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

Charles Wilson (Chair)
Gulf of Mexico Research Initiative

C. Duane Armstrong
National Aeronautics and Space Administration

Michael Carron
Gulf of Mexico Research Initiative

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National Oceanic and Atmospheric Administration

Robert Dickey
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Alan Leonardi
National Oceanic and Atmospheric Administration

Jerry Miller
Office of Science and Technology Policy

Donald Rice
National Science Foundation

Paul Sandifer
National Oceanic and Atmospheric Administration

David Shaw
Gulf of Mexico Research Initiative

Andrew Shepard
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 2nd Annual Gulf of Mexico Oil Spill and Ecosystem Science conference to be held January 2014 in Mobile, Alabama.
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.
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.
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
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.
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.
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.
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.
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.

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.
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.
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 presentations 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
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
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
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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
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
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
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 1st 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)
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.
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.

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.
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.).

**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.

**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
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.

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.
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

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.

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 rival 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
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 C30αβ-hopane as an internal conservative marker. Quantitation data for C30αβ-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.

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 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 (C1), 264/324 (C2) and 232/346 (C3) nm, respectively. The fluorescent oil component ratios, C2/C1 and C3/C1, 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.
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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.

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.

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 - 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

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±0.2 kg CH4/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
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.

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

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 13C 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 ± 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.

Session: 001 - 20
Track: Chemical Methods for Comprehensive Oil Spill Analysis
Date: Tuesday, January 22 3:15 PM
Type: Oral Presentation

Novel Bamboo-Type TiO2 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 TiO2 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 TiO2 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

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: 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.
Science Abstracts

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 µm. All the TiO2 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.

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 Joyce, 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 (δ13C) 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 δ13C space, while in radiocarbon (D14C) space, these two potential sources are separated by more than 1000‰. Thus D14C provides a more sensitive tracer to infer introduction of Macondo oil into the food web and sediments. We measured D14C and δ13C 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 14C relative to surface DIC and we found a significant linear correlation between D14C and δ13C 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.

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 234Th and its parent 238U 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 3-4 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 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.
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±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 0.8±0.12). However, two of the 25 samples showed greater alkane biodegradation.

Measurement of the bulk oxygen content (5.9±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.

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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. Rampydrolysis 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.
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. Fryisinger, 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 including 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.

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

WSO were isolated by liquid-liquid extraction,1 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.


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 analytes 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.

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 (13C) 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.
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.

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.
Science Abstracts

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 14C-free oil degradation and mixing in coastal environments with 14C-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.

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 in demanded.

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 (C27αββ-20R) and a C29 diasterane (DiaC29βα-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.

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.
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-TiO2 (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. TiO2 nanotubes showed increased oil photodegradation compared to pure oil. Microtox analysis showed an increase in water toxicity with irradiation.

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

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

Photooxidation of triaromatic steroids in Macondo well oil

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.

Photochemical and Photocatalytic Transformations of Surface Crude Oil in Seawater Systems

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

**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.

**Science Abstracts**

**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×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.

**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.

**Portable GCMS for the Analysis of Dredge Material**

**Presenter:** Amber Russell – BTS

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

**Abstract:**

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.
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 ± 10, 822 ± 4 and 133 ± 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.
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 showed specific biomarker patterns in terms of the hopanes (m/z 191), the diasteranes and regular 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 (494–509 ppm) and PAHs (41000–149119 ppb); however, the extracts from background samples have lower level of alkanes (0.7–6.0 ppm) and PAHs (20–1200 ppb). This work provides important information to monitor the fate and transport of petroleum contaminants released from the Deepwater Horizon spill and provides information regarding differences between background and oil contamination that can be used as reference parameters.
Science Abstracts

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

Abstract:
Integrated remote sensing and water quality sampling were conducted to evaluate the extent of impact to marshes following the Deepwater Horizon oil 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 unoiled marshes, reflecting the senescence of the intact vegetation.

Macondo 252 Oil in Louisiana Salt Marshes

Presenter: R. Turner – 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 biogradation indices are compared to explore the degree of recovery in time and space, and to develop baseline values to measure the degree of oiling.

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 Zuijdgeest, Swiss Federal Institute of Technology, Zurich; Corine Samaras, FSU; Chris Hagan, FSU; John Kaba, FSU; Brian Wells, FSU; Stacia Dudley, FSU; Matt Smith, FSU
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⁻¹ 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 oiling. 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⁻¹ 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.

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-clean up. 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.
Science Abstracts

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 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.

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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.

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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 unoiled marsh location in Terrabonne 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
Science Abstracts

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 H2S is expected to increase in wetland sediment, making it more toxic and inhospitable to marsh vegetation. High H2S 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 H2S 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.

Microbial Community Analysis of Deepwater Horizon Tarballs

**Presenter:** Nikaela Yarbrough – University of Alabama Tuscaloosa  
**Authors:** Nikaela Yarbrough, The University of Alabama; Suja Rajan, The University of Alabama, Melanie Beazley, The University of Alabama, Patricia Sobeky, 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
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 CO₂ and CH₄ 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 CO₂ and CH₄ production on laboratory-incubated soils from 10 marshes (5 unoiled, 5 oiled) in Terrebonne and Barataria Bays. We found an increase in CO₂ 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 CO₂ fluxes, soil temperature and water content. In laboratory assays, both CO₂ and CH₄ production were greater in Terrebonne (higher OM and water content) than Barataria soils. CO₂ 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.
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 “buttered” emulsion (250mg) resulted in a high incidence of edema/axial deformities and subsequent mortality (40-90%). Suspended non-contact water exposures at the same “buttered” 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)

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.
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. Further analysis is underway to determine if species composition, size, and growth vary between oiled and unoiled sites.

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

**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.
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 biodegradation 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 ongoing. 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.

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%. By April 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.
Silent Spring Revisited: Insects and Spiders in Louisiana’s Saltwater Marshes after the Macondo Blowout

Presenter: Brooke Hesson – LSU
Authors: Brooke Hesson, Gerald Soderstrom, 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. 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.

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 Cobleentz, 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 spill (DWH) 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.

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...
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.

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.

Oiling Increases Marsh Sediment CO2 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 (CO2 flux rates) in 9 different marshes sites along the Mississippi coast (6 oiled and 3 unoiled). At each site, we measured diurnal sediment CO2 fluxes on three separate dates (September, October, December) using LiCor LI8100 Automated CO2 Soil Flux System. A strong effect of oil exposure was observed, with sediment CO2 efflux being 64% greater in oiled marsh sites compared to unoiled sites (1.31 vs. 0.80 μmol CO2/m2/s, p = 0.069). Current data are unable to discern the biological driver behind the observed CO2 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.

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

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
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.

**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.

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

**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; CH₃Hg⁺) compound. MMHG is produced in anoxic sediments by sulfate-reducing bacteria. More depleted δ34S 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 δ34S signal in consumer organisms as an indicator of sedimentary derived MMHG and assess stable isotopes δ13C and δ15N to trace MMHG throughout the Northern Gulf of Mexico food web.

**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 Bhattacharya, Louisiana State University; Kris Ackouvy, Louisiana State University; Lauren Navarre, Louisiana State University; Jizhong Zhou, University of Oklahoma; Qianxin Lin, Louisiana State University; Irving Mendelsohn, 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.

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

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⁻², 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⁻² 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 as part of a broader evaluation of how disturbance mediates relationships between microbial communities and keystone coastal wetland plants.

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

Presenters: 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.
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⁻². 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.

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.

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 (<em>Aythya</em> spp) and buffleheads (<em>Bucephala albeola</em>) taken from oiled areas in Alabama and unimpacted areas in Florida. Additional comparisons of redhead (<em>A. americana</em>) liver concentrations were made with previous reports. In all analyses, we found that concentrations were below detection limits and δ¹³C 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.
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 coupled 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.

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 unoiled 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 unoiled 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 O2 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.

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...
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.

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 Pajerowska-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.

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 amendments. 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 phototoxity is an important component of the toxicity of Macondo oil.
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

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. 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, SO4 & TPH were evaluated.

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

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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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.

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 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.
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.

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.
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.

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.

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.
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 Gibeaut 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 (DPSER) 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.

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.

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,
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.

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.

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, BBCP, 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.
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.

**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,
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.

**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.

**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.

**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
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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.

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.
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.
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limitations, both in containing the oil spread and in allowing recovery of the spilled oil.3-5 We present efficient, biobased small molecule solidifiers for oil remediation and spill clean-up.6 By varying the sugar head group (mannitol, sorbitol and xylitol) and alkyl tail group (C4-C14) 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.

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 CO2, CS2 and carboxylic acids. The ability of the ammonium dithiocarbamates and thioureas, obtained by addition of CS2 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.

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.

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
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.

**Science Abstracts**

**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

**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.

**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.
Science Abstracts

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 LD50 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 DISPERGANTS 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; Xia 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
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.

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.

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.

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
Science Abstracts

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 slower 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
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.
Science Abstracts

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.

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.

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 diocylsulfosuccinate (DOSS), a component of Corexit dispersants used here. In 92 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

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 12:15 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 off 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
A Smart Oil Spill Dispersant Formulation for Reduced Environmental Impact and Consumption

Presenter: Courtney A. 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.

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

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.
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 olate 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.

**Sub-sea oil spill dispersant effectiveness. A new evaluation methodology**

**Presenter:** Nicolas Passade-Boupat – Total

**Authors:** Nicolas Passade-Boupat, Total; Marianna Rendon 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.

**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 Pins, 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 Pins, 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.
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.

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**

**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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**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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**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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**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

**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
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(ε-caprolactone) (PCL), is attractive for inner block as it can absorb nonpolar 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.

**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 µL) 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 (Twee 80), and sorbitan trioleate polyethoxylate (Twee 85), as well as the hydrolysis transformation products of DOSS (α/β-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.

**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) functionalyzed 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 functionialized 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 functionialized CB make these composite particles attractive agents for oil emulsification and enhanced surface oil removal.
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 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

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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.

**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).

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-propanediol 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-propanediol glycol.

To determine the rates of indirect photolysis, irradiation experiments were conducted in Gulf of Mexico seawater and Macondo crude oil matrices.

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.

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
(DTAB) and non-ionic surfactant penta ethylene glycol monodecyl ether (C10E5) 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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**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.

**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...

**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.
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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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Track: Dispersant: New Developments in Science and Technology and Implications to Deep Sea Oil Releases
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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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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 Dioctylsulfosuccinate (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

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.
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.

**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 CO2-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.

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**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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**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
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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.

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 m2/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 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.
Plankton Dynamics Following the BP Oil Spill

Presenter: Kendra Daly – University of South Florida

Authors: Kendra Daly, University of South Florida; L. Schwierzke-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 µg L-1) and detritus concentrations (62,470 per m³) 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 ind m³), had very low densities and was replaced by Temora turbinata (2011 maximum abundance: 643 ind m³) as the dominant species.
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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 µL L\(^{-1}\) (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.

**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 (LC50), and growth inhibition (IC50) 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. IC50 levels ranged from 44 to 698 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. LC50 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.

Potential Food Web Impacts Following the Deep Water Horizon Oil Spill: Toxicity Effects on Phytoplankton and Zooplankton

**Presenter:** Amber Garr – Harbor Branch Oceanographic Institute

**Authors:** Amber Garr, Harbor Branch Oceanographic Institute; Susan Laramore, Harbor Branch Oceanographic Institute; Will Krebs, Harbor Branch Oceanographic Institute; Zoe Wambaugh, Humboldt State University

**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 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
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 WFFS 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.

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 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.
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.

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 to enter 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.
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.

**Science Abstracts**

**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 μm yr⁻¹.

**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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Session: 005 - 14
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.

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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
catastrophic effect on settlement, but we also found high natural variability that could mask even large impacts and so further monitoring is necessary.

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.

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 Louchoiarn, Texas A&M University

Abstract:
Live, benthic foraminiferal assemblages were compared at oiled and unoiled 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-μm. 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/10cm3 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.
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.
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 3H-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.
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 µm 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.

Phytoplankton associations in the vicinity of DeSoto Canyon, northwestern Gulf of Mexico: Preliminary results

Presenter: James A. Nienow – Valdosta State University
Authors: James A. Nienow, Valdosta State University; Anna Shultz, Valdosta State University

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 LC50 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 LC50 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 x1011; 10 mg/L: 5.91 x 1010; 20 mg/L: 1.36x1010 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
consequences for the complex trophic interactions of coastal ecosystems in which M. leidyi plays an important role.

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**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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**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:**

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.
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.

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, 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.
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. Wetzel, 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 (bailed 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 sub-lethal effects on immune function, reproductive capacity, and genotoxicity in fish from affected and unaffected areas.

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.

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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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.

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 Mieve, University of Florida; Alan Beers, University of Florida; Andre Espaillat, 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-exposure 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.

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.
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. Merkens, 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.

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.
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-ethoxycoumarin O-deethylase (EROD) activity in liver. We collected over 500 fish during and after the oil spill, including Lutjanus campechanus (red snapper), Balistes capriscus (grey triggerfish), Pagrus pagrus (red porgy), and Seriola dumerilii (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 biliverdin 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.

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 Institute of Oceanography; Mark A. McDonald, WhaleAcoustics; Sean M. Wiggins, Scripps Institute of Oceanography; Simone Baumann-Pickering, Scripps Institute of Oceanography; Marie A. Roch, Scripps Institute 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.

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.

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.
**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.

**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.
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.

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.
Session: 007 Ecosystems of the Open Ocean: Microbes Mammals and Models—Analysis and Modeling

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 (947µ 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 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.

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.
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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° 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 σ-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 O2 and CO2. The model receives (initial) boundary information from the operational 1/8º 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 1/2º 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; Lianyuan 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.rms.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.
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.

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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 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.
Review of Slope Circulation between the Mississippi Delta and DeSoto Canyon from Observations

Presenter: Peter Hamilton – SAIC

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 though 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.

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

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 northern Gulf of Mexico.
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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.

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.

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: CO2 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 CO2 using a wave
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.

**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.

**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

**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.
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.

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.

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-
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.

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.

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\(^{-1}\) (~500 m d\(^{-1}\)) even at depth, suggesting strong upwelling signals along the northern rim of the DeSoto Canyon consistent with remote sensing studies.

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
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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**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 DeepC 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 rafos floats were deployed at the depth of 300 meters.
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.

**Science Abstracts**

**Session: 009 The Submesoscale Route to Transport and Mixing**

**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.

**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, 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. Oloscoaga, 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.
Ensemble Forecasting in the Gulf of Mexico during the CARTHE-GLAD experiment

**Presenter:** Patrick Hogan – Naval Research Laboratory


**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 of 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.

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.
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.

Can satellite chlorophyll data be used to monitor submesoscale transport and mixing in the ocean?

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.

Upper ocean energetics during the Grand Lagrangian Deployment (GLAD) Experiment

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.
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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 sec) with a small amplitude O(0.2 m) swell and at 0.6 m below the surface, the TKED typically varies by a factor of 2 within a single wave.

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 determinisitic 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.
stratification, FS at MP is almost entirely determined by QfS0 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 QfS0 with a negligible contribution from FE or FT.

Inertial Currents in the Northern Gulf of Mexico During The GLAD Experiment

Presenter: Ad Reniers – rsmas/um

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.
**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; Sh elley Riedlinger, Naval Research Laboratory; Eric Rogers, Naval Research Laboratory; Clark D. Rowley, Naval Research Laboratory; O.M. Smedstad, QuiniteQ 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.
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.

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 AVHHR. 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/). 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).

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.

Evaluating forcasts 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
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.

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.

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; Xiaqian 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, nonlinear 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  

**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
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.

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.

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.

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
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 mis-aligned 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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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.

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...
contributions is highly complex under fast-turning winds in a moving tropical storm.

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 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.

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.

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.
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.

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.

BOEM’S RECENT ADVANCES IN OIL SPILL MODELING IN THE GULF OF MEXICO

Presenter: Rebecca Green – Department of the Interior/BOEM

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.

Ocean Condition Forecasts Using a Multi-Model Consensus during the Grand Lagrangian Deployment (GLAD) Experiment

Presenter: Emanuel Coelho – UNO/NRLSSC

Abstract:
GLAD is part of CARTHE and is designed to understand the dispersion of surface materials under the action of ocean surface processes. Several
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 NCOM 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.

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

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.
Science Abstracts

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.

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°, ~1.8 km) ocean model based on HYCOM, which includes the majority of the northern gulf coastline. Nested within the lower-resolution (1/25°, ~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.

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
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) has 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.

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.

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 Atmósfera 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
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.

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 representor 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.

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.

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
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.

**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.

**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.

**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
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

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 spilt. 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.

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. Fontham, 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.

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. Fontham, 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.
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.

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 average 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.

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?
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.

Behavioral Health in the Gulf Coast Region Following the Deepwater Horizon Oil Spill

Session: 011 - 9
Track: Public Health Impacts of the Deepwater Horizon Oil Spill
Date: Tuesday, January 22 11:00 AM
Type: Oral Presentation

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
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.

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.

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 re-opened 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.

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. Fontham, 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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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.
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.

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 (SOD1, 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
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.

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.

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.

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. Ososky, 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
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.

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.

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.
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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.

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. Fontham, 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.

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: Aacenaphthenequinone (ANQ), 1,4-Anthraquinone (AQ) and 9,10-Phenanthrequinone(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...
concentrations (10µM and 20µM), but ANQ did not oxidize NADPH. The DNA strand scission assay showed that damage caused by 20µM PNQ is similar to that caused by 0.5µM 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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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)
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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.

Seaweed 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."

Healthy Gulf—Healthy Communities: Areas of Concern for Community Agencies

Presenter: Samuel R. 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
• 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.

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**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. Fontham, 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.

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**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, jamiezhang@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.
**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.

**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.
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

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.

Enhancing Community Resiliency through Cooperative Extension Training

Presenter: Paul Monaghan – 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.

Surviving the Spill: The Seafood Supply Chain in Alabama and Mississippi After the Deepwater Horizon Disaster

Presenter: Stefanie Christensen – 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.
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 Ballestero – UNH/Coastal Response Research Center

Authors: Heather Ballestero, 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).

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.
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. Fenthham, 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 Trapido, 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; Theresa Goedeke, NOAA National Centers for Coastal Ocean Science; Susan Lovelace, NOAA National Centers for Coastal Ocean Science; Susan Lovelace, 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.
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.

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:**
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,
subscaler 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 gage the financial impact on individuals and families as they make important financial decisions that may impact outcome.

**Science Abstracts**

**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:**  
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.

**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  
**Abstract:**  
We present preliminary results of a study that examines the perceptions of people living in the Gulf of St. Lawrence, Canada, regarding the proposed oil and gas development in the Gulf. The study is part of a larger project that aims to understand the socio-economic impacts of the Deepwater Horizon oil spill on the Gulf of St. Lawrence. The study uses a survey-based approach and includes interviews and focus groups to gather data from a diverse range of stakeholders. The results of the study show that there is a high level of distrust towards oil and gas development in the Gulf, which may impact the tourism and economic activities in the area.
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.

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.

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.
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.

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 CH4) 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 µM 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.
Dissolved methane and CO2 in the Gulf of Mexico post Deep Water Horizon oil spill.

Abstract:
Using profiles of methane concentrations, δ13C values of methane and dissolved inorganic carbon (DIC), and Δ14C 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-1. δ13C 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. δ13C values of the DIC dropped from 1.1 - 1.3‰ at the surface to 0.6 - 0.8‰ immediately below the chlorophyll and CH4 maxima. The Δ14C 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.

Spills, seeps, and pelagic foodwebs in the Northern Gulf of Mexico: What do stable isotopes tell us about oil, gas, and discolored zooplankton?

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 δ13C of particles, low δ13C 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 δ13C (~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.
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.
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.

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

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.

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.

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/cm2/yr (Th-234 dating), as compared to pre-event rates 0.06-0.1 g/cm2/yr (Pb-210 dating). Re-collection of cores during Sept. 2011 indicated that sediment MAR's of 0.1-0.2 g/cm2/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.
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 (210Pb,234Th) documents an order of magnitude increase in mass accumulation 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.

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,
diversity, or species composition could be detected. Preliminary results of these analyses will be presented.

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; Chagyoon 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 in 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 (Eh=350 mV) or reduced (Eh=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.
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; Aij 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.

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 Limnologia; 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 ± 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
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 coastal 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.

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 HgCl2-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.
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.

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 O2, depletion of this electron acceptor may indicate the past presence of hydrocarbons. Here, we present attempts to quantify O2 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.

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 C14-C42, 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.
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 km 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 (~ 0.1 ± 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.

Optimization of proteomic profiling in the deep sea black coral, Leio pathes 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.
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.

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 cyclone 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.
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.
Science Abstracts

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

Session: 014 - 5
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
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.

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.

Science Abstracts

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

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.

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
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.

### Relating Interfacial Mechanics and Coalescence Behavior of Irreversibly Adsorbed Tween 80 Layers at Oil/Water Interfaces

**Presenter:** Matthew Reichert – 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.

### 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.

### Oil droplet-Ambient Particle Aggregation in Marine Environments

**Presenter:** Christopher Fuller – Clarkson University  
**Authors:** Manognya 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
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.

**Abstract:**

**Authors:**

Ali Khelifa, Environment Canada

**Presenter:**

Ali Khelifa – Emergencies Science and Technology Section / Environment Canada

**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

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**Science Abstracts**

**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 um. 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.
Science Abstracts

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 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 - 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.
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.

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.

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, Humboldt 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-1. Control treatments (without oil added) were run simultaneously. High mortality rates (ca. 90%) were observed at crude oil concentrations ≥ 50 µl L-1. Mortality due to crude oil exposure was lower than 10% at concentrations of 10 µl L-1 in all studied zooplankton communities. However, crude oil concentrations of 10 µl L-1 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

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**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 µl L⁻¹ for 3 days in dim light. Survival of nauplii decreased from ca. 70% at 1 µl L⁻¹ to 10% at 25 µl L⁻¹ after 72 h, with a median lethal dose (LD₅₀) of 2.5 µl L⁻¹. Negative effects (mortality + morbidity) were higher than 80% at concentration ≥ 1 µl 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.

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**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.

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**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 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**

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 µl 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: 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.

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**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.
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.
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.

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.

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 Methylococccaeae. 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. Methylococccaeae 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
Science Abstracts

‘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.
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.
Changes in the redox state in pore water and marine sediments following the 2010 BP blowout

Presenter: David Hastings – Eckerd College


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, 13C, 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 HNO3 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 0.08 ppm, respectively, no significant enrichment of these metals is observed in these sediments. High sedimentation rates, depleted 13C 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.

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; Mahmoud 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 “Psedomonas”. This new approach is expected to have applications in monitoring biological properties of the sea surface.
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 Chanthamonti, University of Calgary; Melissa 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 homogenously 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 asphaltenes. 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 biodegradation in lab experiments and in natural reservoir profiles under aerobic and anaerobic conditions will be shown as well as indicators of microbiological activity.

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...
Science Abstracts

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:

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 key genes involved in response to oil and dispersant exposure.

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 key genes involved in response to oil and dispersant exposure.

The use of -omics to detect enviornmentmal 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 tens 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.

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.

Session: 015 - 17
Track: Biodegradation Pathways and Environmental Impacts of Hydrocarbon Discharge-omics and Biogeochemistry Approaches
Date: Tuesday, January 22 2:00 PM
Type: Oral Presentation

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

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

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]
protein transport and breakdown, cytochrome P450, and DNA repair responses. Predicted metabolite turnover demonstrated differential metabolism of sulfur-containing and phenolic compounds.

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.

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 (cypsla, 1b1, 1c1, 3a65; plus ahrr and sult6b1) displayed greater levels of up-regulation compared to oxidative stress genes (nqo1, prdx1, hmx1 and pgm1) 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.
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.

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.
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; Qingzi 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 mousse 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 traces 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.

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, un-impacted) to evaluate spill effects on indigenous bacterial communities. Natural Delta C-14 and del C-13 abundances were used to trace in situ bacterial hydrocarbon remineralization to dissolved inorganic carbon (DIC). BB DIC samples were significantly deplete 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.

Science Abstracts
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.

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. Mesocosms 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.
The designed mesocosm for the coastal marsh wetland in this study consists of two mud modules (MMs) with different elevations to enable evaluation of phenanthrene, pyrene, and benzo[e]pyrene degradations in sediment that is intermittently emerged by tidal movement or constantly submerged. The MMs are placed in a tank above an air chamber inside the tank filled with water. The water level (tidal movement) is controlled by filling the air chamber with air and letting the water back to the air chamber periodically. The experiment, with triplicate and one control mesocosms, took place for 15 weeks. Samples were taken weekly from each MM in the mesocosm using a straw and then the sample extracts were analyzed on a HP 5890 GC/5972 series mass selective detector using EPA Method 8270. The results show that PAH degradation rates in the intermittently emerged sediment (0.012 day\(^{-1}\) – 0.043 day\(^{-1}\)) are higher than those in the submerged sediment (0.011 day\(^{-1}\) – 0.024 day\(^{-1}\)) due to facultative degradation reactions and physical exchange processes.

**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.

**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...
suggestions 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.

**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 Dodia, 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 N2O 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 N2O 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 CO2 and CH4 emission rate than the other treatments without the biosurfactant. Nitrogen had a less effect on CO2 and CH4 emission but strong impact on N2O generation. Crude oil, on the other hand, appeared to inhibit N2O 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.
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.

**Science Abstracts**

**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 (gltA), 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 gltA and bssA mRNA clone sequences demonstrated that members of the aromatic hydrocarbon-degrading Geobactereceae 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 gltA, bssA and mcrA peaking in winter. BssA and gltA transcript levels followed an identical trend, suggesting that anaerobic aromatic hydrocarbon degradation is dominated by the Geobactereceae. The results of qPCR demonstrated a 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.

**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
**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.

**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 (DO2) 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 DO2 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.
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, UMCEES

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

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 Hastings; Florida State University: Jeff Chanton; Georgia Tech: Joel Kostka

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 (C5-C40). A sub-surface intrusion at 1000-1300 m depth occupied an estimated area of 4500 km2 (or 1500 km3), 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 - 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:

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.
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 O2 minus ambient O2 concentrations allow for calculations of net O2 sediment-water fluxes. Over a six month period at MC118, ambient O2 concentrations within a meter of the sediment surface ranged from 120 to 180 µM. Chimney dissolved O2 concentrations controlled by sediment demand ranged from ambient to near zero µM 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.

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 of 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-O2 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.
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.

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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 throughout 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 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.

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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
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 (≤ C17) alkanes were preferentially degraded over high molecular weight (> C17) 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.

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.

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
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.

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 Daivs 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 Imagex 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 (0-40db) 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.

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 Larther, 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.

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...
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; 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.

**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:**
Calcarenous 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.
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 Napthalenes, Phenanthrenes, and Chrysenes by GCMS using 13C 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.

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Increase in Nickel and Vanadium Concentrations in Sea Bottom Sediment Collected from the Continental Shelf off of Western Florida after the Deepwater Horizon Oil Spill

**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.
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.

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
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.

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:

The 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.

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-glutaminate (FA-Glu) were produced via fermentation. Isoforms of these biosurfactants will be purified and characterized for 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...
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).

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 +10+ 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.

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.

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
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

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

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 Marshal, 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

Incorporating comprehensive species data in ecosystem science and recovery initiatives

Presenter: Fabio Morettszohn – 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. Morettszohn, Harte Research Institute; T. Lacher, Texas A&M University College Station; M. Comeros-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.
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.

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 Linoleicacid 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 hypotheses that the mixture would be effective in water and that it would be more effective in fresh water than salt water.
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 Rangoonwala, 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 Lousiana, 2 in Alabama, 1 in Missisipi, 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^2 of surface waters.

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**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/) 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.

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**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.
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.

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 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⁻¹ (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.

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.
Science Abstracts

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 km² 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 - 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.

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.
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.

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.
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 micro lenses 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.

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; Mahmoud Shijvji, 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.

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...
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.

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 Lippihardt; 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 Osidelo – Southwest Research Institute

**Authors:** Olufemi Osidelo, 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.

**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...
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.

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/m3 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.
Science Abstracts

Session: 019 Models and Observations Working Together to Understand the Deepwater Horizon Oil Spill

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 (N2-fixing) organisms, which can support high rates of new production in the plume margins. Here we present direct measurements of N2- and CO2-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 mesoscale 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.

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...
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 an capability of the oil spill modeling framework, and a number of the key algorithms and capabilities included.

**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:**
Gliders are 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 STStrategies (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.

**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, Angellique 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 Jutt, 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.
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. Curchin, 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; A. Reniers, University of Miami; A. Valle-Levinson, University of Florida; M. Wei, NRL

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.

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. Curchin, 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, UD; 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.
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.

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.

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 designed 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...
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.

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 δ13C 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 δ13C 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 δ13C (~ -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.

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
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.

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.

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.
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 McCrorquodale, 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.

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 specifically for environmental disaster response. 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 produced 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.

**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.

**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.
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 usable 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
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

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

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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

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