: Models and Observations Working Together to Understand the Deepwater Horizon Oil Spill

Date: Wednesday, January 23 2:30 PM  
Type: Oral Presentation

## Contour-based averaging of oil location data and model ensembles

**Presenter:** Arthur Mariano – U of Miami

**Authors:** Arthur Mariano, University of Miami; Ed Ryan, University of Miami; Juan Restrepo, University of Arizona; Shankar Venkataramani, University of Arizona; Steven Rosensthal, University of Arizona; Emanuel Coelho, University of New Orleans; Gregg Jacobs, Naval Research Laboratory

### Abstract:

The problem of averaging and assimilating estimates of oil locations from both observational data and numerical model estimates is analyzed for the 2010 Deepwater Horizon oil spill in the Gulf of Mexico. A contour-based blending procedure is defined that is very efficient for averaging the location of large oil blobs. The boundaries of the oil blobs are digitized and the boundary points are matched between the different oil location estimates. A generalized version of the contour analysis method (Mariano, 1990) is used to average the position of the boundary points for the matched, segmented set of boundary points from each estimate. An optimal boundary for each time is calculated from all available oil location estimates and a polygon filling algorithm is then used to fill in the interior oil locations at whatever resolution is required. The advantages of using a contour-based method and just the boundary

# Science Abstracts

points for averaging and assimilating different estimates of oil blob locations are highlighted using both real data and ensembles of numerical model generated oil locations.

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Session: 019 - 11

Track: Models and Observations Working Together to Understand the Deepwater Horizon Oil Spill

Date: Wednesday, January 23 2:45 PM  
Type: Oral Presentation

## **The Deepwater Horizon Subsurface Plume Formation and Persistence: A turbulent diffusion theory model for the MC-252 Gulf of Mexico spill**

**Presenter:** Louis Thibodeaux – Louisiana State U.

**Authors:** Louis J. Thibodeaux, Louisiana State University; A. Rost Parsons, NOAA; Edward B. Overton, Louisiana State University

### **Abstract:**

Among the discoveries of Deepwater MC252 well blowout was the so called sub-surface plume. Reports documented its presence at 1100 to 1200 m with concentrations of soluble hydrocarbons, dispersants, an oxygen-deficit, oil degrading microorganisms, etc. The objective is to propose a process scenario for location, formation, content and fate, herein termed the oil-trapping layer. Based on the presence of a stratified water-column in the permanent thermocline above the blowout point, an eddy diffusion process mass balance model of oil-material in the trapping layer is developed. Simple algebraic equations result and used with MC-252 well site data calculations were performed. Key features of the oil trapping process with and w/o dispersants will be presented and discussed. Solutes rather than liquid droplets are preferentially retained. This and other finding compared to field data suggests that the theory and model proposed is a realistic explanation for the presence of and persistence of the sub-surface plume.

Session: 019 - 12

Track: Models and Observations Working Together to Understand the Deepwater Horizon Oil Spill

Date: Wednesday, January 23 3:00 PM  
Type: Oral Presentation

## **Mapping historical $\delta^{13}\text{C}$ data from sedimentary organic material in the Gulf of Mexico provides background for tracking oil contamination**

**Presenter:** Brad Rosenheim – Tulane University

**Authors:** Brad E. Rosenheim, Tulane University; Matthew A. Pendergraft, Tulane University; George Flowers, Tulane University; Robert Carney, Louisiana State University

### **Abstract:**

Through the last several decades, 291 measurements of  $\delta^{13}\text{C}$  have been published within the Gulf of Mexico. Compilation of these measurements illustrates existing petroleum seeps and establishes background data to verify potential incorporation of hydrocarbon pollution into the sediment. The fundamental difference between oil  $\delta^{13}\text{C}$  ( $\sim -27$  permil PDB) and that of marine sedimentary organic material ( $-21$  -  $-18$  permil PDB) allows discrimination between the two sources. Through time, the spatial scope of measurements has contracted toward the Mississippi-Atchafalaya outlets, and the large variability associated with riverine organic material necessitates some degree of spatial averaging. In the outer shelf and abyssal Gulf of Mexico, the data are sparser but less variable, and they are useful in delineating hydrocarbon seeps. These data offer a cost-effective screen test for incorporation of Macondo hydrocarbon into benthic environments and could eventually be used to provide verification for models of hydrocarbon transport during the spill event.

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Session: 019 - 13

Track: Models and Observations Working Together to Understand the Deepwater Horizon Oil Spill

Date: Wednesday, January 23 3:15 PM  
Type: Oral Presentation

## **Coastal Models of Oil Transport in the Gulf of Mexico during Normal and Extreme Conditions**

**Presenter:** Joel Dietrich – University of Texas at Austin

**Authors:** JC Dietrich, University of Texas at Austin; CN Dawson, University of Texas at Austin

### **Abstract:**

After the destruction of the Deepwater Horizon drilling platform during the spring of 2010, the northern Gulf of Mexico was threatened by an oil spill from the Macondo well. Transport forecasts require physics-based



# Science Abstracts

computational models and high-resolution meshes that represent the waves, tides and circulation in deep water, on the continental shelf, and within the complex nearshore environment. This work applies the ADCIRC coastal circulation model with a Lagrangian particle transport model to simulate the three-dimensional transport of oil in the Gulf of Mexico. The transport model accounts for the source of oil at the wellhead; advection due to tides, riverine discharge, oceanographic currents, meteorological forcing and breaking waves; and sinks such as evaporation and biodegradation. Transport is validated against available measurements, including satellite images of surface oil extents during the event. In addition, hypothetical oil transport is considered during two hurricane scenarios.

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Session: 019 - 14

Track: Models and Observations Working Together to Understand the Deepwater Horizon Oil Spill

Date: Wednesday, January 23 3:30 PM  
Type: Oral Presentation

## **River diversions, residence times and estuarine-shelf exchanges in deltaic Gulf of Mexico estuaries: Implications for oil spill trajectory modeling**

**Presenter:** Dubravko Justic – Louisiana State University

**Authors:** Justic Dubravko, Louisiana State University; Lixia Wang, Louisiana State University; Haosheng Huang, Louisiana State University

### **Abstract:**

A prominent characteristic of the deltaic Gulf of Mexico estuaries is their extremely complex geomorphology. Any particle or tracer being advected through these estuarine systems is likely to be trapped at some point, giving rise to significant enhancement of mixing, stirring and dispersion. Due to the highly frictional nature of the deltaic landscapes, coastally-induced water level fluctuations are greatly reduced in the upper estuary and the water residence times generally increase with the distance from the estuary mouth. Modeling of estuarine-shelf exchanges is additionally complicated by the fact that estuarine residence times are strongly affected by pulsed freshwater discharges from river diversions on the lower Mississippi River. We discuss some fundamental challenges in developing oil spill trajectory models in these systems that pertain to model resolution, spin-up times, data requirements, and model calibration issues.

Session: 019 - 15

Track: Models and Observations Working Together to Understand the Deepwater Horizon Oil Spill

Date: Wednesday, January 23 3:45 PM  
Type: Oral Presentation

## **Development of a high-resolution, three-dimensional hydrodynamic model of Galveston Bay**

**Presenter:** Matthew Rayson – Stanford University

**Authors:** Matthew Rayson, Stanford University; Edward Gross, Stanford University; Oliver Fringer, Stanford University

### **Abstract:**

Predicting the transport and fate of pollutants in Galveston Bay will be aided by the implementation of the SUNTANS unstructured mesh hydrodynamic model - capable of resolving intricate features of the coast such as the Gulf Intracoastal Waterway. There are various challenges with modeling the dynamics of geometrically complex systems like Galveston Bay. The Gulf of Mexico is a microtidal environment and therefore the variability of the coastal circulation is influenced by a variety of processes rather than a single dominant driver such as the tide. All mechanical and buoyancy drivers must therefore be implemented into the model including: tides, wind stress, freshwater discharges, atmospheric heat and evaporative fluxes, and possibly, meso-scale coastal phenomena. Understanding the influence of each of these drivers and their interaction with the topography will enable us to predict circulation patterns and residence times under a variety of conditions helping to guide future data collection and monitoring efforts, essential for a reliable forecast prediction system.

# Science Abstracts

Session: 019 - 16

Track: Models and Observations Working Together to Understand the Deepwater Horizon Oil Spill

Date: Wednesday, January 23 4:00 PM  
Type: Oral Presentation

## **3-D Numerical Modeling of the Lake Pontchartrain Basin – Real-time Forecasting. Application to the 2010 Macondo Blowout Oil Spill**

**Presenter:** Joao Pereira – University of New Orleans

**Authors:** Joao F. Pereira, University of New Orleans; Alex McCorquodale, UNO; Germana Peggion, UNO; Devin Villegas, UNO; Edward Holmberg, UNO; Ioannis Georgiou, UNO; Gabriel Retana, Brown and Caldwell; Ezra Boyd, LPBF; Andy Baker, LPBF; John Lopez, LPBF

### **Abstract:**

A 3D finite volume model of the Lake Pontchartrain basin was used in the response efforts to the Macondo Blowout Oil Spill. The hydrodynamic modeling, which complemented a daily monitoring of the slick location, was performed with FVCOM, a 3D finite-volume unstructured grid code that simulated the surface and subsurface currents. A post-processing and visualization tool (Tecplot® 10.0), was applied to obtain the particle tracking from the current fields simulated. This work was performed while using simplified boundary conditions.

The model is now prepared to be used in real-time forecasting of currents, salinity and particle tracking while using more accurate forecast data. A series of tools have been developed to allow a fast transfer of data, e.g., water temperature, salinity, wind speed and direction, from the Hybrid Coordinate Ocean Model (HYCOM) database, and atmospheric fields from the Coupled Ocean/Atmosphere Mesoscale Prediction System (COAMPS), into the 3D FVCOM model. Periods of June and July 2010 are used for testing the developed tools and the performance of the model.

Session: 019 -

Track: Models and Observations Working Together to Understand the Deepwater Horizon Oil Spill

Date: Wednesday, January 23 8:30 - 10:30  
Type: Poster

## **Analysis of Total Petroleum Hydrocarbons and Polycyclic Aromatic Hydrocarbons of Deepwater Horizon oil buried in Pensacola Beach sands and their chang**

**Presenter:** Christopher Hagan – Florida State University

**Authors:** Christopher Hagan, Florida State University; John Kaba, Florida State University; Brian Wells, Florida State University; Stacia Dudley, Florida State University; Markietta Butler-Hill, Florida State University; Dayma Wasmund-Nault, Florida State University; Markus Huettel, Florida State University

### **Abstract:**

In this contribution we present data on Total Petroleum Hydrocarbons (TPH) and Polycyclic Aromatic Hydrocarbons (PAHs) and their spatial and temporal degradation patterns in Pensacola Beach sediments, Florida in the months after the Deepwater Horizon oil washed onto Florida's beaches in 2010. Sediment cores were taken from Pensacola Beach beginning June 30, 2010 and following collection of cores on three dates in July were then taken approximately once per month thereafter. Cores were sampled from three areas, starting in the saturated intertidal zone and moving inland with the second core taken at the high water line and the third core collected from the more dry sediment just above the spring tide high water line. Cores were analyzed for TPH using a GC/FID and for the EPA 16 Priority PAHs using GC/MS/MS. This data will be used to create a timeline of TPH and PAH degradation over space and time on Pensacola Beach and also to assess the effects of BP's "Operation Deep Clean" by comparing hydrocarbon concentrations in the beach sediments before and after the cleanup effort.

# Science Abstracts

Session: 019 -

Track: Models and Observations Working Together to Understand the Deepwater Horizon Oil Spill

Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

## Oil Slick Dispersion Simulations: Experiments with the BIOCAST System

**Presenter:** Jason Jolliff – Naval Research Laboratory

**Authors:** Jason Jolliff, NRL Stennis; Travis Smith, NRL Stennis; Sherwin Ladner, NRL Stennis; Robert Arnone, USM; Sergio deRada, NRL Stennis

### Abstract:

The Naval Research Laboratory is developing nowcast/forecast systems designed to combine satellite ocean color data streams with physical circulation numerical models to produce prognostic fields of ocean surface optics. The Deep Water Horizon disaster provided a test case for the Bio-Optical Forecasting system (BIOCAST system) to rapidly combine the latest satellite imagery with surface ocean circulation fields and produce oil slick dispersion scenarios. In one such sequence of experiments, MODIS true color images were combined with high-resolution surface circulation fields from the Coupled Ocean-Atmosphere Mesoscale Prediction System (COAMPS) to produce 96-hour oil trajectory simulations. In another case, longer-term regional circulation model results were combined with oil slick source/sink scenarios. Collectively, the experiments suggest how the different scales of space-time make disparate demands of any potential nowcast/forecast system designed specifically for environmental disaster response.

Session: 019 -

Track: Models and Observations Working Together to Understand the Deepwater Horizon Oil Spill

Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

## Healthy Gulf, Healthy Communities Regional Forum

**Presenter:** Angie Lindsey – University of Florida

**Authors:** Tracy Irani, University of Florida; Sebastian Galindo; University of Florida; Angie B. Lindsey, University of Florida; Deidra Slough, University of Florida; J. Glenn Morris, Jr., University of Florida

### Abstract:

On April 26, 2012 the Community Outreach and Dissemination Core of the Healthy Gulf, Healthy Communities project held a Regional Forum at four different sites in Florida. The purpose of the Forum was to work with

community leaders to develop strategies for managing future disasters, discuss project plans, identify research products that benefit communities and provide network opportunities. The Forum included three discussion topics that were in alignment with the research projects in the grant. They included individual and family resiliency, community health and resiliency, and seafood safety. Participants worked in groups to complete a SWOT analysis, needs assessment and strategic direction segment. Sites then came together through videoconference to share their insights. The findings were consistent among the groups. Groups discussed the lack of transparency within government organizations, underutilizing volunteers and a need for stronger communications as major barriers during the environmental crisis. However, they stated that community collaboration was strong.

Session: 019 -

Track: Models and Observations Working Together to Understand the Deepwater Horizon Oil Spill

Date: Wednesday, January 23 8:30 - 10:30

Type: Poster

## Surf-Zone Mobilization and Alongshore Movement of Residual Sediment and Oil Balls Left from the Deepwater Horizon Oil Spill

**Presenter:** P. Soupy Dalyander – USGS

**Authors:** P. Soupy Dalyander, Joseph W. Long, Nathaniel G. Plant, and Dave Thompson, USGS

### Abstract:

During the Deepwater Horizon spill, some oil that reached the surf zone of the northern Gulf of Mexico mixed with suspended sediment and sank to form sub-tidal mats. If not removed, these mats can break apart to form surface residual balls (SRBs) and subsequently re-oil the beach. In this study, a method was developed for estimating SRB mobilization and alongshore movement. A representative suite of wave conditions was identified from buoy data for April 2010, until August 2012, and used to drive a numerical model of the spatially-variant alongshore currents. Potential mobilization of SRBs was estimated by comparing combined wave- and current-induced shear stress from the model to critical stress values for several size SRBs. Potential alongshore flux of SRBs was also estimated to identify regions more or less likely to have SRBs deposited under each scenario. This methodology was developed to explain SRB movement and redistribution in the alongshore, interpret observed re-oiling events, and thus inform re-oiling mitigation efforts.

# AP1 - Teacher Workshop

As part of their sponsorship, the National Science Foundation (NSF) asked that regional teachers be invited to participate at the conference. The conference organizers waived the registration fees for participating teachers. NSF funding provided travel for 4 teachers from TX, MS, AL and FL. Louisiana Sea Grant provided matching funds to support local travel costs for a teacher from LA and MS-AL Sea Grant provided staff time and travel to organize and attend the conference and teacher workshop. The Gulf region Sea Grant entities collaborated in identifying teachers. MS-AL Sea Grant conducted a breakout session in advance of the conference to identify general elements and approaches to translate science into the classroom (see addendum below ) and a workshop on the final day of the conference to capture lessons learned, educational opportunities, and educator needs coming out of a science conference. Those notes and a synthesis of the workshop are captured here.

## Key points:

- Teachers and students want to be involved in real science
- Research should be relevant to the students, and it is best if the data that is collected by students are incorporated into a large-scale publically shared monitoring or research activity or at least made available on the web or in newspapers
- Teachers that increase their content knowledge and enjoy learning the topical information are more likely to spend more time teaching those topics and concepts
- Many scientists under or overestimate student content knowledge and therefore their presentations are not at the right level, but their direct interaction with students is extremely valuable and demonstrates the diversity of research topics and sciences (e.g. not all scientists are in a lab coat)
- Partnerships between teachers and scientists can be mutually beneficial and take advantage of each of their strengths; the students are great beneficiaries from those partnerships
- There are multiple ways to share science in the classroom and there is no single approach that works for all situations; a combination of approaches is advantageous
- Teachers would like direct access to
  1. scientists to enter their classroom and share their work in-person or remotely (live or taped);
  2. presentations (PowerPoints or videos) from conferences to share with their students and test them on the material;
  3. data (or subset of data) collected by scientists so students can strengthen their analytical skills and compare with their own test results;
  4. opportunities to increase content knowledge and develop lesson plans through workshops, scientific conferences, summer internships, teacher at sea and similar programs.
- Teachers that participate in activities should be provided honorarium, stipend or other compensation for their personal time and effort in science outreach and education activities

# AP1 - Teacher Workshop

## Strategies to get research efforts that are underway and research results into the classroom

- Bring scientists into the classroom—they can be briefed by teacher ahead of time to discuss their research topics that meet benchmarks and to provide content at the right level
- Field work—allows students to be part of the process and do something tangible, authentic and relevant
  - Tie into existing frameworks such as monitoring programs or large scale research projects
  - One example is for students to participate in water quality testing and the results are shared in the local paper
- Provide raw data that has been collected by scientists
  - Allow students to use analytical skills to interpret raw data and then compare with scientist's interpretation
- Bring year-long activities into the class such as aquariums that are set up, WQ (WebQuest system) tested and used throughout year, grow-out programs such as paddlefish grow-out (from eggs at beginning of year to juveniles that are released at the end of year) and plantafish.org
- Travelling science displays/vehicles—bring science to the school to share specific topics and content, which allows the same material and information to be shared across a large geographic area and not overburden the school district or teachers with funding and setting up permanent equipment
- Science fairs—scientists can mentor students from formation of project idea through final display
- Field trips—are ideal but many school districts do not allow them until all testing is completed at the end of the school year, which limits opportunities to the last month of school
- Include home schooled students through the web and homeschool groups that teach science
- Train scientists on how to engage with the public and teachers; a collaborative approach can be used where the teacher and scientist co-teach a topic to ensure it is at the right level
- Provide presentations, methods, and research results for teachers to convert the content into something useable for the classroom and learning level; this would be teacher initiated if the basic content was provided
- Connect to the public through the classroom by having school, school district, and/or Parent Teacher Organizations highlight the scientist(s) coming to the school and possibly offering public venue for them to share results in addition to the classroom teaching
- Provide teacher professional development opportunities that focus on content, activities, and generating lesson plans to apply to the classroom (e.g. workshops, video conference, teacher at sea, internships)
- Provide support for teachers to attend future conferences but pre-select teachers that would be committed to this activity, provide supplemental information for the teachers ahead of time and have specific expectations and deliverables from the teachers after the conference
- Profile scientists and industries so students learn of different career opportunities



# AP1 - Teacher Workshop

## Technology uses

- Skype to bring scientists into the classroom whether at sea or in the lab
- Simulation models can be used and are especially valuable when there is an interactive component where decision points must be made (e.g. Oregon Trail)
- Interactive maps and cartoons can be beneficial in sharing science concepts (e.g. Science on a sphere)
- Video documentaries can be used in the classroom with follow-up questions
- Use alternatives to books such as web-based interfaces
- Science education webpage(s) offer customized products that can be used in the classroom (e.g. lesson plans, simulation models, data, resource guide, scientist contacts, articles and video clips written at high school level and with accompanying questionnaire for students to complete)
- Develop a platform on the web for teachers to share ideas, lesson plans, etc. and communicate with each other and the willing members of the scientific community.

## Challenges

- Field trips cannot be completed until school year testing is finished
  - Possible solutions: bring science to the school via technology, equipment, travelling displays, etc.
- Resources for science equipment (aquariums, greenhouses, weather stations, etc.) is limited or there is sometimes a grant that provides initial funds for it but no funds available for training to use equipment, maintenance, repairs, or refills (e.g. water testing solutions) so not able to be used over the long term
  - Possible solutions: provide long term grants that are front loaded to provide the initial equipment to a large number of classrooms and teacher training and then multi-year “maintenance” funds to provide equipment repair and hotline for technical and other support.
- Scientists cannot commit an entire day (or two if split schedule) to come to every science class
  - Possible solution: bring multiple scientists to school, have advertised after school presentation for public (although attendance may vary) or use Skype

## Evaluation

- Evaluation needs to be a long term commitment and designed before project implementation
- The evaluation should include an analysis of how funds have been used and how long they were used to implement the project
- Use a mixed methods approach pre-test/post-test for content (e.g. teacher training, students), attitudinal (teachers comfort level in subject, pre- and post-workshop), and interviews (what was learned and what was important)
- Collect numerous metrics and track students after they graduate
- Approach the evaluation as a partnership (scientist create the evaluation of content material and teacher collects the data)

## Potential actions that can be implemented soon

# AP1 - Teacher Workshop

**Gulf of Mexico Research Initiative (GOMRI)** At the workshop, GoMRI representatives discussed the following actions that can be implemented by the program in the near-term.

Provide web space for teachers to share ideas and lesson plans and communicate with each other and the GOMRI outreach team

- Generate list of GoMRI scientists and outreach specialists willing to visit or Skype into classroom (organize by specialty and make publically available)
- Contact GoMRI PIs to request specific PowerPoints and data
- Create an education resource page on GOMRI website that is easy to access and well organized and links to content that is not otherwise easy to access
- Generate list of teachers that would like to engage with scientists and/or have access to GOMRI educational resources (possible leads to identify teachers and share results include NSTA, NMEA, biology teacher association, environmental science teacher association, state science teacher)
- Provide relatively nominal resources to teachers to purchase and maintain equipment related to GOMRI research and a hotline to a scientist to work with kids on the research, troubleshoot problems and share results (this could be done at multiple locations/schools to compare results)
- GOMRI may have funds to implement lesson plans
  - Need consistency in lesson plans to link them to all state standards
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## Teachers at the Workshop

- Share with the workshop organizers which scientists from the conference they are interested in inviting to classroom
- Share with the workshop organizers which conference presentations and data they would like or which experimental designs they would like more information on
- Develop a sample lesson plan or laboratory exercise based on conference presentations
- Beta-test GOMRI education webpage(s) when available
- Teachers may be willing to QA/QC lesson plans in classroom
-

# AP1 - Teacher Workshop

## Participants

### Texas

**Matthew Young**

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### Louisiana

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**Jeanell Sullivan**

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### Mississippi-Alabama

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### Florida

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**Lisa Pitman, PhD**

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### Other Participants

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# AP1 - Teacher Workshop

## Addendum - Notes from Teacher Breakout Session January 20, 2013

### Identify general elements and approaches to translate science into the classroom

#### Guest speakers

- Scientists discuss their research
- Prepare guest speakers to discuss topics that meet benchmarks
- Sometimes speakers are viewed as a “celebrity” by students
- Shows diversity of “scientist”—not just someone in a lab coat

#### Skype

- This can be a way to interact with researchers
- They can focus on a specific project within a theme that is being covered in the class
- This can be done while scientist are out at sea

#### List of scientists

- The list of scientists with their expertise would be very helpful
- Recruit scientists willing to meet face-to-face or via skype with classes

#### Simulation models

- JASON-hurricane simulation model
- Can be a documentary/cartoon
- Best if it is interactive where decision points are used and the outcome can change based on student input  
(e.g. Oregon Trail)
- This can be done one-on-one, small group setting, entire class

#### At-Sea Data collection

- Nautilus
- ECOGIG GOMRI group is going out on this vessel
- They are collecting videos for documentary

#### Use of Raw Data

- “Water watch” uses raw data from this program for graphing skills
- Some QA/QC of data would be helpful
- FCAT—Florida standardized test
  - Greatest challenge relates to how scientists collect and interpret data, it would be useful to help with this

# AP1 - Teacher Workshop

## Anything that does not involve books is good

- In-person interaction
- Web-based

## Science on a Sphere

- CARTHE (GOMRI project) is providing data
- DROPPS (GOMRI project) physically has one on-site at TAMU Port Aransas

## GOMRI Website

- Create an education specific page linked from the home page that has information customized for educators
- Offer free resources
  - Provide articles written at high school level and include a questionnaire at the end for the students to complete
  - Provide video clips that are easily accessible to present different topics
- CARTHE will have an education specific section of their website

## Travelling science

- WOW (Weather on Wheels)
  - Large vehicle
  - They pull in information from many stations
  - Some activities are inside and some are outside
- Local aquariums
  - Some animals are brought; includes animals from the rainforest
- Doesn't have to just be biology based
- Set up and take down for a travelling display/interactive initiative is more efficient than individual teachers setting up and taking down displays

## Field Work

- Allow students to do something tangible
- Engage in something that is authentic and relevant; it is important that the data is used
  - Tie into efforts that will use the data that is collected (Lake Ponchartrain)
  - Have information published (e.g. local paper provides water quality information that the students collected)
- Water testing
  - A shared bus can take students to three different locations to test the water
    - There was a high cost associated with this and the school did not support it
  - High school students love testing water and seeing what the changes are
    - Once per week students at schools in LA and AL do this
    - Students get their hands wet

## Science Fairs

- Have GOMRI scientists help students with science projects
- Using a mentor model is more successful than other models



# AP1 - Teacher Workshop

- Mentors should start at the beginning of the year

## Discovery Channel

- CCC streaming video access
  - Can search for specific videos by subject, organism, etc.
  - It is a single location to find many different videos
  - Activities are included with the videos

## Home School Groups

- They can engage in efforts via the web
- Science and math are subjects that home school groups address and team teach; they are looking for resources (e.g. guest presenters)
- High school kids published a field guide to plants for a park, now home school kids are using that field guide to learn about trees, etc.

## Limited access to science/environment

- Not all schools are close to water to test it
- Bring science opportunities to them
- Aquarium
  - Set one up in the classroom for interpretation
  - Test the water and other aspects throughout the year
- Opportunities to repopulate/restore through classroom activities
  - Example is a paddlefish grow-out program where students get eggs and then grow-out and release the paddlefish into the wild
  - “Plant a fish.org” –plant a mangrove and grow it out in the class then it is planted at a restoration site

## Field Trips

- Many school districts are required to finish all testing prior to having field trips, this makes opportunities limited to the end of the year (e.g. last month of school)

## Identify projects/GOMRI work that can go immediately into the classroom

- This should be “real” science—living data that are being used
- List examples of science that is underway that can be shared with the classroom
- Louisiana AP Class (Baton Rouge)---every lesson is tied to the oil spill
  - Much of this started from the video conference series that was held
  - Class uses real time data

## Good graphics are essential for understanding and interpreting data

- Examples
  - Climate change graphic with one page summary
  - Maps
  - Charts

# AP1 - Teacher Workshop

## Additional conversation with Matt Young and Alan Blackman

### Challenges

- Often there are limited funds
  - Matt purchased 33 aquariums on his own and 3-5 kids adopt if for the year and test water, etc. throughout the year
- Often scientists cannot be at the school for the entire day to teach every class
  - Can't pull the students out of their other classes so they can hear a scientist talk
  - It is challenging to do the talk after school hours since students may not participate
  - Skype and recorded information can overcome these
- Funding provides equipment but then there are no follow-up funds for repairs, maintenance, etc.
  - E.g. a school has a greenhouse to do aquaculture/hydroponics but the top of the greenhouse is gone and there are no funds to get a new one
  - Sometimes there are not operational funds to pay for the use of the equipment (electricity, etc.) or additional test kits (e.g. water test kit)
  - The PTO can help with funds at times
- We should add weight to the evaluation of funds question
  - We should evaluate how the funds were used and how long they were used
  - Example is with a weather station
    - They received the stations but they were not set up
    - They were not trained on how to use them
    - There was no money available to replace those that were damaged
    - There is turn over with teachers and the equipment is lost or knowledge on how to use it is lost
  - Require that there are demonstrations on how to use the equipment in the classroom
  - Have long-term follow-up
  - Provide a hotline for teachers to call if they have problems or give a point of contact that will be available long term
    - So that issues with equipment can be addressed
    - So that students can ask questions of the expert and get answers