# DEEP-C: DEEP SEA TO COAST CONNECTIVITY IN THE EASTERN GULF OF MEXICO

Consortium Director – Eric Chassignet

## ADMINISTRATION

### 1) Contract Activity

Established a subcontract between the FSU Magnet Lab and an outside entity (3D Data) in order to create a three dimensional maps using Deep-C data, plotting samples with a link to data analyses. Deep-C coordinator requested and received confirmation from Ocean Leadership prior to setting up the subcontract that pre-approval was not required since the work did not represent a "significant change" to our Consortium's scope of work.

### 2) Risks and Impacts

A number of planned cruise schedules had to be adjusted and several science days were lost this quarter due to inclement weather. *Corrective measures: Deep-C chief scientists worked closely with FIO to modify cruise schedules as needed. One entire cruise was also rescheduled (due to weather) from the previous quarter to this quarter in order to obtain the required samples.*

## RESEARCH

### 1) General progress update

**a. Accomplishments** *(Please list highlight notable accomplishments (no more than 5) under the appropriate task.)*

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**Task 1: Geomorphology and Habitat Classification**

- Conducted an acquisition and acceptance test of a Chirp Sub-bottom profiler for the MILET platform.
- Conducted seafloor mapping, deep-tow video, and sub-bottom profiling to document sedimentary processes and benthic habitat along the northern margin and slope of the De Soto Canyon.
- Conducted a bathymetric survey within a shelf break canyon off Pensacola at the site where moorings were recovered in May 2013 for circulation studies by FSU physical oceanographers (Nico Wienders and Allan Clarke).

**Task 2: Physical Transport of Particulate and Dissolved Material from the Deep Ocean to the Coast**

- Completed mooring recovery and established additional CTD and water sample stations for the Mason/Chanton biochemistry work.
- Carried out the CMR SailBuoy experiment in the Gulf of Mexico from March to May 2013 and compared the data with operational HYCOM outputs for salinity and

temperature. The Sailbuoy recovery occurred on May 15th aboard the RV Apalachee.
- Tested a new model grid extending to the west of the Mississippi River Delta was against in situ data. Model hindcast runs are now in progress covering the period 2004 through 2013.
- Prepared airborne expendable current profilers (AXCPs) at UM-RSMAS, replacing the parachutes and the cords.

**Task 3: Geochemistry, hydrocarbon chemistry, and isotope tracing**
- Established the *"Marine Oil Snow Sedimentation & Flocculent Accumulation" (MOSSFA) Working Group* – a collaborative effort between members of C-IMAGE, Deep-C, and ECOGIG. The primary goal of the working group is to integrate ongoing studies and develop new ideas and collaborations to promote a comprehensive view of the factors controlling the formation and deposition of oil-associated marine snow and its accumulation as flocculants on the seafloor, in the context of oil and gas release and dispersant application in the marine environment.
- Completed packaging of a new standard reference material for weathered oil in collaboration with the National Institute of Standards and Technology. This is a major milestone, as the NIST can now distribute this material to colleagues as a means to test methods and intercalibrate. Generally, weathered-oil reference materials are made in the lab with a hot plate. Here we are using a "natural" source, more environmentally relevant. This is also another benefit of actively collaborating with a government entity.
- Participated in the national inter-laboratory calibration experiments (Brooks Rand) for Hg (MMHg and iHG) in water samples, in order to test and validate the high sensitivity and accuracy of Hg speciation analyzer (Tekran 2700).
- Determined mercury concentrations on seagrass, small fish species living in seagrass, fish preyed on by gag grouper gag grouper and pelagic fish. Obtained muscle and liver samples from Madison Swanson Marine Protection Area.
- Developed a new technique to subsample oil films collected from oiled rocks found along the Gulf Coast. This effort has shed new light on how oil weathers as function of the oil thickness and exposure to sunlight and done at WHOI by an undergraduate student working in The Reddy Lab this summer.

**Task 4: The Ecological Pathways**
<u>Microbial and Plankton Communities</u>
- Rates, pathways, toxicity, and controls of hydrocarbon degradation in oiled sands (ecology and biogeochemistry): *Pensacola Beaches (2010-11)* – completed high-volume metagenome sequencing and bioinformatics for hydrocarbon-degrading bacteria, revealing that genes for nutrient acquisition increased in abundance in response to oiling. These genes are being extracted, amplified, and quantified (Georgia Tech, FSU, Shimadzu Corporation (http://www.shimadzu.com/); *Panhandle Shelf Bight* – effect of microbial community structure on ecosystem function using DNA extracted from sand (N=159) and water (N=72) for sequencing; sampling effort includes ciliate and foraminifera assemblages (Ga Tech, UWF); phytoplankton community structure in surface waters contains higher concentrations of lutein,

chlorophyll b and degradation products of chlorophyll a, especially along the Pensacola transect than does deeper water (DCM), suggesting that prasinophytes and/or chlorophytes form a heretofore unaccounted for and significant component of the phytoplankton (Valdosta State University).

- Test "Dirty Blizzard" hypothesis that oiled particles reached the seafloor of the De Soto Canyon (2010-2012). Completed DNA extraction and started sequencing microbial communities from 100s sediment samples. (GaTech, USF, FSU)

Fish Ecology and Macrofaunal Invertebrates

- Established Mercury Marine Ecology Workgroup combining expertise in mercury analyses and fish ecology, especially for economically important species.
- Deepwater Shark PAH biomarkers (1-3/species, 134 species, 2010-2012) -- (i) PAHs largely below detectable levels (based on Phase I PAH biotransformation enzyme activity induced by PAH exposure); where detectable, they differed little from levels in reference sites; (ii) sharks experiencing continued exposure to low PAH levels (based on activity of Phase II biotransformation enzymes that metabolize some PAHs and on PAH bile metabolites (increased pyrene and naphthalene, unchanged benzo(a)pyrene), at levels comparable to those in other human-impacted sites (e.g., contaminated by chronic pollutant sources rather than catastrophic events).
- Collaborated with USF, UM, and Florida Atlantic University building database of Gulf of Mexico (from Pulley Ridge to Macondo wellhead) for development of Atlantis food-web model.

**Task 5: The Earth System Model**

- Ran a hindcast for Hurricane Ivan using the high vertical resolution NCOM DeSoto Canyon model. Hurricane Ivan passed over the SEED observational array, which can be used for validation of the simulation. The simulation is being used to examine the deep ocean response of the canyon to a hurricane, including the possibility for cross-slope transport.
- Implemented waves in the Gulf of Mexico COAWST coupled system. The system is now ready for hindcast/nowcast simulations. Good progress has been made toward the coupled De Soto Canyon region model, a subset of the Gulf of Mexico configuration.
- Running two versions of the real-time COAMPS coupled model: both have a 6 km atmosphere, one has a 3 km ocean, the other a 1 km ocean. Analysis of the results is in progress. A "test" version of COAMPS is being run on an experimental basis to test the incorporation of the ecosystem model into COAMPS. There is still ample work to be done with the coupling and the integration of the biological and optical modules into the coupled system, but this is a positive step towards the full integration of the Earth System Model capability.
- Prepared consistent geophysical model data (wind, wave and ocean currents, density and mixing coefficients) needed as input for oil spill model testing and hindcast experiments of the Deep water Horizon oil spill. A data assimilative ocean hindcast of 4 km resolution with the HYCOM ocean model was used with a similar resolution wave model using the University of Miami wave model. Both the ocean and wave models are forced with the NCEP North American Regional Reanalysis data available

at 3-hour frequency. Evaluation of the model outputs are underway and once complete the outputs will be made available through the Deep-C data server.
- Began conducting simulations with the high resolution NGoM-HYCOM model, focusing on the impact of river plume dynamics on the hydrocarbon transport during the 2010 Deepwater Horizon incident.

**b. Obstacles (***Please note items the GoMRI's Admin Unit can assist with, such as oil samples. Include corrective measures being taken.)*

- On March 24, 2013, the Naval Research Lab (NRL) computer room suffered a catastrophic failure due to a water leak. The NRL computer room housed the local grid-engine that was being used to run the real-time COAMPS model in support of Deep-C. The COAMPS system was therefore moved to the IBM iDataPlex at the Department of Defense Shared Resource Center (at NAVO). The move was successful, despite a few issues with the SWAN wave model. These issues are being addressed and are expected to be corrected soon. The computer room failure also corrupted the "ocean color climatology" that was built for the Gulf of Mexico. *Corrective measures: The Gulf-wide and Northern Gulf Ocean Color climatologies have been reprocessed and will be backed up and distributed via the COAPS server.*

- Researchers throughout GoMRI consortia are concerned about the low availability of large ships in the Gulf of Mexico for collecting oceanographic, biotic, and abiotic samples. More recently, they have voiced concern about the lack of other at-sea sampling platforms – especially submarines and large ROVs capable of survey and sampling operations to at least 2000 m with capabilities for high resolution video and still cameras, instruments to measure environmental variables and multi-function manipulator arm(s) and sampling containers for specimen collections. *Corrective measures: Deep-C chief scientists are joining forces with colleagues from other GoMRI consortia to share cruises and maximize our capacity to buy days at sea. Also, the outcome of the preliminary discussions is that there is some possibility that NOAA and GoMRI could enter into an agreement that would allow GoMRI consortia the ability to negotiate directly with NOAA for ship time (and payment) if and when ships are available. Discussions have not yet started for the submarine and ROV needs.*

**c. Collaboration (***Please list any new collaborations with individuals or organizations outside of Deep-C that began during this quarter.)*

- Professor Kuki Chin (Georgia State University) and Professor Kirsten Kuesel (Friedrich Schiller University, Jena, Germany) collaborated with Georgia Tech ecologists to cultivate anaerobic hydrocarbon-degrading bacteria from deep sea sediments of De Soto Canyon, investigating the physiological pathways of biodegradation. Both scientists invited Georgia Tech Ph.D. students to work in their labs to learn specific cultivation techniques.
- Texas A&M University-led GISR Consortium sought out Deep-C University of West Florida to deploy their drift cards

- Tingting Zhao (FSU Department of Geography) is collaborating with Deep-C biogeochemists to map 14C on seafloor.
- Deep-C Data Center personnel began collaborating with GRIIDC to develop an automated submission process for dataset information forms using extensible markup language web service technology. These datasets are nearing a state of completion for analysis to feed into an undergraduate independent research project, a master's thesis, and several manuscripts to be submitted for publication