NGI

Northern Gulf Institute

a NOAA cooperative institute

Annual Progress Report

Reporting Period:

July 1, 2012 - June 30, 2013

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INTRODUCTION

This Northern Gulf Institute (NGI) Annual Progress Report reviews and summarizes the research and the education and outreach goals accomplished during the reporting period of July 1, 2012 to June 30, 2013. While NGI had two NOAA awards active during this time period, NA06OAR4320264 and NA11OAR4320199, the items in this report cover only award NA11OAR4320199. The report consists of two (2) sections and appendices. The first section provides the General Description of NGI, the NGI Direction, Organization and Operations, NGI Research Focus Areas and Highlights, and Distribution of funding to NGI from NOAA. The second section is titled Project Reporting. It begins with the list of all of the awards to the NGI of projects currently active. The section describes the project objective and research conducted for each project and other project details, along with contact information and related NOAA sponsor and strategic goal. Appendix A provides the total count of publications for this reporting period, and Appendix B summarizes the total number of employees and students supported by NOAA funding at NGI. Appendix C lists other agency awards NGI received during this reporting period.

NGI General Description and Core Activities

The Northern Gulf Institute (NGI) is a National Oceanic and Atmospheric Administration (NOAA) Cooperative Institute, a partnership of five complementary academic institutions and NOAA, addressing important national strategic research and education goals. Mississippi State University leads this collaboration, partnering with the University of Southern Mississippi, Louisiana State University, Florida State University, Alabama's Dauphin Island Sea Lab, and NOAA scientists at various laboratories

NGI develops, operates, and maintains an increasingly integrated research and transition program, the results of which raise awareness and understanding of the Gulf region. NGI was recognized by the NOAA Cooperative Institute Science Review Panel in October 2009 for its significant efforts to address important questions related to the NOAA Strategic Goals. NGI has been recognized as critical and well positioned to provide baseline, current, and future science and outreach needs to the region. The necessity of such a role for NGI is acutely demonstrated by northern Gulf of Mexico catastrophes like Hurricane Katrina and the Deepwater Horizon incident.

The Institute contributes to NOAA's priority interests in the four NGI research themes of Ecosystem Management, Geospatial Data Integration and Visualization, Coastal Hazards, and Climate Effects on Regional Ecosystems. Important recent research accomplishments by NGI researchers, in collaboration with multiple NOAA researchers, focus on the issues and resources of the Gulf with many of the tools and protocols transferrable to other coastal environs. Additional details are available in the second section on Project Reporting.

The NGI Education and Outreach Program provides an integrated comprehensive approach to educate the public on NGI priority issues associated with NGI research and to facilitate the transition of NGI research to NOAA operational centers. The program connects universities to NOAA and works closely with the educational programs at the Gulf of Mexico Alliance, the various Gulf of Mexico Sea Grant programs and the NOAA Gulf of Mexico Regional

Collaboration Team. Together we develop communication and significant long term messaging campaigns to address identified priority issues.

As part outreach and part research planning, NGI participated in or hosted several workshops during this reporting period. The NGI Education and Outreach Program disseminates content and reports of research accomplishments through a multi-media approach including listserv emails, Twitter, Facebook, and continual updates to the institution's website with NGI audience relevant news. Content includes recent information about research activities and transitioned results, essential components of the collaboration, operation updates, and other outreach items of interest (*see:* www.NorthernGulfInstitute.org). NGI is participating in the development of a consortium of universities in Mexico for cooperative research in the Gulf of Mexico. NGI participated in two workshops providing input on multi-university interactions and tools for coastal resiliency and ecosystem management. Continued interactions are anticipated. The NGI Education and Outreach Program strives to enhance NOAA workforce development by including students in several aspects of the cooperative institute. They are involved in research project performance and reporting, internships, career fairs, NGI associated volunteer opportunities, and network support

NGI Management, Mission, and Vision

The NGI leadership team adopted a ten year NGI Strategic Plan on June 24, 2011 (http://www.northerngulfinstitute.org/about/documents/strategicPlan2011-2021.pdf). With input from its university and NOAA partners, the NGI Program Office strives to make the complex collaborations as efficient and easy as possible for the participants with regular teleconferences, semi-annual meetings and annual conferences.

Mission and Vision Statements

NGI Mission: NGI conducts high-impact research and education programs in the Northern Gulf of Mexico region focused on integration – integration of the land-coast-ocean-atmosphere continuum; integration of research to operations; and integration of individual organizational strengths into a holistic program. The program shall measurably contribute to the recovery and future health, safety, resilience and productivity of the region, through sustained research and applications in a geospatial and ecosystem context.

NGI Vision: NGI will be a regional leader providing integrative research and education to improve the resiliency and conservation of the Northern Gulf of Mexico.

Organizational Structure

The NGI Program Office's strategic location at the Stennis Space Center, MS, facilitates close interactions with multiple NOAA activities (National Coastal Data Development Center, National Marine Fisheries Service, National Data Buoy Center, and Lower Mississippi River Forecast Center) and key stakeholder groups including the NOAA Gulf of Mexico Regional Collaboration Team, regional Sea Grant programs, the Gulf Coast Ecosystem Restoration Council members, and the Gulf of Mexico Alliance. With the completion of the Mississippi State University Science and Technology Center at Stennis Space Center, which houses NGI and NOAA activities, NGI has the foundation and the building blocks to maintain and grow its role in northern Gulf of Mexico environmental research and education. MSU employees moved into the MSU Science and Technology Center in December 2011. Employees from NOAA National Marine Fisheries Service and National Coastal Data and Development Center moved into the building in the fall of 2012. Since its initial award on October 1, 2006, the NGI's leadership has worked diligently to build collaborations between the five academic institutions and NOAA research and education programs. NGI activities during this progress reporting period total $8,126,529 in NOAA support. NGI continues to use this NOAA investment to contribute to the recovery and future health, safety, resilience and productivity of the Northern Gulf of Mexico region, through sustained research and applications in a geospatial and ecosystem context. NOAA cooperative institute metrics summarizing published research and staffing support are provided in the appendices.

In 2006, the NGI Council of Fellows, consisting of a senior investigator from each of the member institutions, established an Executive Office at MSU in Starkville, Mississippi, and a Program Office at Stennis Space Center, Mississippi. Funding for the NOAA led research began in the spring of 2006 and research initiatives at the NGI partner institutions began in February 2007. Significant efforts are being made to address important questions related to NOAA's long-term goals of Climate Adaptation and Mitigation, Weather-Ready Nation, Healthy Oceans, Resilient Coastal Communities and Economics, and NOAA enterprise-wide capabilities. The second five-year cooperative agreement began in October 2011. Some final research and education activities from the first five years continued during this reporting period along with related new project activity. Several completely new activities began under this new cooperative agreement. Only activities covered under this new cooperative agreement are contained in this report.

Figure 1 illustrates the NGI organizational structure and collaborative connections. The top row reflects the oversight role of MSU. The Director of NGI, a tenured professor who reports to the MSU Vice President for Research, has his principal office on the MSU campus, but often visits Stennis Space Center, MS. The Director's responsibilities are to serve as primary liaison to NOAA's Executive Council and as the principal point of contact for the Cooperative Institute Program Manager. At the direction of the Director, the NGI Co-Director assists in this role.

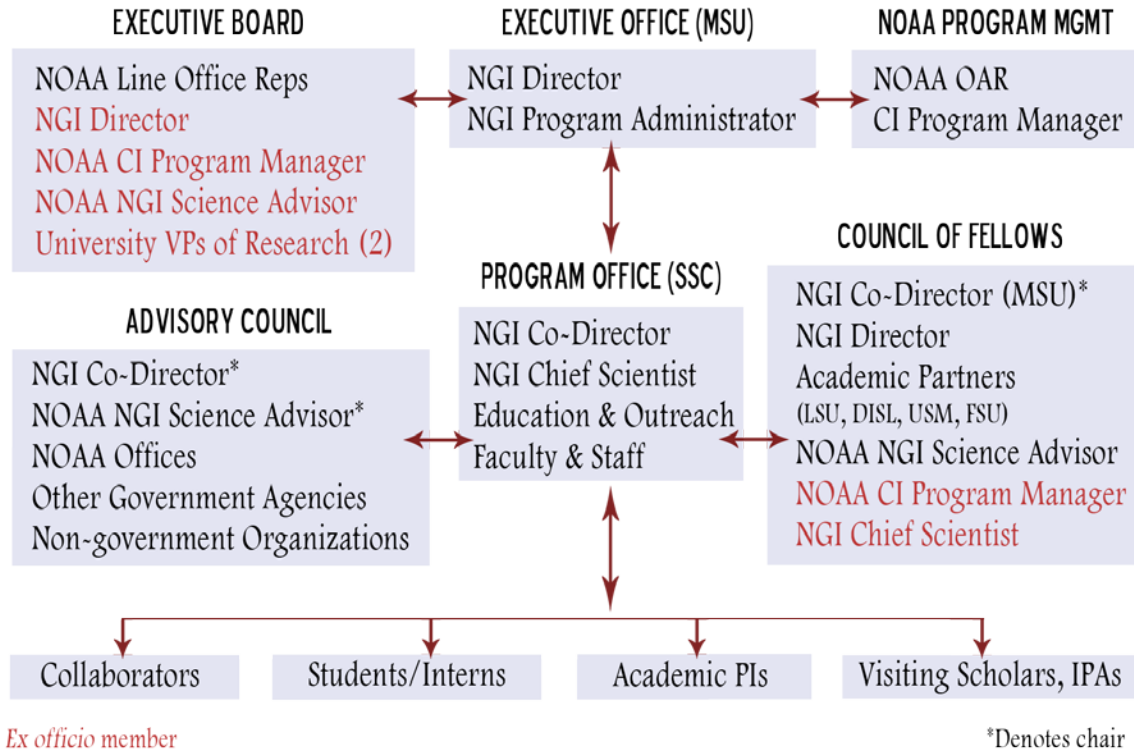


Figure 1. NGI organization diagram.

NGI program operations and implementation is guided by the NOAA October 1, 2011 cooperative agreement award, adoption of a Memorandum of Agreement between MSU and NOAA, and compliance with the NOAA Cooperative Institute Interim Handbook. The Executive Office and Program Office staff coordinate with the NOAA Office of Oceanic and Atmospheric Research on amendments to the original award which support research and education by NGI in support of activities of NOAA line offices. These include the Office of Oceanic and Atmospheric Research, National Marine Fisheries Service, National Environmental Satellite Data and Information Service, National Weather Service, and the National Ocean Service.

The NGI Program Office located at the Stennis Space Center, Mississippi, is staffed by MSU employees, including the Co-Director, Chief Scientist, and research and outreach faculty. The Program Office is responsible for maintaining regular interaction with the Council of Fellows, the NGI Advisory Council, and the NOAA NGI Science Coordinator. NGI participates in the NOAA Gulf of Mexico Regional Collaboration Team. It also has prime responsibility for the day-to-day management of the Institute that includes project management, facilitating meetings of the Council of Fellows, the NGI Annual Conference, and NGI students, contractors and visiting scholars on-site at Stennis. The Program Office constantly upgrades services to the research and education affiliates, and applies adaptive management approaches to improve program stewardship.

NGI has 3 councils that make management and advisory contributions to the Institute. The Council of Fellows is composed of senior scientific/ technical representatives from each NGI member academic institution, as well as the NOAA NGI Science Coordinator, and the NOAA

OAR CI Program Manager. The Council is chaired by the NGI Co-Director or designee. The Council of Fellows is the principal vehicle for NGI concept development, program strategy, annual research plans, peer review, resource allocation, research and technology coordination, and achieving the overarching goal of regional and disciplinary integration.

The Council of Fellows

For period of July 1, 2012 through June 30, 2013, the NGI Council of Fellows consisted of:

- William McAnally, Ph.D., Mississippi State University (chair)
- Monty Graham, Ph.D., University of Southern Mississippi
- Eric Chassignet, Ph.D., Florida State University
- Chris D'Elia, Ph.D., Louisiana State University
- John Valentine, Ph.D., Dauphin Island Sea Lab

A meeting of the NGI Council of Fellows was held via telecom on October 3, 2012. On May 14, 2013, the Council of Fellows and the Advisory Council held a joint session to allow exchange of recommendations from the Advisory Council and updates on progress from the Fellows. The Fellows interact at various conferences and meetings between semi-annual Council of Fellows meetings.

The NGI Executive Council

The NGI Executive Council consists of six Senior NOAA officials and vice presidents of two NGI academic partner institutions. Dr. Bonnie Ponwith serves as Chair. The NOAA OAR Cooperative Institute Program Manager, the NOAA NGI Science Coordinator, and the NGI Director serve as *ex officio* members of the Executive Council. The Executive Council is primarily responsible for broad policy and program direction for the NGI. The Council plans to meet at least once yearly to review NGI programs and progress and to transmit NOAA strategic plans and priorities to the NGI management in order to ensure program alignment with these priorities. It last met on November 9, 2010. The Executive Council provides information regarding the NGI successes to the NOAA Administrator to justify inclusion of NGI funding in the NOAA core budget. The NGI is committed to transparency, accountability, governance control, and effective integration through the Executive Council. The NGI Executive Council consists of:

- Bonnie Ponwith, Ph.D., Director, NOAA SE Fisheries Science Center (Chair)
- Gary M. Carter, Director, Office of Hydrologic Development (retired)
- Margaret Davidson, Director, NOAA Coastal Services Center
- Louisa Koch, Director, NOAA Office of Education
- Al Powell, Ph.D., Director, Center for Satellite Applications and Research
- Alan Leonardi, Ph.D., NOAA Atlantic Oceanographic and Meteorological Laboratory
- David Shaw, Ph.D., VP for Research & Econ. Dev., Mississippi State University
- Denis Wiesenburg, Ph.D., VP for Research, University of Southern Mississippi
- Philip Hoffman, OAR CI Program Manager (*Ex-officio*)
- Julien Lartigue, Ph.D., NOAA NGI Science Coordinator (*Ex-officio*)
- Robert Moorhead, Ph.D., NGI Director (*Ex-officio*)

The NGI Advisory Council

The NGI Advisory Council serves as the principal interface to the regional stakeholder community of the NGI. It has broad representation from the entities listed in the organizational chart, and meets regularly to identify and prioritize research and educational needs in the Northern Gulf region. The Advisory Council provides input on the current research and education/outreach programs of the NGI. NGI supports the formation and efforts of workgroups around each of the major themes of the NGI and accepts direction from the Advisory Council when they identify the need. The Advisory Council met May 14, 2013 (Stennis Space Center, MS) to assess NGI research directions and advise the Fellows on important issues facing the region. The NGI Advisory Council members are:

- Steven Ashby, Ph.D., MSU/NGI Co-Director (Chair)
- Duane Armstrong, NASA Stennis Space Center
- Russ Beard, NOAA National Coastal Data Development Center
- David Brown, Ph.D,, NOAA National Weather Service, Southern Region
- Miles Croom, NOAA National Marine Fisheries Service
- Alyssa Dausman, USGS Gulf Coast & LMV
- Todd Davison, NOAA Gulf Coast Services Center
- Lisa Desfosse, NOAA National Marine Fisheries Service
- Kristen Fletcher, Coastal States Organization
- Judy Haner, The Nature Conservancy
- Karl Havens, Ph.D., Florida Sea Grant College Program
- Matt Johnson, NPS Gulf Coast Network
- Julien Lartigue, Ph.D., NOAA NGI Science Coordinator
- Kristen Laursen, NOAA Fisheries Service
- Larry McKinney, Harte Research Institute
- Helmut Portmann, NOAA National Data Buoy Center
- Matt Romkens, USDA National Sedimentation Lab
- David Ruple, Grand Bay National Estuarine Research Reserve
- Ben Scaggs, EPA Gulf of Mexico Program
- LaDon Swann, Ph.D., MS-AL Sea Grant Consortium
- Robert Twilley, Ph.D., Louisiana Sea Grant
- Suzanne Van Cooten, Ph.D., NOAA National Weather Service LMRFC
- Kelly Lucas, Ph.D., MS Department of Marine Resources
- Jeff Waters, US Army Corps of Engineers
- Chuck Wilson, Ph.D., GOMRI Chief Scientist

Executive Summary of Important Research Activities

Twenty new projects were initiated during the reporting period while four projects from the previous year received additional funding. New research areas included analysis of weather data and modeling for improved forecasting, use of mobile data collection platforms such as wavegliders for environmental monitoring, and integrating ecosystem modeling approaches for fisheries and habitat assessments.

Research inquiries are yielding promise. To date, initial analyses and results related to ecosystem-based management include:

- A four-dimensional, high-resolution approach was used to understand the dynamics governing the Big Bend Region (BBR) circulation and transport during the spring months. The findings reiterate the importance of the Madison Swanson Marine Preserve (MSMR) as a spawning aggregation site for gag grouper. These results therefore provide, for the first time, a description of mechanisms capable of providing transport from the shelf break to the nearshore portions of the BBR from a fully 4D perspective. In addition, it is the first successful attempt at describing the role of the physical ocean circulation in setting the transport from adult gag spawning grounds to juvenile gag nursery habitats in the BBR.
- A study of behavioral patterns of adult smalltooth sawfish indicated that they do not leave U.S. waters and primarily remain in Florida waters. They use very shallow flats and channels in Florida Bay from January through May, but also occur in deeper water along the edge of the continental shelf at least from March through August.
- Microcosms are highly reliable for determining the survival rate or persistence of enterococci. Sewage enterococci do not appear to persist in the water column as their concentration quickly declined over time. Enterococci counts dropped an average of 0.8 logs with a range of 0.1-1.6 logs after two days in environmental waters. By the fourth day, counts declined further by an average of 2.1 logs with a range of 0.7-3.5 logs. Enterococci counts had declined even further after eight days by an average of 3.8 logs and a range of 2-5.2 logs.

Several projects are focused on improvements in measurement and monitoring for use in continued research by the originating researchers and others in the scientific community. These include:

- A demonstration on the use of a wave glider to enhance the spatio-temporal resolution of pCO_2 and ocean acidification data in the northern Gulf of Mexico.
- Evaluating the sensors and payloads available (visible, video, hyperspectral, multispectral, and lidar) to conduct the missions identified by the River Forecast Centers (RFCs).
- Protocols are being developed within the Integrated Products Team (IPT) to continually update NOAA's Okeanos Atlas, an interactive, geospatial application that provides access to data information corresponding to exploration missions conducted aboard the R/V Okeanos Explorer.

New algorithm development for forecasting models was conducted in data assessment research that included:

- Statistical comparisons for air temperature, relative humidity, anemometer, and wave sensors test data to standard sensor data sets.
- Analysis of ultrasonic anemometer and ultrasonic antenna data that was collected during Hurricane Isaac to compare results of two different methods.
- Assessing Statistical Climate Variability from the TAO Buoy Array. The El Niño/Southern Oscillation (ENSO) signal is strongest for Sea Surface Temperature, followed closely by air temperature. No ENSO signal is noted for Relative Humidity.
- The bias of ATMS, SSMIS and AMSR-2 satellite data was determined, so that the satellite data correction can be used to improve hurricane vortex initialization.

Several workshops and outreach activities have been conducted under the funding and goals of NGI. From these, NGI has produced:

- Hypoxia modeling and glider implementation workshop with accompanying white papers that provide guidance to the Hypoxia Task Force, NOAA's NGoMex Program, and partners interested in the use of gliders to supplement monitoring
- Ecosystem based modeling
    - An Integrated Ecossytem Assessment workshop on Community Ecosystem Models was held at Stennis Space Center. Participants included representatives from NOAA (CSC and NWS), EPA, Naval Research Lab, Corps of Engineers Research and Development Center, Northern Gulf Institute, and the private sector.
    - Atlantis and TroSim modeling coordination workshop held in New Orleans involving NOAA CSC, AOML, GLERL, EPA, NGI, and the private sector.
    - The NOAA-NGI Diversity Internship Program supported 10 interns at 9 academic and federal locations across the Gulf coast. Interns were from 2 demographic groups underrepresented in NOAA's workforce (African-American and Asian) and included undergraduate students, Master's and PhD candidates. Internship activities and focus areas were very diverse and ranged from offshore field work to computer based modeling to surveying people, and from fisheries to ecosystem valuation to river stage forecasting.

Distribution of NOAA Funding

Total NOAA funding awarded to NGI during the progress reporting period was $8,126,529. This funding spans all three NOAA CI tasks as well as each one of NGI's themes, with several projects having multiple themes (Fig. 2 and 3).

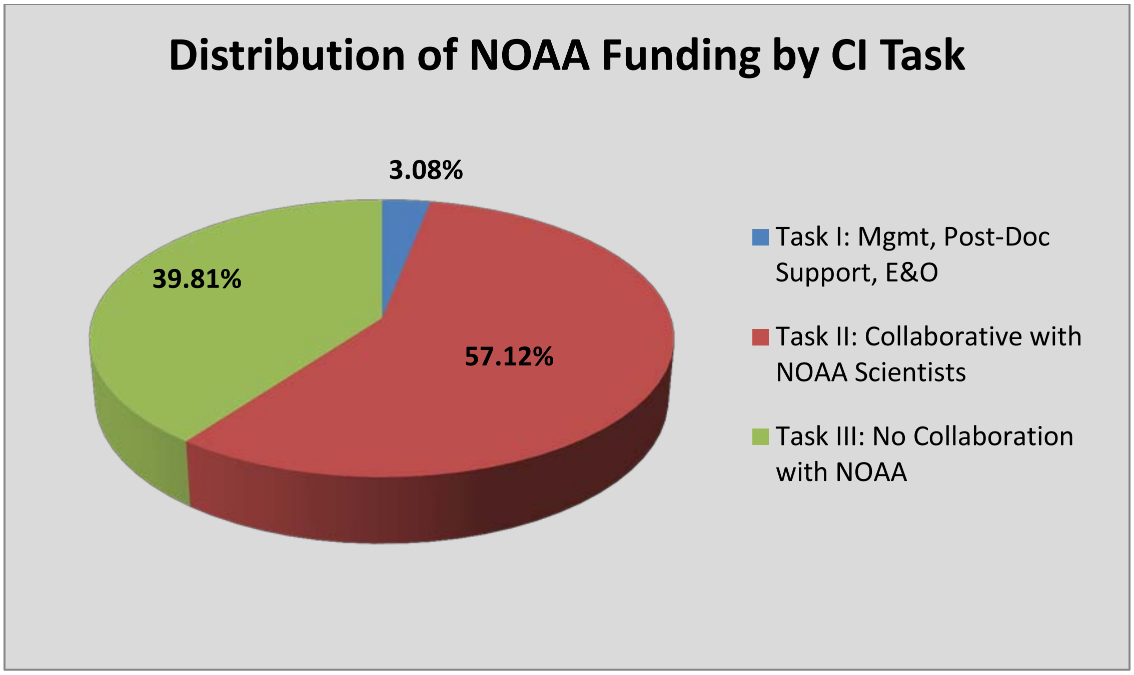


Figure 2. Distribution of NOAA funding by the three cooperative institute task categories.

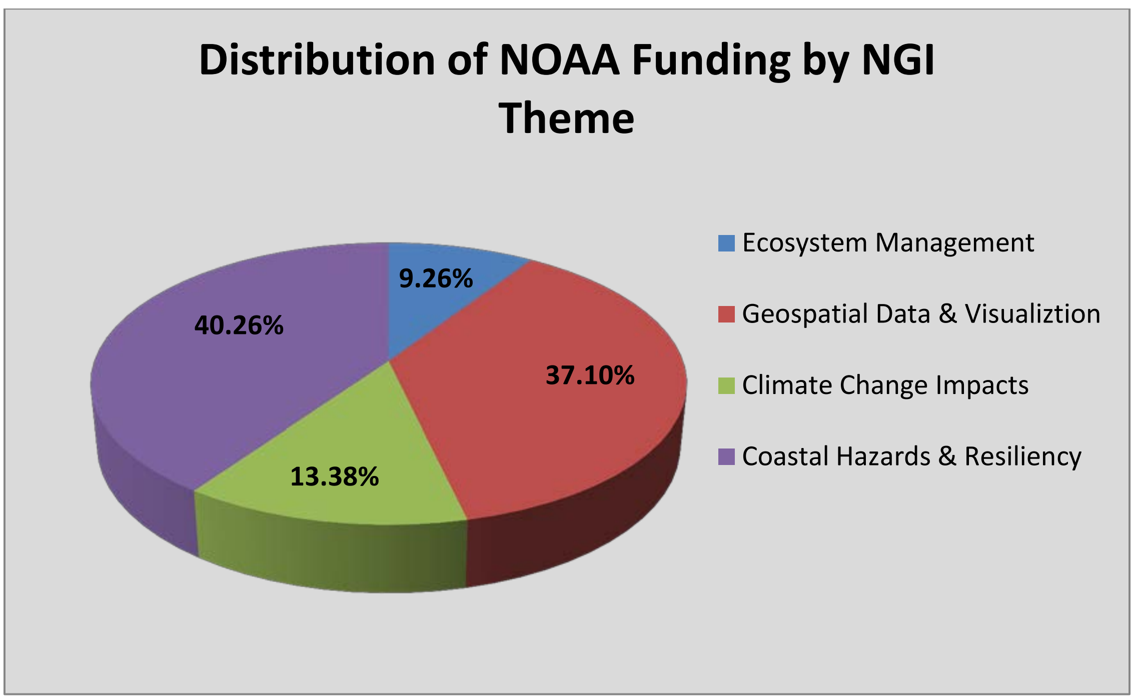


Figure 3. Distribution of NOAA funding by the four NGI themes.

Task I Activities

Task I funding supports the central management and coordination of the five complementary academic partners working together with NOAA. This year, Task I funding helped support the administration of NGI, students, education and outreach, and other research activities (Fig. 4). Administration included leading the efforts of the CI as well as program and project management on each of the traditional CI projects awarded this year. Details of student support can be found in the project reports for NGI file numbers 12-NGI2-16 and 12-NGI2-22.

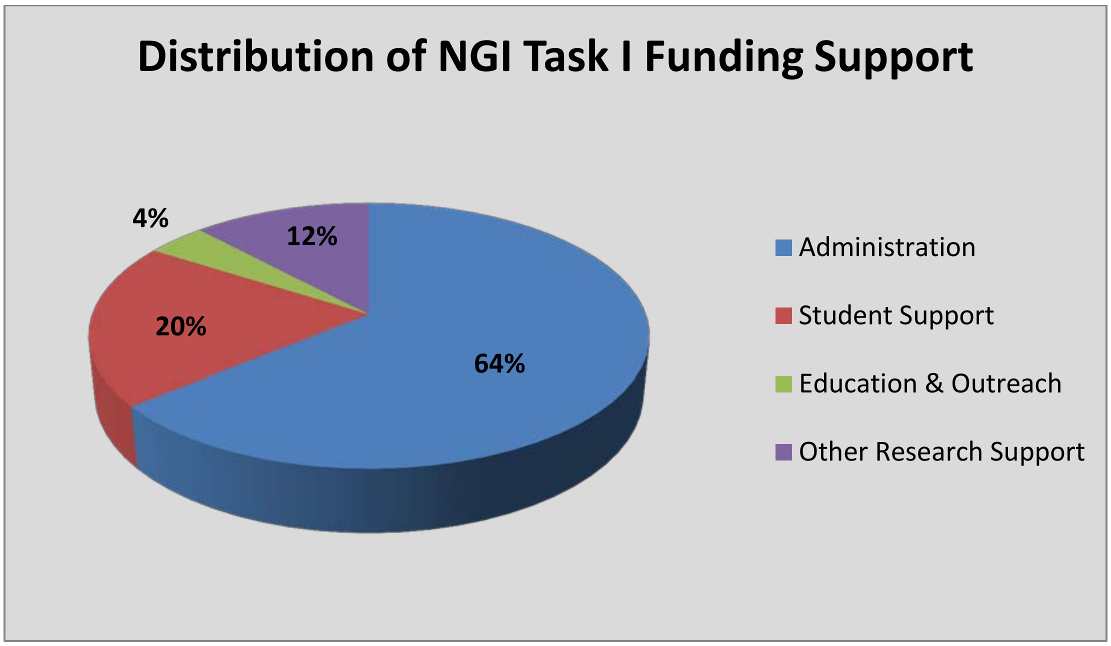


Figure 4. Distribution of NGI Task I funding.

PROJECT LIST

Table 1 is provided as a quick reference for locating projects within this report.

Table 1. Projects for the July 1, 2012- June 30, 2013 reporting period.

NGI File #	Institution	PI	Project Title	Page #
11-NGI2-02	DISL	Just Cebrian	Monitoring in Small Embayments as Early Warning System for Ecosystem Change on Larger Saptial Scales	17
11-NGI2-04	MSU	Robert Moorhead	Optimal UAS River Observing Strategy	21
11-NGI2-05	MSU	John Harding	Hypoxia Research Coordination Support	24
11-NGI2-06	USM	Paula Moreno	Linkage between the Commercial Shrimp Fishery and Juvenile Red Snapper in the Northern Gulf of Mexico	25
11-NGI2-08	FSU	Xiaolei Zou	Applications of Advanced Satellite Microwave Radiances and Retrieval Products to NWP and Climate Studies	28
11-NGI2-09	FSU	Xiaolei Zou	Toward Operational Uses of Geostationary Imagery & FY-3 Polar-Orbiting Microwave Radiance Radiance Data in the GSI Analysis System	30
12-NGI2-12	DISL	Ruth Carmichael	Data Management in Support of NOAA's Integrated Ecosystem Assessment for the Gulf of Mexico through the NGI	33
12-NGI2-16	MSU	Steve Ashby	Summer Internship for the NGI Ecosystem Data Assembly Center	36
12-NGI2-17	USM	Vernon Asper	Developing an Enhanced Stereo Camera System for Environmental Monitoring	37
12-NGI2-18	MSU	Bill McAnally	Ecosystem Approach to Management for the Northern Gulf	40
12-NGI2-19	USM	Stephan Howden	Waveglider Pilot Project in Support of the NOAA Ocean and Great Lakes Acidification Research Implementation Plan	43
12-NGI2-20	FSU	Mark Bourassa	Climate Variability in Ocean Surface Turbulent Fluxes	46
12-NGI2-21	FSU	Shawn Smith	U.S. Research Vessel Surface Meteorology Data Assembly Center	52
12-NGI2-22	MSU	Steve Ashby	Student Assistance with Statistical Analysis of Meterological and Oceanographic Data	59
12-NGI2-23	MSU	Jane Moorhead	Analysis of Engineering Test Data	60

NGI File #	Institution	PI	Project Title	Page #
12-NGI2-24	MSU	Pat Fitzpatrick	Assessing Statistical Climate Variability from the TAO Buoy Array	63
12-NGI2-25	MSU	Pat Fitzpatrick	Evaluation baseline operational ocean surface current predictions and low-member multi-model ensembles in the Gulf of Mexico	76
12-NGI2-26	MSU	Steve Ashby	Gulf Hypoxia Model Transition and Glider Implementation Panel Support	87
12-NGI2-27	MSU	Robert Moorhead	Engineering Studies for NOAA UAS Program	90
12-NGI2-28	USM	Shiao Wang	Persistence of Microbial Indicators, Source Tracking Markers, Pathogens, and their Molecular Signatures in Gulf Beach Waters	91
12-NGI2-29	DISL	Tina Miller-Way	Northern Gulf Institute Diversity Internship Program	96
12-NGI2-30	USM	David Dodd	Development of Multibeam Data Processing Procedures and Techniques for Fisheries Applications	100
12-NGI2-31	FSU	Dean Grubbs	Determination of Habitat Use and Movement Patterns for Adult Smalltooth Sawfish	102
12-NGI2-32	MSU	Trey Breckenridge	Advanced Developmental Server for the NGI/NCDDC Ecosystems Data Assembly Center (EDAC)	107
12-NGI2-33	FSU	Eric Chassignet	Increasing our Understanding of the Interaction between Physical and Ecological Processes in the Gulf of Mexico and Carribean	108
12-NGI2-34	FSU	Xiaolei Zou	Bias Characterization and Hurricane Initialization using ATMS, SSMIS, and AMSR-2	112
12-NGI2-35	USM	Scott Milroy	Geospatial Data Visualization and Access for NOAA's Exploration Data Collection	114
12-NGI2-36	MSU	Scott Samson	Enhancing the Mississippi Digital Earth Model (MDEM)	116
12-NGI2-37	USM	Stephan Howden	Time-Series and Underway Assessments of Ocean Acidification and Carbon System Properties in Coastal Waters	120
12-NGI2-38	USM	Monty Graham	Assessing and Coordinating NDBC's Strategic Initiatives Relating to Marine Observing Systems	124

NGI FILE #11-NGI2-02

Project Title: Monitoring in Small Embayments as Early Warning System for Ecosystem Change on Larger Spatial Scales

Project Lead (PI) name, affiliation, email address: Just Cebrian, DISL, jcebrian@disl.org

Co-PI(s) name(s), affiliation, email address: Bart Christiaen, DISL, bchristiaen@disl.org

Project objectives and goals

Because of their limited depth, low flushing rates and close proximity to land, small embayments, such as bayous and coastal lagoons, are potentially more vulnerable to excessive inputs of nutrients and organic matter than the larger bodies of water they are connected with. This project has as primary objective to test if these small systems could function as an early warning system for changes in ecosystems on larger spatial scales. More specifically, our goals are to detect if:

1. shallow embayments and lagoons are more impaired in water column quality compared to the larger bodies of water they are connected with,
2. there are differences in the degree of impairment between three embayments with different degrees of anthropogenic disturbance and different flushing rates,
3. shallow embayments react faster and more intensely to changes in the watershed than the bodies of water they are connected with.

In order to test these questions, 6 permanent monitoring stations were set up inside and outside three small embayments with different degrees of anthropogenic disturbance. Each of these sites was sampled on a bi-monthly basis. During each sample event, a pair of YSI-6600 sensors was deployed for a period of 8 days, inside and outside each embayment. Multiple water samples were collected at the start and end of each deployment, and subsequently analyzed for nutrients (particulate and dissolved), total suspended solids, organic carbon (particulate and dissolved) and water column chlorophyll. A subset of these samples was used to assess abundance and diversity of the microbial community inside and outside each of the embayments.

Description of research conducted during the reporting period and milestones accomplished and/or completed

- The field sampling as described in the project narrative was completed during the previous reporting period (July 1st 2011 to June 30th 2012). We added two additional sample rounds during summer and fall 2012. During this period, 72 water samples were collected (for a total of 252 during the entire project).
- We finished analyzing all water samples for nutrients (NO_3^-, NO_2^-, NH_4^+, PO_4^{-3}, dissolved organic nitrogen and particulate organic nitrogen), chlorophyll and organic carbon (dissolved and particulate).

- We finished the calculation of ecosystem metabolism inside and outside each of the embayments, using the dissolved oxygen data from the 21 pair-wise deployments of the YSI-6600's, and environmental data from nearby weather stations.
- A subset of 84 water samples was analyzed using flow cytometry, in order to determine the abundance of cyanobacteria, heterotrophic bacteria and viruses. In addition, 84 slides were prepared for determining the relative abundance of protists using epifluorescence microscopy.
- A subset of 62 water samples was used for DNA extraction, followed by QPCR using primers for functional genes in the nitrogen cycle (*nirS* and *nirK* as a proxy for presence of denitrifiers in the water column, and *nifH* as a proxy for microorganisms capable of nitrogen fixation).

Description of significant research results, protocols developed, and research transitions

Our three sample sites (State Park, Kee's Bayou and Gongora) connect to the same body of water and experience similar tidal cycles, but each is impacted differently by human activities. State Park is the most pristine lagoon; Kee's Bayou is the intermediate site, while Gongora is the most impacted, both in terms of nutrient loading and physical disturbance. State Park and Kee's Bayou contain sizable beds of shoalgrass (*Halodule wrightii*) and widgeongrass (*Ruppia maritima*), but Gongora has no seagrass beds. The lack of seagrass beds in Gongora is in part caused by higher water column chlorophyll concentrations, and consequently by higher light attenuation in the water column.

In winter, the environmental characteristics within the embayments are similar to those outside. In summer, the average water temperature is slightly higher within the embayments. When water temperatures are high, diurnal shifts in dissolved oxygen are more extreme inside the lagoons compared to the surrounding bodies of water. These diurnal shifts are very pronounced the months of July and August. During this period, the water column within the embayments often becomes hypoxic at night.

There is no significant difference in net ecosystem metabolism (NEM) inside the three embayments. However, each of the embayments is more heterotrophic compared to the adjacent bodies of water. The differences within and outside the embayments are more pronounced during summer, when water temperatures are high. For State Park and Kee's Bayou, ecosystem respiration and gross primary production are always higher inside the embayments compared to the bodies of water they are connected with. Inside Gongora, gross primary production and respiration are usually lower, compared to the body of water it is connected to. The spatial and temporal patterns in gross primary production and respiration are clearly related to the distribution of submerged aquatic vegetation within and outside the embayments.

Our results show that total dissolved nitrogen, dissolved organic carbon and light attenuation are consistently higher inside the embayments compared to the larger bodies of water they are connected to. However, the magnitude of these differences does not change between embayments with varying degrees of anthropogenic disturbance, or between seasons. There is no clear trend in water column chlorophyll for State Park and Kee's Bayou, although Gongora has always higher chlorophyll concentrations compared to its immediate environment. The concentration of particular organic carbon in the water column follows the same patterns as that of chlorophyll, indicating that a large fraction of particular organic matter consists of phytoplankton cells. The consistent gradients in dissolved organic carbon indicate that these three shallow embayments export carbon to the adjacent bodies of water. Because the three sites are net heterotrophic, the gradient in dissolved organic carbon is probably caused by outwelling from the wetlands surrounding the embayments.

Based on the strong seasonal patterns in dissolved oxygen concentrations, and the consistent higher amounts of dissolved organic carbon and nitrogen within the embayments, we posed two additional hypotheses. Because of the larger amount of substrate, shallow embayments should harbor larger populations of heterotrophic microbes than the surrounding bodies of water. This could impact the basic structure of the microbial food chain, and alter the balance between viral lysis and grazing. In addition, the large shifts in dissolved oxygen during summer could provide a competitive advantage to microbes that are facultative anaerobes (i.e. able to switch terminal electron acceptor during respiration), as they would be able to flourish both when oxygen concentrations are high (during the day) and when oxygen is scarce (at night).

There was no difference in the abundance of heterotrophic microbes and viruses within and outside the three embayments. However, both groups showed a clear seasonal pattern, with higher abundances in summer and lower abundances during winter. The presence of *nirS* and *nirK* genes (both indicators of denitrifiers, a group of microbes that are facultative anaerobes) also showed a clear seasonal pattern. These organisms were more abundant during summer (when diurnal shifts in dissolved oxygen are more pronounced). However, the relative abundance of these microbes was low, and did not change throughout the year.

Our results indicate that small embayments are more impaired in water column quality compared to the larger bodies of water they are connected with. There is evidence of a difference in water quality between the three embayments, as Gongora has significantly higher concentrations of chlorophyll in the water column, compared to the other embayments. However, the net ecosystem metabolism of these sites seems to be more influenced by seasonal effects, than by the gradient in anthropogenic disturbance.

Information on collaborators / partners: None Reported

Information on any outreach activities:

> *General Description*: People living near our sample sites expressed an interest in learning about the project after observing our work.
> *Hosted speakers, workshops and/or any training:*
>> *Type (speaker, workshop, training)*: Lecture
>> *Name of event*: Not Applicable
>> *Date*: July 23, 2012
>> *Location*: Kees Bayou, FL
>> *Description*: We organized a lecture on biology in small coastal lagoons, including a demonstration of sample techniques, for people living near one of our

sample sites (Kees Bayou). The lecture took place on the lawn of one of the properties adjacent to the embayment.
Approximate Number of Participants: 10

NOAA sponsor and NOAA office of primary technical contact: Russ Beard, NESDIS

Related NOAA strategic goals: Healthy Oceans

Related NOAA enterprise objectives: Science and Technology

NGI FILE #11-NGI2-04

Project Title: Optimal UAS River Observing Strategy

Project Lead (PI) name, affiliation, email address: Robert Moorhed, MSU, rjm@ngi.msstate.edu

Co-PI(s) name(s), affiliation, email address: Jim Aanstoos, MSU, aanstoos@gri.msstate.edu

Project objectives and goals

The goal of this proposal is to determine the optimal UAS platforms and instruments for inland flooding prevention, detection, and mitigation, by examining the needs and the available technology. This will be accomplished in 4 steps:

- By documenting available UAS platforms and instruments that can reasonably be used in the NAS to monitor floods and levees, as well as collecting in writing some of the RFC needs.
- By hosting a workshop at which NOAA RFC scientists will learn about the various platforms and instruments. Selected platform providers and instruments providers would be invited, based on the initial paper study to provide information on their technology. The NOAA scientists will identify their science problem, explain their needs, and react to the technology providers. The technology providers will explain their existing and planned platforms and instruments. The goal is to determine optimal configurations and theorize optimal operational scenarios. For example, radar systems are an optimal way to detect ice jams (it can detect the difference in surface roughness between water and ice), but a visible camera in general is lighter and should be able to be flown with a lighter platform, reducing operating cost and potentially allowing a less demanding approval process from the FAA. Is the radar worth the extra cost and hassle? A presentation on the issues in obtaining a certificate of authorization (or waiver) would also be an informative presentation.
- By compiling a report of the workshop presentations, discussions, and conclusions.
- In addition to the workshop-related efforts, a small test of one candidate UAS will be conducted which will provide performance data for an additional option to be considered by the workshop participants. This UAS will be a small, low-cost, low-altitude vehicle. The test will show to what extent data obtained from such a vehicle can support some of the RFC needs.

Description of research conducted during the reporting period and milestones accomplished and/or completed

- In concert with UASPO designed, organized, developed, and executed a workshop in February 2012 that brought together NOAA RFC personnel and UAS technology providers / operators. The workshop was a step towards integrating UASs into the workflow for the RFCs.
- Composed a summary report from that River Workshop that has the RFC's observation requirements and UAS lessons learned. The body of the report summarizes the two

days of presentations and discussions. Appendix A contains four tables: the workshop agenda, the workshop attendees, the RFC requirements that UAS could potentially address, and the UAS sensor resolutions needed for the RFC requirements. Appendix B identifies the lessons learned to date by multiple agencies, as well as their concerns and best practices.

- Based on Rivers Workshop report, determined that near infrared (NIR) imagery was the second most important datastream from small UASs for RFCs, visible being clearly the most important. Thus we sought to procure an inexpensive sUAS (less than 10 pounds and less than $10,000) that could carry an industry standard MSS camera, both to collect data and to train workforce. An analysis of alternatives resulted in a decision in Fall 2012 to purchase a Robota Triton with a 12Mpixel visible camera and a 3Mpixel MSS camera.
- Trained on the Robota Triton and collected test data using in restricted airspace.
- Obtained Puma UAS training (as primary and secondary operators).
- Obtained FAA Class II Medical and initiated study for FAA ground school exam (Hathcock).
- Completed initial work on georectifying and mosaicking imagery.
- Studied Lower Pearl River braids (south of Bogalusa, LA) to determine appropriate launch and landing points for Robota Triton and Puma AE; reported findings.
- Obtained permits from the Bogue Chitto National Wildlife Refuge and the Pearl River State Wildlife Management Area (areas south of Bogalusa, LA) to overfly.
- Composed and submitted 3 CoAs:
    - Lower Pearl River area (approved June 2013)
    - MSU North Farm (in stage 4 review)
    - Noxubee Wildlife Refuge (NWR) (in stage 4 review)

The MSU North Farm is a broad open area (no trees), very near to our facility that will allow quick and easy testing. Noxubee Wildlife Refuge provides a nearby area (less than an hour drive) similar to the Lower Pearl River area for testing.

Composed Mission Concept Review for Lower Pearl River study.

Description of significant research results, protocols developed, and research transitions

The summary of the workshop documents and prioritizes the RFC needs.

Information on collaborators / partners:

Name of collaborating organization: NWS LMRFC
Date collaborating established: May 2008
Does partner provide monetary support to project? Amount of support? No

Does partner provide non-monetary (in-kind) support? Yes, their time and advice. They assist in providing requirements.
Short description of collaboration/partnership relationship: We have worked with the LMRFC in the past to design and build a software tool called "FloodViz" that allows 3D visualizations of river data. It allows one to see the depth of the water in context.

Information on any outreach activities:

General Description: A workshop to educate RFC leaders on UAS technology, to ascertain RFC needs, and to develop a list of requirements and wants.
Hosted speakers, workshops and/or any training:

Type (speaker, workshop, training): Workshop
Name of event: Optimal Unmanned Aircraft Systems River Observing Strategy Workshop
Date: February 21-23, 2012
Location: Boulder, CO
Description: A workshop to educate RFC leaders on UAS technology, to ascertain RFC needs, and to develop a list of requirements and wants.
Approximate Number of Participants: 40

NOAA sponsor and NOAA office of primary technical contact: Robbie Hood, NESDIS

Related NOAA strategic goals: Climate Adaptation and Mitigation, Weather-Ready Nation

Related NOAA enterprise objectives: Science and Technology

NGI FILE #11-NGI2-05

Project Title: Hypoxia Research Coordination Support

Project Lead (PI) name, affiliation, email address: John Harding, NGI, jharding@ngi.msstate.edu

Project objectives and goals

There is a need for Hypoxia Research Coordination Workshops in several U.S. regions, including the Gulf of Mexico. The workshop objectives are to: (1) bring stakeholders together to share on-going hypoxia activities in the Gulf of Mexico region; (2) discuss synergies and leveraging opportunities among the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force, Gulf of Mexico Alliance, and Gulf Coast Ecosystem Restoration Task Force; (3) review status of and solicit input regarding the hypoxia monitoring matrix and implementation plan, hypoxia modeling matrix, hypoxia data management plans, hypoxia communications plan, and Hypoxia Impacts on Gulf of Mexico Fisheries Report and Plan; (4) discuss hot topics/issues (e.g., oil spill, new methodologies, ship and platform issues) related to hypoxia activities that might have broad relevance to all participants.

Description of research conducted during the reporting period and milestones accomplished and/or completed

Participated in multiple discussions on 2013 hypoxia workshops and accompanying hypoxia model transition and glider panels and associated white papers.

Description of significant research results, protocols developed, and research transitions

None Reported

Information on collaborators / partners:

> *Name of collaborating organization*: David Scheurer, NOAA NCCOS Center for Sponsored Coastal Ocean Research
> *Date collaborating established*: Jul 1, 2010
> *Does partner provide monetary support to project? Amount of support?* Yes
> *Does partner provide non-monetary (in-kind) support?* Yes
> *Short description of collaboration/partnership relationship*: Workshop co-sponsor

> *Name of collaborating organization*: Alan Lewitus, NOAA NCCOS Center for Sponsored Coastal Ocean Research
> *Date collaborating established*: Jul 1, 2009
> *Does partner provide monetary support to project? Amount of support?* Yes
> *Does partner provide non-monetary (in-kind) support?* Yes
> *Short description of collaboration/partnership relationship*: Workshop co-sponsor

Information on any outreach activities: None Reported
NOAA sponsor and NOAA office of primary technical contact: Alan Lewitus, NOS

Related NOAA strategic goals: Climate Adaptation and Mitigation, Healthy Oceans

Related NOAA enterprise objectives: Science and Technology, Engagement

NGI FILE #11-NGI2-06

Project Title: Linkage Between the Commercial Shrimp Fishery & Juvenile Red Snapper in the Northern Gulf of Mexico

Project Lead (PI) name, affiliation, email address: Paula Moreno, USM, Paula.Moreno@usm.edu

Project objectives and goals

The main goals of this project are to: 1) characterize the distribution of the juvenile red snapper (RS) and the shrimp fishery in the northern Gulf of Mexico; 2) help determine how strong the association between juvenile red snapper occurrence and the shrimp fishery is, and 3) help identify where the association is strongest.

Description of research conducted during the reporting period and milestones accomplished and/or completed

This report covers the period of performance from May 31, 2012 to November 30, 2012.

Description of significant research results, protocols developed, and research transitions

The Gulf of Mexico shrimp fishery generates the highest bycatch ratio of any U.S. marine fishery. In the Gulf, this lucrative fishery has been identified as having detrimental effects on red snapper (*Lutjanus campechanus*) stocks due to high mortality of juvenile red snapper, thus exacerbating competing interests among three top fisheries in this region: the shrimp fishery, recreational and commercial red snapper (RS) fisheries. The reduction of RS bycatch in the shrimp fishery is considered essential to rebuilding RS stocks to support maximum yield by 2032. Since 2008, regulations designed to protect RS stocks allow managers to implement additional seasonal closures if adequate reduction in RS bycatch is not met. The closure may be selected from an extensive area that extends from the Texas-Mexico border to east of Mobile Bay, Alabama, where the majority of the shrimp fishery operates, and within the 18 to 55m depth interval, which represents important habitat for juvenile RS and where higher bycatch rates are reported. However, extensive closures to the shrimp fishery would pose risks to its viability. Minimizing negative impacts to the shrimp fishery while maximizing the gain to RS stocks, i.e. maximizing reduction of juvenile mortality, requires knowledge about the areas that contain highest density of juvenile RS but do not represent an important fraction of the shrimp fishery activity. To achieve this goal, we developed a large-scale model that examined juvenile (age-1) RS density in relation to shrimping intensity, depth and regions west of the MS river delta following a methodology detailed in the previous NGI report. We found that the preferred depth range occurred between 35 and 65m, which is largely in agreement with a previous study in the same region that found juvenile RS was scarce in waters shallower than 18m or deeper than 70m, and to a great extent supports the range selected for the candidate closure area. Interestingly, our model indicates that the relationship between RS density and shrimping intensity is non-linear. A negative association was observed at high shrimping intensity (above 1,700 tows), while a slight positive effect occurred below this level of shrimping. A positive association is conceivable if the shrimp fishery also significantly increases mortality of juvenile RS predators, such as Atlantic croaker (*Micropogonias undulatus*), which is among the most abundant finfish species present in the bycatch. However, further investigations are needed to draw conclusions since low-level shrimping was poorly represented in our study, as indicated by the large uncertainty below 25 tows.

Regarding the three regions examined, the western and central regions had significantly higher RS density compared to the eastern region. The spatial analysis showed that low shrimping, indicated by the lower quartile, was more prevalent in the eastern and central regions than in the west. This is not surprising due to the combined effect of the Texas Closure, which encompasses most of the central region, and hurricane Katrina in 2005, which adversely impacted the shrimp fishery fleet, particularly in LA. Thus, in the western region other favorable conditions may occur compared to the eastern region that contribute to higher RS settlement and/or survival and explain the higher RS density despite fewer sites with low shrimping. For example, 25% of the western and 25.7% of the central regions, respectively, are comprised of sites with mean depths within the peak response of RS, contrasting with only 16.9% in the eastern region. Also, the eastern area in the summer is subject to persistent hypoxia, which is known to displace marine organisms, including red snapper.

This study showed that the shrimping intensity is variable throughout the GOM, but some sites have consistently (50% or more of the years) low intensity. The spatial analysis showed that in any given year the highest degree of overlap between low shrimping intensity and high RS density occurred in the central region. Using the summer peak responses of juvenile RS predicted by the model, we found that in this 4-year period the most favorable areas were located in waters off the south Texas coast ranging from 38.2 to 58.3 m deep (mean = 45.9, SD = 6.6) and off the coast of east Texas and west Louisiana in waters between 33.4 and 53.3 m depth (mean = 40.1, SD = 5.5). Each area covered 2,800 and 6,800 km^2, respectively. Thus the largest area was located between east Texas and western Louisiana, which also corresponds to the largest overlap of low shrimping and high RS density. Notably, this area was previously reported as a persistent juvenile RS hotspot and comprised the highest RS density off the LA coast to the west of the Mississippi river delta. If a 20-km buffer is set around this larger area to allow for easier implementation (i.e., continuous area) of a time-area closure of the shrimp fishery and to promote expansion of high RS densities, the total area of this candidate closure area amounts to 24,000 km^2. Over half of this region overlaps with the Texas closure, which has been implemented within 200 miles off the Texas coastline to protect the brown shrimp fishery since 1981. Regulations to protect RS stocks pose that an additional closure to the shrimp fishery would best be achieved by selecting from a large area (exceeding 60,000 km^2). Our study suggests that, based on densities of summer year-1 recruits, and to avoid closing highly important areas for the shrimp fishery, it would be beneficial to target the prime RS habitat for summer age-1 recruits in waters between 92°17'W and 95°21'W at depths ranging conservatively from approximately 22 to 65 m. This would allow protecting the dominant RS age class in summer trawls and increase survival to age-2 when individuals migrate to deeper waters outside of the main shrimping grounds. Since 60% of this area is contained inside the Texas closure, the additional "new" closure would be an area of approximately 9,460 km^2 located to the east of the Texas closure boundary. Should an additional closure be required, regulations establish that the start date should coincide with the opening of Texas Closure, which typically lasts from mid-May to mid-July. Since the additional 9,460km2 are adjacent to the Texas Closure, implementation of this measure is facilitated.

Joint Amendment 27/14 allows managers to impose further time-area closures on the shrimp fishery to protect RS and recent fisheries management plans emphasize the need to protect habitat to achieve sustainable fishing. Our study identified important summer habitat for juvenile RS that has not been subject to intensive trawling by the shrimp fishery and thus would represent a candidate area for closure, if one is needed. In addition, current Habitat Areas of Particular Concern (HAPCs) in the northern GOM are located in deep waters, thus failing to include important nursery habitat for RS. Considering that RS continues to be overfished, our findings suggest that the area off eastern Texas and west Louisiana would be suitable as a potential candidate for HAPCs.

An unequivocal relationship between the abundance of RS juveniles and shrimp fishery effort in the GOM has been difficult to demonstrate, in particular the recent drastic decline in shrimp fishery effort to levels less than 74% of the 2001-2003 levels within the 18-55m depth strata has not resulted in the expected increase in juvenile RS abundance. While population trends result from multiple and complex factors that may affect age groups differently, including an interaction of density-dependent and independent factors, this study suggests that a fine resolution analysis that examines the effects of shrimp fishery intensity on juveniles, along with important habitat descriptors such as depth, is more productive than a non-spatial analysis of global shrimp effort. Also, instead of using the more commonly used fished days derived from shrimp landings to characterize shrimp fishery intensity, we used the number of tows obtained from Electronic Logbook (ELB) data, which has been shown to more accurately reflect shrimping effort, particularly when effort is required at fine-scale. To better understand how the distribution of the shrimp fishery effort influences juvenile RS, future studies should follow a similar spatial approach to investigate life-history parameters such as juvenile mortality (and survival), estimated from age-0 and age-1 relative abundance indices.

This study is unique in that it provides a regional density-habitat model of juvenile RS that accounts for shrimp fishery effort at fine-scale (20 x 20 km cells). Deriving and mapping fine-scale shrimp effort took advantage of ELB data, resulting from a NMFS supported monitoring program of the shrimp fishery in the Gulf of Mexico. However, a limitation of our study was the inability to distinguish unsampled (i.e. not monitored with ELB devices) from untrawled cells. As a result, such cells were excluded from this study and likely underestimate low effort sites. This limitation may be rectified in future studies by obtaining complete records of travel locations of vessels with ELB on board.

Information on collaborators / partners: None Reported

Information on any outreach activities: None Reported

NOAA sponsor and NOAA office of primary technical contact: Lisa Desfosse, NMFS

Related NOAA strategic goals: Healthy Oceans

Related NOAA enterprise objectives: Science and Technology

NGI FILE #11-NGI2-08

Project Title: Applications of Advanced Satellite Microwave Radiances and Retrieval Products to NWP and Climate Studies

Project Lead (PI) name, affiliation, email address: Dr. Xiaolei Zou, FSU, xzou@fsu.edu

Project objectives and goals

- Develop advanced satellite microwave products for improving typhoon and hurricane predictions.
- Transition of existing algorithms and products to the operational centers.
- Generate climate-quality of observations to better our understanding of the climate variations at global and regional scales.

Description of research conducted during the reporting period and milestones accomplished and/or completed

- Develop a new RFI detection method in continental based on principal component analysis (PCA) and double PCA.
- Assess the affection of the scattering from water droplets and ice particles within clouds on GPS RO.
- Estimate the usefulness of satellite observations for surface solar irradiance and wind for prediction and assessment of energy distribution.
- Evaluate the impacts of RJ approximation on ATMS calibration biases.
- Find a four-month oscillation in the surface-sensitive satellite AMSU-A microwave measurements in the Arctic and Antarctic, and confirm that with the ERA-Interim reanalysis data.

Description of significant research results, protocols developed, and research transitions

- Develop a new RFI detection method in continental based on principal component analysis (PCA) and double PCA.

  An accurate RFI detection will not only enhance geophysical retrievals over land but also provide evidences of much needed protection of microwave frequency band for satellite remote-sensing technologies. In this study, a new RFI detection method in continental based on principal component analysis (PCA) and double PCA, results show that this method works at any geographical location over the globe and in both non-scattering and scattering surfaces. It is also tested that the DPCA can be applied at the granule data level, offering a real-time RFI detection method before C- and X-band data is delivered to users.

- Estimate the usefulness of satellite observations for surface solar irradiance and wind for prediction and assessment of energy distribution.

Wind and solar energy are projected to be major sources of the world's power in the coming decades. In this study, we first introduce satellite observations for surface solar irradiance and wind, and then discuss using the data for prediction and assessment of energy distribution. The reanalysis results based on satellite observations and numerical weather prediction model are used to study the distribution of solar and wind energy and the variation of the distribution related to climate change. A comparison of a decadal mean wind energy between two decades (from 1949 to 1958 vs. from 1999 to 2008) shows that most of Asia had experienced a decrease in surface wind energy. Therefore, decisions about renewable energy developments need to consider such climate change scenarios.

Information on collaborators / partners:

Name of collaborating organization: NOAA/NESDIS
Date collaborating established: August 2010
Does partner provide monetary support to project? Amount of support? No
Does partner provide non-monetary (in-kind) support? Yes
Short description of collaboration/partnership relationship: Help mentor graduate students and postdoctoral fellow; provide data support.

Information on any outreach activities:

General Description: During the reporting period, we attended the 2012 American Geophysical Union (AGU) Fall meeting and the 2013 American Meteorological Society (AMS) annual meeting to present our recent research results.
Hosted speakers, workshops and/or any training:
Type (speaker, workshop, training): Speaker
Name of event: 2012 AGU Fall meeting
Date: December 3-7, 2012
Location: San Francisco, CA
Description: Oral Presentation
Approximate Number of Participants: 20,000
Hosted speakers, workshops and/or any training:
Type (speaker, workshop, training): Speaker
Name of event: 2013 AMS annual conference
Date: January 6-10, 2013
Location: Austin, TX
Description: Oral Presentation
Approximate Number of Participants: 2000

NOAA sponsor and NOAA office of primary technical contact: Fuzhong Wang, NESDIS

Related NOAA strategic goals: Climate Adaptation and Mitigation, Weather-Ready Nation

Related NOAA enterprise objectives: Science and Technology

NGI FILE #11-NGI2-09

Project Title: Toward Operational Uses of Geostationary Imagery & FY-3 Polar-Orbiting Microwave Radiance Data in the GSI Analysis System

Project Lead (PI) name, affiliation, email address: Xiaolei Zou, FSU, xzou@fsu.edu

Project objectives and goals

This project will refine the assimilation process of GOES-11/12/13 imager radiance assimilation and FY-3 Polar-Orbiting microwave radiance data assimilation in National Centers for Environmental Prediction (NCEP) global forecast systems. The goal is to incorporate these data into NCEP operational forecast systems and to use them as preparation.

Description of research conducted during the reporting period and milestones accomplished and/or completed

- Assess the added values of GOES-11/12 imager radiance data to other satellite data for improved coastal precipitation forecasts using the NCEP GSI analysis system and the regional ARW forecast model.
- Develop an added cloud detection algorithm to MHS quality control, and examine the impact of the new algorithm on data assimilation and forecasts of the limited-area ARW using the NCEP GSI analysis system.
- Develop a regional, pixel-dependent cloud mask (CM) algorithm to identifying cloud-free pixels for direct assimilation of infrared radiance observations from GOES in mesoscale forecast modeling systems.
- Principal component analysis (PCA) and five-pint filter are used for filtering the noise primarily contained in FY-3B MWHS.
- Evaluate FY-3B MWRI measurement over ocean with model simulations based on CRTM and NCEP GDAS analysis.

Description of significant research results, protocols developed, and research transitions

- Develop a regional, pixel-dependent cloud mask (CM) algorithm to identifying cloud-free pixels for direct assimilation of infrared radiance observations from GOES in mesoscale forecast modeling systems.

  A cloud mask (CM) algorithm is required for identifying cloud-free pixels for direct assimilation of infrared radiance observations from Geostationary Operational Environmental Satellites (GOESs) in mesoscale forecast modeling systems. In this study, a regional, pixel-dependent CM algorithm is developed in which the threshold for each CM test for a target pixel is determined by a one-dimensional optimization approach based on probability distribution functions of the nearby cloudy and clear-sky pixels within a 10ox10o box centered at the target pixel and tested for GOES-12 imager infrared channels. The purpose of the proposed CM algorithm is to isolate cloud-free pixels from cloudy pixels for data assimilation using mesoscale forecast models. In this CM algorithm, the implicit dynamic thresholds are determined at pixel-resolutions. An innovative aspect of this algorithm is that the thresholds for each CM test are determined by a one-dimensional optimization approach considering the local distribution of clouds. It is observed that the distribution of optimized thresholds over land displays more variation than over ocean in addition to larger average threshold values. The performance of the new developed CM algorithm is evaluated by comparing with Moderate Resolution Imaging Spectroradiometer (MODIS) CM during the period from May 19 to May 23 in 2008. Totally 5,616,090 GOES-12 Infrared Imager pixels are tested and the average Probability of Correct Typing (PCT) based on MODIS CM is 92.94% over land, and 91.50% over ocean respectively.

- Principal component analysis (PCA) and five-pint filter are used for filtering the noise primarily contained in FY-3B MWHS.

  Detecting, characterizing, and removing observation noise in FY-3B MWHS data are extremely important before they could be effectively applied in NWP and climate studies. PCA has been employed for characterizing the noise in the MWHS data, and a five-point filter has been used for filtering the noise primarily contained within the first PC mode. The reconstruction of the brightness temperature spectra with the first term in the PCA reconstructed field smoothed provides an effective data filter. This PCA-based filter is not only accurate and robust but also flexible in its implementation. It can be applied on a swath-by-swath or granule-by-granule basis, it is very good for research transitions.

Information on collaborators / partners:

Name of collaborating organization: NOAA NESDIS
Date collaborating established: Aug 2010
Does partner provide monetary support to project? Amount of support? No
Does partner provide non-monetary (in-kind) support? Yes
Short description of collaboration/partnership relationship Help mentor graduate students and postdoctoral fellow; provide data support

Information on any outreach activities:

General Description: During the reporting period, we attended the 2012 American Geophysical Union (AGU) Fall meeting and the 2013 American Meteorological Society (AMS) annual meeting to present our recent research results.
Hosted speakers, workshops and/or any training:

Type (speaker, workshop, training): Speaker
Name of event: 2012 AGU Fall meeting
Date: December 3-7, 2012
Location: San Francisco, CA
Description: Oral Presentation
Approximate Number of Participants: 20,000

Hosted speakers, workshops and/or any training:

Type (speaker, workshop, training): Speaker
Name of event: 2013 AMS annual conference

Date: January 6-10, 2013
Location: Austin, TX
Description: Oral Presentation
Approximate Number of Participants: 2000

NOAA sponsor and NOAA office of primary technical contact: Fuzhong Weng, NESDIS

Related NOAA strategic goals: Weather-Ready Nation

Related NOAA enterprise objectives: Science and Technology

NGI FILE #12-NGI2-12

Project Title: Data Management in Support of NOAA's Integrated Ecosystem Assessment for the Gulf of Mexico through the NGI

Project Lead (PI) name, affiliation, email address: Ruth H. Carmichael, DISL, rcarmichael@disl.org

Project objectives and goals

This project continues a NOAA affiliation with the Dauphin Island Sea Laboratory (DISL) on ecosystem data management systems. The goal is to maintain and expand a NGI member institution internal data management system that links to the existing data management program within the EDAC. Specifically, our objectives are to a) enhance and support integration of regional ecosystem data management into the NGI Ecosystem Data Assembly Center via NOAA's National Coastal Data Development Center, b) continue NOAA's affiliation with DISL to meet NOAA data management goals, c) continue creation and publication of place-based meta-data and associated summary data sets as DISL's contribution to this assimilative effort with NOAA, d) continue testing and integrating automated end-to-end data management (sensor to archive) techniques (this year we will provide training on and begin implementing NOAA's new standards), and e) support NGI research efforts (graduate & PI level) that are beneficial to both NOAA Integrated Ecosystem Assessment (IEA) and Regional Ecosystem Data Management (REDM) efforts. Making datasets readily available and accessible and overcoming hurdles to faculty and student participation in metadata creation will facilitate scientific studies, public education, and outreach. The resulting data management systems will enhance REDM efforts and expand the capability of EDAC to gather ecosystem data.

Description of research conducted during the reporting period and milestones accomplished and/or completed

- 12 metadata records published
- 5 new metadata records in progress
- Began documenting older legacy datasets in addition to current research (a long-term goal of DISL)
- Began revising previously published records to meet updated NOAA NCDDC standards
- Data Manager (Lei Hu) and Deta Management Specialist (Mimi Tzeng) attended "Online ISO Metadata Training Series", webinar course by Jacqueline Mize of NOAA NCDDC (24 Jul – 11 Sep 2012) to learn about ISO 19115-2 and discern applications for DISL.
- Hosted metadata training workshop for DISL research community (March 8).
- Created (and published first issue of) a quarterly Data Management Newsletter to keep the DISL research community up to date on activities and innovations in DISL data management.

- Participation in NSF's "Envisioning Success - A Workshop for Next Generation EarthCube Scholars and Scientists" workshop, Washington, DC (Mimi Tzeng, by invitation from NSF).
- DISL's Data Management Center website was continually updated

Description of significant research results, protocols developed, and research transitions

The Data management program at DISL, consisting of a formal Data Management Center, Senior Data Manager, Data Management Specialist, and Data Management Committee has been extremely successful at incorporating metadata creation, data archiving, and overall data management into the regular process of research at DISL. In 2013, the newly hired Data Management Specialist began reviewing and updating DISL's metadata records. After only a few months, we are back on track with our usual productivity in metadata creation and publication. In addition, the new Data Management Specialist has begun converting our existing metadata records and approaches to meet the new NOAA standards and incorporated DISL into the burgeoning NSF EarthCube program through participation in a number of events. Our major accomplishments during the three month period covered by this report include: 1) updating, creating and publishing a number of metadata records; 2) attending additional NSF EarthCube events in Washington, DC, 3) publishing the inaugural Data Management newsletter and an article for the DISL newsletter, "The Skimmer", and 4) hosting an updated metadata training workshop.

Information on collaborators / partners:

Name of collaborating organization: Russ Beard, NCDDC
Date collaborating established: None Reported
Does partner provide monetary support to project? Amount of support? None Reported
Does partner provide non-monetary (in-kind) support? None Reported
Short description of collaboration/partnership relationship: None Reported

Name of collaborating organization: Rost Parsons, NCDDC, rost.parsons@noaa.gov
Date collaborating established: None Reported
Does partner provide monetary support to project? Amount of support? None Reported
Does partner provide non-monetary (in-kind) support? None Reported
Short description of collaboration/partnership relationship: None Reported

Information on any outreach activities:

- Metadata Training Workshop by Kathy Martinolich and Mimi Tzeng at DISL on 8 Mar 2013 (15 attendees included faculty, research staff, and students).
- DISL Data Management Newsletter distributed by email 15 May 2013.
- Article written for DISL's "The Skimmer" newsletter, published in the June 2013 issue.
- Attended (by invitation from NSF) "Envisioning Success - A Workshop for Next Generation EarthCube Scholars and Scientists" – NSF workshop at the Carnegie Institute in Washington, DC 17-18 October 2012 (70 early career attendees). Invitation to

attend this workshop was a direct result of attending the second EarthCube charette in June 2012.

- Participation in EarthCube Connections - an online tool to link interdisciplinary collaborators. Since joining, Mimi Tzeng has been asked to review an NSF EarthCube proposal and invited to join the Advisory Committee on another EarthCube proposal.

NOAA sponsor and NOAA office of primary technical contact: Russ Beard, NESDIS

Related NOAA strategic goals: Climate Adaptation and Mitigation, Weather-Ready Nation, Healthy Oceans, Resilient Coastal Communities and Economies

Related NOAA enterprise objectives: Science and Technology, Engagement, Organization and Administration

NGI FILE #12-NGI2-16

Project Title: Summer Internship for the NGI Ecosystem Data Assembly Ceter

Project Lead (PI) name, affiliation, email address: Steve Ashby, MSU, sashby@ngi.msstate.edu

Project objectives and goals

Provide a summer intern with exposure to ongoing research conducted by NGI and NCDDC as related to the ongoing development of the Ecosystem Data Assembly Center (EDAC). The intern will gain knowledge of NOAA activities, and the potential career paths NOAA can offer. Specifically, the intern will work jointly with NCDDC on the data file management and information system components within the EDAC architecture.

Description of research conducted during the reporting period and milestones accomplished and/or completed

Assisted in the work on large file data servers (THREDDS) and the development of OceanNOMAD data inventory. Provided reprogramming for improved data storage.

Description of significant research results, protocols developed, and research transitions

Generated socioeconomic maps and geospatial catalogs of data/emergency services.

Information on collaborators / partners:

> *Name of collaborating organization*: Charles Carlton, NOAA NCDDC
> *Date collaborating established*: July 2011
> *Does partner provide monetary support to project? Amount of support?* None Reported
> *Does partner provide non-monetary (in-kind) support?* Yes
> *Short description of collaboration/partnership relationship:* Collaborated on data management activities.

Information on any outreach activities:

Products are available to the public.

NOAA sponsor and NOAA office of primary technical contact: Russ Beard, NESDIS

Related NOAA strategic goals: Weather-Ready Nation, Resilient Coastal Communities and Economies

Related NOAA enterprise objectives: Engagement

NGI FILE #12-NGI2-17

Project Title: Developing an Enhanced Stereo Camera System for Environmental Monitoring

Project Lead (PI) name, affiliation, email address: Vernon Asper, USM, vernon.asper@usm.edu

Co-PI(s) name, affiliation, email address: Max Woolsey, USM, maxwell.woolsey@usm.edu; Roy Jarnagin, USM, roy.jarnagin@usm.edu

Project objectives and goals

The goal of this project is to develop an autonomous undersea stereo camera system primarily for the assessment of fish populations. The equipment is to be mounted to a mooring and deployed in an area of interest with up to three identical units for visual coverage of four directions. A single unit, such as the prototype designed in this project, consists of a pair of industrial cameras, a single video camera, and a logging system. The resulting 3D images and video will provide complementary information for fish species identification.

The Southeast Fisheries Science Center began using stereo imagery as a tool for fish surveys in 2008. The enhanced system in development will replace the original equipment while generally maintaining the same handling protocol that has been used in previous field service. Cameras of the new stereo pair have larger sensors and will have a greater separation. Increasing the separation can provide a greater stereo field. A drawback is that individual camera housings must be used, where the original system required only a single housing with ports for the stereo cameras and video camera. A mounting system has been designed to allow servicing of the cameras without affecting their critical relative positioning. Different mounting brackets can be substituted to vary the camera separation distance, which was not possible with the original system.

The objective of this project is to produce a prototype of the new stereo camera system. Off the shelf cameras, computer and communications equipment, power components, cabling, and connectors must be integrated into commercial and custom machined housings. The housings themselves must be assembled onto a mounting structure that in turn can be mounted on a NMFS mooring. The equipment is to be powered and triggered by NMFS existing “octopus” cabling. Software must be developed for controlling the cameras and support systems, interpreting operator-defined settings, and logging – which includes stereo pair image acquisition, video capture, and general record keeping. Capability must also exist to synchronize multiple camera systems on the same mooring and to vary camera settings during acquisition.

Description of research conducted during the reporting period and milestones accomplished and/or completed

Initial concepts of the hardware and software designs were discussed with the NMFS, Southeast Fisheries Science Center, who provided details of their existing system and improvements needed to enhance data quality. From this collaboration, milestones and technical challenges were identified. Although the existing system was used as a reference for discussion, the new equipment required a completely revised mechanical structure with electrical connections between housings made through pressure-rated cabling and acquisition software written from a clean slate.

Transmitting images over depth-rated cabling at high data rates has been a challenge in previous undersea imaging applications. Recent industry tests revealed favorable gigabit Ethernet communication over Subconn Micro-Series cables and connectors. This line of connectors, however, is limited to a maximum of 8 conductors, which are all required by the gigabit Ethernet standard. One of the cameras providing the necessary resolution and sensor size, the AVT Manta G-145C, advertised a power-over-Ethernet (PoE) option. An industrial gigabit PoE switch had just been released by Moxa, the EDS-G205A-4PoE. Unlike rack-mount PoE gigabit switches, this unit could fit into an underwater housing. The AVT camera was connected to the Moxa switch via a segment of Subconn cabling and connectors. Using AVT's viewer software, images were streamed from the single camera at 8 frames per second with default settings.

The next milestone was determining the proper optics necessary for 74 degrees horizontal angle of view from each camera of the stereo pair, a goal specified by NMFS. The elements comprising the optical system include the imaging sensor, the lens assembly, and the port of the housing. Naturally, the angle of view in water is different from bench tests in air. A dome-port housing was selected so that the port itself would cancel the effect of the water interface. A 6mm focal length lens was therefore selected to produce the 74-degree view for the given sensor used in the AVT Manta camera. Unfortunately, upon testing in water, the dome port was found to overcompensate for the refraction occurring at the water interface, which widened the field of view excessively. Further testing revealed that an 8mm lens from Schneider Optics met the specified angle of view within two degrees. Currently a pair of these lenses is on order.

Mounting of the stereo pair was dependent on the outcome of the above milestones, particularly the success of the single connector used for power and data and also the discovery of the lens needed for proper coverage. Initial CAD drawings are now being refined to accommodate the selected camera and its new lens within the dome-port housing. Positioning of the cameras relative to each other is critical. Any time this geometry is disturbed, a long calibration procedure must be performed by NMFS researchers. The commercial camera housing is intended to be mounted by band clamps around the cylindrical housing body, thus the critical positioning could be disturbed easily during lens adjustments or other routine tasks. A custom end cap was designed to hold the camera within the housing while serving as the mounting point to the external indexing frame. The main tube and port of a housing can be pulled from this rear end cap leaving the camera still solidly mounted to the frame, thus maintaining the integrity of the stereo camera geometry. This mounting structure is a key innovation of this system allowing the use of separate camera housings (needed for greater camera separation) without the overhead of excessive calibration procedures.

Comparatively, the video camera configuration was quite simple. The camera itself is typically used in surveillance applications and has an Ethernet interface and streaming capability. A 3.5mm focal length lens was mounted to the camera which will be installed behind a small flat viewport in the main pressure housing which has not been machined yet. The small form factor computer chosen for the prototype has two Ethernet ports, and one will likely be dedicated to the video camera. For now, tests have been carried out through the Moxa switch and software has been run on the same laptop used for the rest of the development of this system. The video capture from this device has been performed through command line interface of the VLC media streaming and encoding software released under General Public License by the VideoLAN team.

A software package was written to control of the cameras autonomously. This acquisition system is a multithreaded C++ program running on a Linux operating system. Currently, this software is being tested on a laptop, but the next step is to run the program on a small computer (of a PC/104 form factor) with similar hardware and running the same operating system. In addition to the pair of camera housings, the computer will reside in a third, slightly larger housing along with the Ethernet switch, the video camera, and a small amount of power electronics. The current version of the acquisition program starts by reading from an operator defined "mission configuration" file. It then launches several threads to control timing of the still images, interface with the still cameras themselves, and manage the video capture.

So far, the acquisition program can configure the cameras based on operator settings and then start its acquisition "mission". Still images are captured with a specified imaging period, and the individual camera threads are kept synchronized. Tests indicate that left and right images are synchronized within 10 milliseconds, which was the limit of the external timer being imaged by the two cameras. These synchronized images were being collected once a second (the rate specified by NMFS researchers) and logged to disk with timestamps as standard TIFF images. The main program also launches the video camera thread which automatically stops and restarts itself after a specified amount of time to enforce a maximum video length. After a total mission time (provided by the configuration file) is reached, the imaging is stopped and the program closes.

Description of significant research results, protocols developed, and research transitions

As a prototyping project, this research contains no significant results in addition to the milestones described above; however, upon completion of the prototype, the acquisition system will transition directly into field trials and data collection.

Information on collaborators / partners:

Name of collaborating organization: NOAA Marine Fisheries Service, Southeast Fisheries Science Center, Mississippi Laboratories
Date collaborating established: July 2012
Does partner provide monetary support to project? Amount of support? No
Does partner provide non-monetary (in-kind) support? Yes, NMFS has provided technical guidance throughout all stages of development.
Short description of collaboration/partnership relationship: NMFS is the primary funding agency for this project.

Information on any outreach activities: None Reported

NOAA sponsor and NOAA office of primary technical contact: Christopher Gledhill, NMFS

Related NOAA strategic goals: Healthy Oceans

Related NOAA enterprise objectives: Science and Technology

NGI FILE #12-NGI2-18

Project Title: Ecosystem Approach to Management in the Northern Gulf

Project Lead (PI) name, affiliation, email address: William H. McAnally , NGI, mcanally@ngi.msstate.edu

Co-PIs names, affiliation, email address: Just Cebrian, DISL, jcebrian@disl.edu; Scott Milroy, USM, scott.milroy@usm.edu; Erick Swenson, LSU, eswenson@lsu.edu; Cristina Carollo, HRI at TAMUCC, cristina.carollo@tamucc.edu; Richard Fulford, USM, Richard.Fulford@usm.edu; Steve Ashby, NGI, sashby@ngi.msstate.edu

Project objectives and goals

The overall goal of this effort is to further NOAA's EAM and support Coastal and Marine Spatial Planning (CMSP) concepts for systems and regions throughout the Gulf of Mexico.

The work will achieve the following objectives: (1) Extend previously initiated Integrated Ecosystem Assessments (IEA) of Perdido Bay, Florida; Mississippi Sound, Mississippi; Barataria Basin, Louisiana; and Galveston Bay, Texas; (2) provide demonstration versions of the Sulis Informatics Services for Perdido Bay and South Florida, and (3) converge NGI and AOML/OCD EAM efforts to expand the applicability of both.

Description of research conducted during the reporting period and milestones accomplished and/or completed

Accomplishments to date:

1. Began identifying existing major data gaps (i.e. beyond the data NGI has been collecting over the past several years) that limit application of the Sulis conceptual ecosystem model (CEEM) to Galveston, Barataria, Mississippi Sound, and Perdido.
2. Completed the Sulis Informatics Services (SIS) demonstration for Perdido Bay EAM and set up an initial demo for the AOML South Florida Program. Results available at: http://www.ngi.msstate.edu/sulis/applications/EAM/index.html
3. Proposed to National Science Foundation further data collection and extending modeling to include ecosystem services.
4. Coordination. Participated in EAM conferences and workshops under various auspices, including a July 2012 workshop in St. Petersburg. Held two workshops on ecosystem modeling:

    - Community Ecosystem Models at Stennis Space Center in July involving NOAA CSC and NWS, EPA, Navy Research Lab, Corps of Engineers Research Lab, NGI, and private sector.

    - Atlantis and TroSim modeling coordination in New Orleans in February involving NOAA CSC, AOML, GLERL, EPA, NGI, and private sector.

    Meeting summaries were prepared and distributed to workshop participants.

Completed Milestones:

FY12 4th Q Work initiated on Tasks

2 Workshops

FY13 1st Q Expanded Sulis SIS Demo of Perdido (3.3)

FY13 2nd Q Initial Demo Sulis SIS Demo of South Florida (3.3)

FY13 3rd Q Journal Paper submitted to *Gulf Research*

Description of significant research results, protocols developed, and research transitions

1. Workshops provided excellent communication and coordination among ecosystem modelers at NOAA, the two NOAA Cooperative Institutes, EPA, the Corps of Engineers, and the private sector. As these models develop further, synergies will increase and ecosystem modeling capability in the Gulf will continue to improve. Findings of the workshops included these key points:
   - Since Atlantis is a large scale model and TroSim is a local scale model, they can be used to provide outputs from each as boundary conditions to the other in order to answer questions at different scales. For example, life cycle processes that occur offshore could be modeled with Atlantis and then biomass provided to TroSim for fine scale applications. Output from multiple local TroSim models could be used as input to Atlantis.
   - Both models have relevance to RESTORE Act activities. NOAA is developing a list of questions from several sources and the NGO Ecosystem Team is prepared to assist in model selection/application and subsequent data requirements.
   - Another interdisciplinary (e.g., social scientists, economists, industry reps, ecosystem services, etc.) workshop is planned for July 2013, using a hypothetical site to develop a generic approach and a new NSF proposal.
2. Leveraging EAM funding with NSF funding enabled significant additions to the Sulis Informatics Services. See http://ngchc.org/tools-view?field_tool_categorization_tid=525 for a listing of NSF-supported tools that were added to Sulis and are now applicable to EAM efforts.
3. A student at MSU began dissertation research to contribute to ecosystem-based management for coastal and marine ecosystems by developing a systematic process and tool using sound science to classify sub-regions within the Gulf of Mexico appropriate to EBM goals. In order to accomplish this task, the following sub-objectives are established:
   - Parameter matrices and scales will be developed that can be populated and used to identify sub-regions within the Gulf of Mexico.
   - A GIS map will be created with different layers representing sub-regions for different EBM protocols.
   - A first-level classification of estuaries will be developed based upon the parameters identified that define sub-regions.
   - A systematic process for identifying sub-regions within large marine ecosystem other than the Gulf of Mexico will be provided.

- The resulting process will be evaluated by applying the framework to Gulf of Mexico ecosystems and validating the resulting sub-regions using expert opinion.

Information on collaborators / partners:

NOAA contributors: Julien Lartigue, Chris Kelble, Becky Allee, Russ Beard, Michael Schirripa

Corps of Engineers R&D Center participated in workshops under an Existing ERDC-MSU CRADA.

Richard Fulford of EPA Gulf Breeze lab actively participated under a new EPA-NGI MOU.

Andrea Vander Woude and others of GLERL participated in a workshop.

Information on any outreach activities:

General Description: Workshop 1
Hosted speakers, workshops and/or any training:
Type (speaker, workshop, training): Workshop
Name of event: Ecosystem Modeling Workshop
Date: July 30, 2012
Location: Stennis Space Center, MS
Description: Presentations on NOAA, NGI, Navy, and Corps ecosystem modeling plans and accomplishments. Discussions on best ways to coordinate differing agencies efforts to maximize public benefit.
Approximate Number of Participants: 29

General Description: Workshop 2
Hosted speakers, workshops and/or any training:
Type (speaker, workshop, training): Workshop
Name of event: Atlantis-TroSim Coordination
Date: Feb. 20, 2013
Location: New Orleans, LA
Description: • Presentations on GLERL Atlantis modeling and Mississippi Sound TroSim modeling and discussions on possible synergistic efforts.
Approximate Number of Participants: 16

NOAA sponsor and NOAA office of primary technical contact: Christopher R. Kelble, NMFS

Related NOAA strategic goals: Healthy Oceans, Resilient Coastal Communities and Economies

Related NOAA enterprise objectives: Science and Technology

NGI FILE #12-NGI2-19

Project Title: Wave Glider Pilot Project in Support of the NOAA Ocean and Great Lakes Acidification Research Implementation Plan

Project Lead (PI) name, affiliation, email address: Stephan D. Howden, USM, stephan.howden@usm.edu

Co-PI(s) name(s), affiliation, email address: Jamie Griffith, Liquid Robotics, Inc, jamie.griffith@liquidr.com

Project objectives and goals

This pilot project for the northern Gulf of Mexico utilizes a Liquid Robotics, Inc. (LRI) Wave Glider, with instruments to measure CO_2 on either side of the air-sea interface, and surface seawater pH, dissolved oxygen, temperature and salinity, to support monitoring goals of the National Oceanic and Atmospheric Administration (NOAA) Ocean and Great Lakes Acidification Research Implementation Plan, the interagency North American Carbon Program (NACP), and the Integrated Ocean Observing System (IOOS), which is led through an office within NOAA. The main goal is to demonstrate that the Wave Glider can help solve the problem of achieving the much needed spatial and temporal resolution of air-sea CO_2 fluxes, and variations in ocean pH, in the very dynamic and heterogeneous northern Gulf of Mexico.

Description of significant research results, protocols developed, and research transitions

The project initially was funded for one round trip Wave Glider deployment from the Central Gulf of Mexico Ocean Observing System buoy in the western Mississippi Bight, around the Mississippi River Balize Delta and back again (Fig. 5). The Wave Glider pH sensor failed soon after deployment on October of 2012 (Table 1). The mission was continued since the other systems were working properly and the main objective of the project could still be realized. However, on October 27, 2012 the Wave Glider was damaged by a vessel and the mast holding the air-block and anemometer was broken. It was decided to repair and redeploy the Wave Glider to meet the project objectives, and the Wave

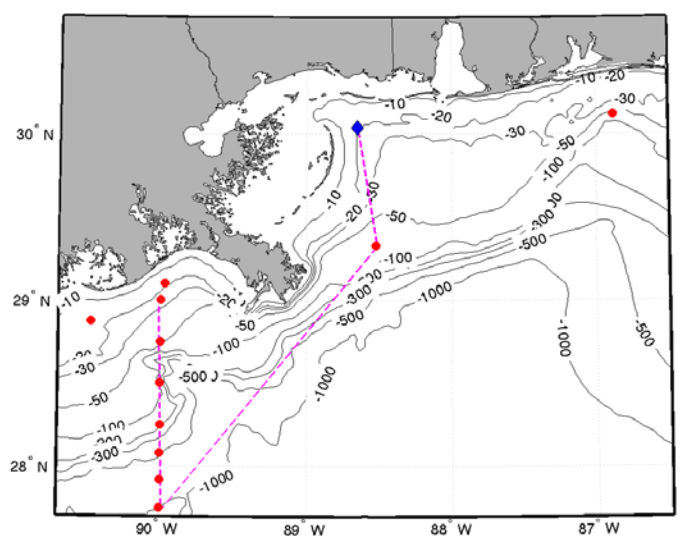


Figure 5. Wave Glider trasects. The magenta line is the 242 km waveglider track. Assuming a speed of 0.6 knots, the round-trip transit time is 18 days. GOMEC2 stations are red circles and the CenGOOS buoy is a blue diamond.

Glider was redeployed in January 2013, and recovered in February 2013 after a successful mission (Table 2).

Table 2. Timeline for Wave Glider missions.

10/15/2012	Deployment	Water samples taken for DIC, TA Chlorophyll dO salinity. Profiles for C, T, P, dO
10/27/2012	Wave Glider damaged by vessel	
12/07/2013	Damaged Wave Glider recovered	Wave Glider shipped to Liquid Robotics for repair
01/23/2013	Deployment	
02/27/2013	Recovery	Water samples taken for DIC, TA Chlorophyll dO salinity. Profiles for C, T, P, dO

Description of significant research results, protocols developed, and research transitions

1. Data from the two deployments were posted in near-real-time on a website of the Gulf of Mexico Coastal Ocean Observing System, where those data are still available (http://gcoos.org/products/maps/waveglider/usm/#.Ud7ETT44V6U). The funding from this effort came through the NOAA IOOS Office.
2. Data from the two deployments have been subject to another level of quality control and are ready for scientific analysis.
3. Collaboration with Dr. Rik Wanninkhof on analyses of these data will provide a context of these data with data collected with the GOMEC-II cruise and other data from vessels of opportunity. A primary goal is to demonstrate how the Wave Glider provides a good solution to enhance the spatio-temporal resolution of pCO_2 and ocean acidification data in the northern Gulf of Mexico.

Information on collaborators / partners:

Name of collaborating organization: Jamie Griffith, Liquid Robotics, Inc.
Date collaborating established: None Reported
Does partner provide monetary support to project? Amount of support? None Reported
Does partner provide non-monetary (in-kind) support? None Reported
Short description of collaboration/partnership relationship: None Reported

Name of collaborating organization: Dr. Rik Wanninkhof, NOAA/AOML
Date collaborating established: None Reported
Does partner provide monetary support to project? Amount of support? None Reported
Does partner provide non-monetary (in-kind) support? Yes
Short description of collaboration/partnership relationship: NOAA/AOML is providing scientific expertise in the collaborative data analysis.

Name of collaborating organization: Gernot Frederich, MBARI
Date collaborating established: None Reported
Does partner provide monetary support to project? Amount of support? None Reported
Does partner provide non-monetary (in-kind) support? None Reported
Short description of collaboration/partnership relationship: None Reported

Name of collaborating organization: Gulf of Mexico Coastal Ocean Observing System (GCOOS)
Date collaborating established: None Reported
Does partner provide monetary support to project? Amount of support? Yes, $25,000
Does partner provide non-monetary (in-kind) support? None Reported
Short description of collaboration/partnership relationship: GCOOS provided a small grant to LRI for this project to integrate an anemometer into the package and work with the GCOOS data management team to ingest the deployment data in near-real-time.

Information on any outreach activities:

In addition to presentations made on preliminary results of this project, the GCOOS Web Glider project page provides an outreach platform.

NOAA sponsor and NOAA office of primary technical contact: Allen Leonardi, OAR

Related NOAA strategic goals: Climate Adaptation and Mitigation, Healthy Oceans, Resilient Coastal Communities and Economies

Related NOAA enterprise objectives: Science and Technology

NGI FILE #12-NGI2-20

Project Title: Climate Variability in Ocean Surface Turbulent Fluxes

Project Lead (PI) name, affiliation, email address: Mark Bourassa, FSU, mbourassa@coaps.fsu.edu

Co-PI(s) name(s), affiliation, email address: Shawn Smith, FSU, ssmith@coaps.fsu.edu

Project objectives and goals

FSU produces fields of surface turbulent air-sea fluxes and the flux related variables (winds, SST, near surface air temperature, near surface humidity, and surface pressure) for use in global climate studies. Surface fluxes are by definition rates of exchange, per unit surface area, between the ocean and the atmosphere. Stress is the flux of horizontal momentum (imparted by the wind on the ocean). The evaporative moisture flux would be the rate, per unit area, at which moisture is transferred from the ocean to the air. The latent heat flux (LHF) is related to the moisture flux: it is the rate (per unit area) at which energy associated with the phase change of water is transferred from the ocean to the atmosphere. Similarly, the sensible heat flux (SHF) is the rate at which thermal energy (associated with heating, but without a phase change) is transferred from the ocean to the atmosphere. In the tropics, the latent heat flux is typically an order of magnitude greater than the sensible heat flux; however, in the polar regions the SHF can dominate.

We examine these fluxes on the basis of in situ data (funded solely by NOAA) and satellite data (leveraged from several NASA projects and from the PI being the NASA Ocean Vector Winds Science Team Leader). The in situ product is well suited for long time scale studies, and comparisons to reanalyses. We find that the variability between flux products is far greater than the accuracy need to resolve climate variability (e.g., interannual time scales and larger), indicating that a great deal more work is needed to make products that are well suited to ocean process studies where the processes are sensitive to the fluxes (as is often the case). We have also found that it is very important to consider high frequency variability (e.g., finer scale synoptic variability) in the calculation of longer-term average fluxes (particularly the ocean uptake of CO_2), and in the case of the Gulf of Mexico's West Florida Shelf, for correctly modeling the regional ocean climate. This is very important for the local ecosystem including some important finfish and shellfish. These studies add to the evidence demonstrating the importance of the ocean and the atmosphere as coupled for climate applications.

The FSU activity is motivated by a need to better understand interactions between the ocean and atmosphere on weekly to interdecadal time scales. Air-sea exchanges (fluxes) are sensitive indicators of changes in the climate, with links to floods and droughts and East Coast storm intensity and storm tracks. On smaller spatial and temporal scales they can be related to storm surge and tropical storm intensity. On longer temporal scales, several well-known climate variations (e.g., El Niño/Southern Oscillation (ENSO); North Atlantic Oscillation (NAO), Pacific Decadal Oscillation (PDO)) have been identified as having direct impact on the U.S. economy and its citizens. Improved predictions of ENSO phase and associated impact on regional weather patterns could be extremely useful to the agricultural community. Agricultural decisions in the southeast U.S. sector based on ENSO predictions could benefit the U.S. economy by over $100 million annually. A similar, more recent estimate for the entire U.S. agricultural production suggests economic value of non-perfect ENSO predictions to be over $240 million annually. These impacts could easily be extended to other economic sectors, adding further economic value. Moreover, similar economic value could be foreseen in other world economies, making the present study valuable to the global meteorological community. By constructing high quality fields of surface fluxes we provide the research community the improved capabilities to investigate the energy exchange at the ocean surface.

FSU produces both monthly in-situ based and hybrid satellite/numerical weather prediction (NWP) fields of fluxes and the flux-related variables. Our long-term monthly fields are well suited for seasonal to decadal studies (available in time for monthly updated ENSO forecasts, within eight days after the end of the month), and our hybrid satellite/NWP fields will be ideal for daily to inter-annual variability and quality assessment of the monthly products. The flux-related variables are useful for ocean forcing in models, testing coupled ocean/atmospheric models, ENSO forecasts, and for understanding climate related variability (e.g., the monthly Atlantic surface pressure is a good indicator of extreme monthly air temperatures over Florida). Our satellite winds are currently undergoing a vast improvement. They were not released during this funding cycle; however, they are expected to be released in at least a beta testing mode during the next funding year. Pending improvements based on the beta testing, the wind product will be released in near real time for oceanographic applications (we are aiming for release within two days). The satellite sensible and latent heat fluxes will continue to be in a development phase. We have addressed many key issues in producing a high quality product, and will soon be moving to integrate these many parts into a product that can be produced with a two day or less delay provided that collaborators can provide the input data within slightly less than two days.

The flux project at FSU targets the data assimilation milestones within the Program Plan. Our efforts combine ocean surface data from multiple Ocean Observing System networks (e.g., Voluntary Observing Ship, moored and drifting buoys, and satellites). One set of performance measures targeted in the Program Plan is the Air-Sea Exchange of Heat, Momentum, and Fresh Water. These fluxes can be related to Sea Surface Temperature and Ocean Heat Content. Additional targets are Ocean Transport and Thermohaline Circulation. Surface winds (stress) contribute to upper ocean and deep ocean transport. The heat and moisture fluxes also contribute to the thermohaline circulation. Ocean Carbon Uptake is highly dependent on wind speed. We have worked with other members NOAA climate observing team to estimate the importance of using six hourly winds vs. monthly averaged winds on estimates of Ocean Carbon Uptake. The FSU flux project also focuses on the task of evaluating operational assimilation systems (e.g., NCEP and ECMWF reanalyses) and continues to provide timely data products that are used for a wide range of ENSO forecast systems. The FSU fluxes support a broad user community. Our web data portal currently shows ~170 registered users from 16 countries. Users are from academic institutions (57), governmental agencies (30), public/non-profit entities, and the military. Although we do not track the users applications, we know that many are using the FSU winds and fluxes to support tropical SST forecast models (e.g., Lamont-Doherty Earth Observatory model; http://rainbow.ldeo.columbia.edu/~dchen/forecast.html).

Description of research conducted during the reporting period and milestones accomplished and/or completed

The tasks pertain to the continued development/production of products and the dissemination of scientific results. Results include an evaluation of the sampling and averaging related biases in the FSU3 in-situ flux products which have led to the determination that the FSU3 methods are not ideal for the non-tropical oceans. This, combined with continued funding reductions, resulted in the termination of the FSU3 product development. We continue to routinely produce the operational FSU tropical Pacific and Indian Ocean products in compliance with GCOS climate principles.

Work Plan and Deliverables for the past year include the following:

1. Update FSU3 Atlantic, Indian, and Pacific Oceans using new ICOADS releases (if available)
2. Continue operation production of the 2˚ Tropical Pacific and 1˚ Legler Tropical Indian Ocean FSU wind products.
3. Publish evaluation of practical applications of FSU3 fluxes
4. Develop quick look (near real time) monthly flux products
5. Improve upon the capabilities of our satellite-based gridded flux product
6. Continue production of satellite and NWP hybrid wind fields for the Gulf of Mexico.
7. Continue updating the information on the tropical web page developed by Ryan Maue.

Progress on these deliverables specifically target the program deliverables related to sea surface temperature, surface currents (via wind observations), and the air-sea exchanges of heat, momentum, and freshwater. The DAC strives to make high-quality fields of surface turbulent fluxes readily available to the research and operational marine climate community.

2.1 *Update FSU3 Products*

Using release 2.5 of ICOADS, we completed FSU3 analysis for the Atlantic and Indian Ocean basins for the period 2005-2007. These updates will be posted to the FSU3 product web site (http://coaps.fsu.edu/RVSMDC/FSUFluxes/research.php) in Fall 2012. Recent evaluation of the FSU3 averaging methods and continued flat to reduced budgets resulted in the PI's decision not to complete the 2005-2007 FSU3 for the Pacific Ocean. No further development of the FSU3 in-situ products are planned. Developing a new FSU in-situ flux product for the pending ICOADS release 2.6 in early 2014 would require substantial new funding and a complete redesign of the data processing methodology.

2.2 *Operational Pacific and Indian Ocean Wind Products*

In keeping with the GCOS climate monitoring principles, we continue operational production of the quick-look 2˚ tropical Pacific (http://coaps.fsu.edu/RVSMDC/html/pacmonyrq.shtml) and 1˚ tropical Indian (http://coaps.fsu.edu/woce/html/ndnquick.htm) ocean pseudo-wind stress products. These operational products continue to have a large user community, although many users are unknown to our group. We typically receive a half-dozen requests per year via email for more information on the Indian ocean winds from Asian scientists working on topics related to the Indian monsoon cycles. The Pacific wind products continue to be used by operational

ENSO forecasters as part of their modeling efforts (e.g., LDEO) and are published monthly in the NOAA Climate Diagnostics Bulletin (http://www.cpc.ncep.noaa.gov/products/CDB/) used widely by the ENSO community. These operational products directly address the Climate and Commerce and Transportation NOAA mission goals by supporting operational ENSO forecasting and subsequent decision making processes for the agricultural communities (particularly in the Southeastern U.S.). We have been 100% success in meeting our goals for production and timeliness.

2.3 *Publish evaluation of practical applications of FSU3 fluxes*

An evaluation of the turbulent fluxes from our FSU3 (in situ) product demonstrated many good qualities regarding spatial structure of the fields. However, it also demonstrated a shortcoming of the technique associated with not accounting for sub-monthly variability, leading to a regionally and seasonally changing underestimation of the heat fluxes. The stresses do not suffer from this problem. This problem, combined with decreases in funding led to our conclusion to cease production of the FSU3 in situ product. An important finding of this work was a demonstration and explanation of the importance of accurately capturing synoptic variability in the determination of submonthly variability. An M.S. thesis further demonstrated and explained why accounting for at least six hourly variability is important (even in monthly averages) for strong mid-latitude storms. We plan to submit this work in late 2012 or early 2013. This work used satellite retrievals to determine latent and sensible heat fluxes, demonstrating key steps in the development of our satellite-based flux product.

2.4 *Develop quick look (near real time) monthly flux products*

This objective was dropped due to ceasing production of our monthly flux product (see 2.3). We will come back to this activity when the satellite product is ready to be released.

2.5 *Improve upon the capabilities of our satellite-based gridded flux product*

The satellite flux product has moved forward in development, passing several milestones. We have demonstrated that we can produce surface turbulent fluxes in satellite swaths, and we have demonstrated that the input data used in these calculations are reasonably accurate. We are also near completion the part of our data assimilation technique that greatly improves the accuracy of co-variability of winds and sea surface temperatures (SSTs). We have achieved this by identifying the physical processes responsible for this co-variance. This subject has been highly controversial for more than a decade, with a variety of physical mechanisms proposed and hotly debated. We are working on a peer reviewed publication. This co-variability is likely to be very important for calculation surface fluxes. We are beginning to examine how important. In areas of strong SST gradients, such as the Gulf Stream, it is expected that these latent heat fluxes are strongly enhanced by this co-variability. These are regions where water vapor is relatively efficiently transport from the atmospheric boundary-layer into the free atmosphere, which seems likely to be very important for at least seasonal and longer time scales. Currently, NOAA provides the only support for the development of the turbulent heat flux portion of this product; although wind and stress portions are largely supported by NASA. Reduction of our flux funding will greatly hamper the development of this product.

2.6 *Continue production of satellite and NWP hybrid wind fields for the Gulf of Mexico*

We have ceased production of our old satellite and NWP product, in part because the satellite data used in the production are no longer available. Rather than developing the system with other satellites, we are working on the global product mentioned above. Preliminary testing for a non-tropical version of the product indicates that we are very close to having this work ready for distribution.

2.7 *Continue updating the information on the tropical web page developed by Ryan Maue*

Dr. Maue has found employment at a location allowing him to move his website. Therefore, we are no longer working with him to maintain that site at COAPS. We consider this effort to be a successful transition that maintains free access. The data will continue to be made available by Dr. Maue, but we will no longer be involved. We are dropping this activity.

Description of significant research results, protocols developed, and research transitions:

None Reported

Information on collaborators / partners:

Name of collaborating organization: ESRL
Date collaborating established: 2010
Does partner provide monetary support to project? Amount of support? No
Does partner provide non-monetary (in-kind) support? No
Short description of collaboration/partnership relationship: We collaborate with ESRL (from Gary Wick) on the use of satellite derived near surface air temperature and humidity.

Name of collaborating organization: CIRES
Date collaborating established: 2010
Does partner provide monetary support to project? Amount of support? No
Does partner provide non-monetary (in-kind) support? No
Short description of collaboration/partnership relationship: We collaborate with CIRES (from Darren Jackson) on the use of satellite derived near surface air temperature and humidity.

Information on any outreach activities:

We continue to provide opportunities for undergraduate students in the fields of meteorology and computer science to learn research and programming skills that will serve them in graduate school and their respective careers. Three undergraduates were employed via this funding over the past year. One an undergraduate honors student examined how cold air outbreaks modify the temperature of the Gulf Stream waters passing through the Florida Straight and this work is now in review with the Journal of Physical Oceanography. Training this student received at FSU resulted in her receiving a graduate appointment at the University of Miami. Florida State

University has now recognized our program as the COAPS Undergraduate Honors program, allowing us to leverage a small amount of financial support for the students.

We have also developed a flux program that is used in training graduate students about the importance of a wide variety of physical considerations, as well as examining the differences between parameterizations. This tool is freely available on our web site: http://coaps.fsu.edu/~bourassa/MFT_html/MFT_docs.php

Information developed on the accuracy requirements for surface fluxes on local, regional, and global scales is used to teach students about some the goals of the global observing system. How various parts of the system can be combined to reach these goals is also discussed. The students also learn to process data to examine surface fluxes and the ocean's response.

NOAA sponsor and NOAA office of primary technical contact: Joel Levy, OAR

Related NOAA strategic goals: Climate Adaptation and Mitigation, Weather-Ready Nation, Healthy Oceans, Resilient Coastal Communities and Economies

Related NOAA enterprise objectives: Science and Technology, Engagement

NGI FILE #12-NGI2-21

Project Title: U.S. Research Vessel Surface Meteorology Data Assembly Center

Project Lead (PI) name, affiliation, email address: Shawn R. Smith, FSU, smith@coaps.fsu.edu

Co-PI(s) name(s), affiliation, email address: Mark A. Bourassa, FSU, Bourassa@coaps.fsu.edu

Project objectives and goals

The central activity of the U.S. Research Vessel Surface Meteorology Data Assembly Center (DAC) at the Florida State University (FSU) is developing and implementing the Shipboard Automated Meteorological and Oceanographic System (SAMOS) initiative (http://samos.coaps.fsu.edu/). The SAMOS initiative focuses on improving the quality of and access to surface marine meteorological and oceanographic data collected in-situ by automated instrumentation on research vessels. In FY2012, 26 U.S.-operated and 3 Australian research vessels routinely transmit daily emails containing one-minute averaged meteorology and surface oceanographic data to the DAC. Broadband satellite communication facilitates this daily transfer at ~0000 UTC. A preliminary version of the data is available via web services within five minutes of receipt. The preliminary data are placed in a common data format, are augmented with vessel- and instrument-specific metadata (e.g., instrument height, type, units), and undergo automated quality control (QC). Visual inspection and further scientific QC result in intermediate and research-quality products that are nominally distributed with a 10-day delay from the original data collection date. All data and metadata are version controlled and tracked using structured query language (SQL) databases. These data are distributed free of charge and proprietary holds via http://www.coaps.fsu.edu/RVSMDC/html/data.shtml, and long-term archival occurs at the U.S. National Oceanographic Data Center (NODC).

The DAC activities focus primarily on NOAA Climate Mission and Technology and Mission Support goals by providing high-quality weather and near-surface ocean data to validate complementary satellite observations; global analyses of the ocean-atmosphere exchange of heat, moisture, and momentum; and computer-model-derived analyses of climate, weather, and ocean parameters. The data distributed by the DAC address the Office of Climate Observation program deliverables related to sea surface temperature, surface currents (via the wind), and air-sea exchanges of heat, momentum, and fresh water.

Research vessels, being mobile observing platforms, are an essential component of the global ocean observing system. They are equipped with computerized data systems that continuously record navigational (ship position, course, speed, and heading), meteorological (winds, air temperature, pressure, moisture, rainfall, and radiation), and near-surface ocean (sea temperature and salinity) parameters while a vessel is underway. Research vessels travel to remote, hard to observe ocean locations far from the shipping lanes sampled by merchant vessels. Research vessels provide essential observations between the fixed locations of surface moorings and support side-by-side comparison to mooring data when moorings are deployed or serviced.

The DAC provides data that quantify the physical and thermodynamic processes governing the interaction between the ocean and atmosphere, key to our understanding of how marine weather systems evolve, how these systems impact the ocean, and how the oceans impact the weather. On longer time scales, understanding the interaction between the ocean and atmosphere is necessary to assess our changing global climate system. The DAC provides high-quality marine meteorological and surface ocean measurements to the research and operational community so that they can identify and model the interactions between the ocean and atmosphere. Benefits include improved weather and climate models and forecasts that provide the public and private sector with the tools to make decisions affecting agricultural productivity, the energy industry, and daily life.

Our user community includes scientists developing algorithms to retrieve marine observations from space, those working to define the range of air-sea exchanges in extreme environments (e.g., the Southern Ocean), and atmospheric and ocean modelers seeking to verify model analyses and forecasts. For many applications, our users require observations in the extremes of the marine environment (e.g., very high or low winds) and need frequent sampling in space and/or time to identify local marine features (e.g., weather and ocean fronts). The research vessels providing observations to the DAC meet these needs and the DAC quality evaluation ensures the users receive fully documented observations to complete their analyses.

Description of research conducted during the reporting period and milestones accomplished and/or completed

Over the past year, we have concentrated on continued data quality evaluation (from collection to archival) for previously recruited vessels, recruitment of additional NOAA vessels, and on the scientific application of SAMOS data. We also continued active participation in the international marine climate community.

Deliverables for addressed in FY2012 included the following:

1. Recruit any outstanding or new NOAA vessels to the SAMOS initiative.
2. Engage OMAO to obtain full metadata for all recruited NOAA vessels.
3. Continue routine quality evaluation of meteorological data for SAMOS vessels currently contributing to the DAC. Research-quality visual evaluation is only conducted for NOAA vessels and those vessels recruited prior to 1 July 2009.
4. Scientific application of SAMOS data.
5. Continue liaison activities with U.S. and international (limited) government agencies, archives, climate programs, and throughout the marine community.

Progress on these deliverables specifically target the program deliverables related to sea surface temperature, surface currents (via wind observations), and the air-sea exchanges of heat, momentum, and freshwater. The DAC strives to make high-quality observations readily available to the research and operational marine climate community.

2.1 Vessel Recruitment (Deliverable 1)

One new NOAA vessel and three new university vessels were recruited in FY2012 (Table 3).

Table 3. Ships transmitting observations to SAMOS DAC during FY 2011 and FY 2012. Four vessels recruited leveraging funding from NSF are shown for completeness. Operators include NOAA, Bermuda Institution of Ocean Sciences (BIOS), Woods Hole Oceanographic Institution (WHOI), Australian Integrated Marine Observing System (IMOS), U.S. Coast Guard (USCG), U. S. Antarctic Program (USAP), Scripps Institution of Oceanography (SIO), and the Univ. of Hawaii and Univ. of Washington.

		Number of ship days with data	
Vessel	Operator	1/10/2010 – 30/9/2011	1/10/2011 – 30/9/2012
Atlantic Explorer[1,2]	BIOS	146	200
Atlantis	WHOI	254	332
Aurora Australis[1]	IMOS/Australia	189	213
Bell M. Shimada	NOAA	--	148
Delaware II	NOAA	15	--[5]
Fairweather	NOAA	65	--
Gordon Gunter	NOAA	193	196
Healy	USCG	133	188
Henry B. Bigelow	NOAA	151	175
Hi'ialakai	NOAA	152	153
Ka'imimoana	NOAA	212	166
Kilo Moana[1,2]	U. Hawaii	287	214
Knorr	WHOI	315	339
Lawrence M. Gould	NSF/USAP	307	256
McArthur II	NOAA	123	5
Melville[1,2]	SIO	30	234
Miller Freeman	NOAA	13	--[5]
Nancy Foster	NOAA	143	135
Nathaniel Palmer	NSF/USAP	166	315
New Horizon[1,2]	SIO	--	10
Oceanus	WHOI	331	48[4]
Okeanos Explorer	NOAA	119	115
Oregon II	NOAA	166	151
Oscar Dyson	NOAA	124	200
Oscar Elton Sette	NOAA	141	183
Pisces	NOAA	182	160
Polar Sea[1,3]	USCG	--	--
Rainier	NOAA	--	--
Roger Revelle[1,2]	SIO	108	357
Ronald Brown	NOAA	94	126
R. G. Sproul[1,2]	SIO	--	16
Southern Surveyor[1]	IMOS/Australia	127	170
Tangaroa[1]	IMOS/New Zealand	127	232
T. G. Thompson[1,2]	U. Washington	--	33
		4413	5070

[1]No research-quality visual data quality control completed.
[2]Funding from the National Science Foundation (NSF) Ocean Instrumentation and Technical Services program supported recruitment (part of UNOLS Rolling Deck to Repository project, shown for completeness).
[3]The *Polar Sea* is currently in caretaker status.
[4]*Oceanus* moved from WHOI to Oregon State University at the start of 2012. This interrupted SAMOS data flow.
[5]No future data expected from Delaware II (decommissioned in 2012) or Miller Freeman (decommissioning in 2013).

2.2 Interaction with OMAO (Deliverable 2)

FSU and OMAO personnel agreed to develop some protocols that would exchange SAMOS data quality information directly to OMAO so that the upper OMAO management could rapidly assess NOAA fleet performance. The result was the development of a JSON web service that automatically provides OMAO with data flow and quality metrics for the NOAA fleet. The metrics provided by this service allowed OMAO to develop a web dashboard to be displayed at OMAO headquarters. Through this ongoing dialog and data exchange, the DAC is providing a service to OMAO that improves the quality of the data collected by NOAA vessels. These improvements continue to expand the quantity of high quality marine observations reaching the national archives from the publically-funded NOAA research fleet. Ongoing interactions between the DAC and OMAO directly address Technology and Mission Support goals in NOAA's strategic plan.

2.3 Data quality control (Deliverable 3)

Automated quality processing is completed on every set of data received from recruited vessels (Table 1). The automated processing continues to be a smooth operation with each data set being versioned and tracked via an SQL database. In FY2012, we evaluated 5070 days of underway meteorological and sea surface temperature data (a 15% increase from FY2012). These data span the global ocean, extending into poorly sampled regions of the Indian, South Atlantic, and Southern oceans. The extent of these data from the tropics to the polar latitudes, along with many reports on the continental shelf, provide observations from the wide range of environmental conditions required by our users to meet objectives in satellite, air-sea exchange, and physical oceanographic studies. The data collected and quality controlled by the DAC directly support the OCO program deliverables related to sea surface temperature, currents (via wind data), and the air-sea exchange of heat, momentum, and fresh water.

Our lead analyst, Jeremy Rolph, continues to conduct daily (not 24/7) visual inspections of all observations. This inspection, a quick-look, does not allow for adding/altering quality control flags on the data. It is a means of ensuring that the data received from the vessel are free of major sensor failures or other problems that would require notification of the vessel at sea. These at-sea notifications are highly desired by the vessel operators and onboard technicians and are the core benefit to the vessel operator. Prompt problem notification results in a quick resolution of sampling issues and adds value to the public investment in expensive shipboard observing systems.

Over the past year, Kristen Briggs, our visual data quality analyst, completed research quality QC for many of the recruited vessels (the exceptions are noted in Table 1). Visual QC allows the analyst to review, add, or modify data quality flags on the merged files. Visual quality control is manpower intensive and has been successful for 2012 only because the DAC continues to leverage NSF funding and shift resources and tasks for our two quality analysts. NSF funds are focused on vessels from the U.S. academic fleet, so our OCO funds have been focused on the quality evaluation of SAMOS observations received from the NOAA, USCG, and polar vessels. The Australians conduct visual QC for IMOS vessels. Even with the additional funding from NSF, we are unable to provide research quality visual QC for newly recruited vessels, with the exception of any new NOAA vessels that come on line. NOAA funding reductions eliminated visual QC for all non-NOAA vessels at the start of calendar year 2013.

We again produced an annual report (Briggs et al. 2013) that summarizes the data quality for all vessels contributing data for the calendar year 2011. The report has been distributed to all operators of SAMOS vessels and provides a foundation for developing automated monthly reports for operators.

2.4 Scientific Application of SAMOS Data (Deliverable 4)

The DAC continues to support existing users of the SAMOS observations and continues to expand our user community. We continue to provide SAMOS observations to Darren Jackson and Gary Wick at NOAA ESRL to support their development of new satellite air temperature and humidity retrieval algorithms.

FSU continues to use SAMOS observations to validate sea surface temperature and salinity fields from the HYbrid Coordinate Ocean Model (HYCOM). HYCOM is widely used by physical oceanographers and marine biologists. FSU is focusing on validating HYCOM in the northern Gulf of Mexico, a region of high productivity for the U.S. fishing industry. The project is an ongoing undergraduate research project and is leveraging additional funding from the HYCOM project. The results reveal an overestimation of the surface salinity in HYCOM near the northern Gulf Coast. The hypothesis is that HYCOM is underestimating the freshwater input from the major rivers along the coastline. Use of SAMOS observations to validate ocean models provides a significant opportunity to quantify model biases and provide direction for future model improvements.

Other known users of SAMOS observations include Jim Manning (NOAA NE Fish Science Center), an international researcher (Mr. Lim) doing satellite wind product validation in the Southern Ocean, John Gunn (Earth & Space Research), and Chad Cary from NOAA's Environmental Modeling Center (Arctic SST data). The NASA PO.DAAC has also included the SAMOS data in one of its data mining tools. In 2012, we also learned that NOAA's Environmental Research Division has been re-serving quality controlled SAMOS observations on their Data Access Program portal. Scientists using their portal include researchers from the Salmon Ecosystem Simulation Management and Evaluation Project (http://sesame.noaa.gov), which is a cooperative experiment involving NOAA, NASA, the CA Dept. of Water Resources, four major universities and several private research organizations to model the life history of the Chinook salmon migrating through the San Francisco Bay estuary system (Lynn Dewitt, personal communication, 2012).

2.5 Liaison Activities (Deliverable 5)

The SAMOS project continues to exemplify strong data stewardship practices for underway data from research vessels and maintains an active partnership with the Australian IMOS project, the UNOLS Rolling Deck to Repository (R2R) project, and the NOAA R2R initiative. The PI routinely receives requests from other marine data programs to share the lessons learned from SAMOS. Without ongoing support from NOAA, the SAMOS project would never have become a model for the management of underway atmospheric and surface ocean data.

The SAMOS DAC serves as the project office for the entire SAMOS initiative. In this capacity, DAC personnel facilitate U.S. and international collaborations on topics such as data accuracy, data acquisition and exchange, training activities, and data archival. The PI performs an active role in the international marine climate community, serving on two JCOMM task teams (*Delayed-Mode Voluntary Observing System* and *Instrument Systems*). Recently the PI contributed to a review of Part II, Chapter 4 of the *WMO Guide to Meteorological Instruments and Methods of Observation* (WMO No. 8).

2.6 Data Distribution

All near real-time (preliminary, 5-min delay from receipt) and delayed-mode (intermediate or research, 10-day delay from receipt) data are available via web (http://samos.coaps.fsu.edu/, under "Data Access"), ftp (samos.coaps.fsu.edu, anonymous access, cd /samos_pub/data/), and THREDDS (http://coaps.fsu.edu/thredds.php) services. The most recent data can be identified by selecting "preliminary" data at http://samos.coaps.fsu.edu/html/data_availability.php and vary depending on which ships are transmitting data on a given day. We routinely test our web services and respond rapidly to failures of the system. Although we do not have a formal data management plan documented, the SAMOS web site includes our mission statement, data policy, and acknowledgements under the "About" tab on the SAMOS home page. The web site also provides access to recruitment materials for vessels, desired SAMOS parameters, accuracy requirements, relevant literature, best practice guides, and training materials.

SAMOS data are not presently provided to the Global Telecommunication System. As part of our work with JCOMM we are analyzing available GTS records from RVs contributing to SAMOS to determine whether adding SAMOS data to the GTS would provide added value to the community. The PI notes that our major user community continues not to require GTS access to retrieve the data. Our current web, ftp, and THREDDS systems meet their needs.

SAMOS data are archived at the U.S. National Oceanographic Data Center on a monthly schedule. To ensure integrity, each archival set includes files that contain the original, preliminary, and research-quality data and metadata (e.g., file naming and format descriptions), a file manifest, and a message-digest algorithm 5 (MD5) checksum for each file. NODC makes the archival sets available online via two types of Dissemination Information Packages: the public may download individual files in the archival set—each file has a unique URL—or the entire archival set in one "tarball" file. Users may find all the SAMOS data by searching for SAMOS under "Contributing projects" on the Open Archive System at http://www.nodc.noaa.gov/Archive/Search. A check on 23 October 2012 located over 700 monthly SAMOS ship archive sets at NODC. Periodically the PI downloads SAMOS data from NODC to ensure system integrity.

Description of significant research results, protocols developed, and research transitions:

None Reported

Information on collaborators / partners:

As noted in section 3, we collaborated with NOAA partners to develop and present professional development materials for in-service marine technicians. Collaborators include Chris Fairall (NOAA ESRL) and Dan Wolfe (NOAA CIRES) in Boulder, CO. The collaboration for this purpose was established in 2011. ESRL and CIRES do not provide any direct monetary support to the activity, but do provide in-kind support (travel and salaries) for their personnel.

NOAA sponsor and NOAA office of primary technical contact: Joel Levy, OAR

Related NOAA strategic goals: Climate Adaptation and Mitigation, Weather-Ready Nation, Healthy Oceans, Resilient Coastal Communities and Economies

Related NOAA enterprise objectives: Science and Technology, Engagement

NGI FILE #12-NGI2-22

Project Title: Student Assistance with Statistical Analysis of Meteorological and Oceanographic Data

Project Lead (PI) name, affiliation, email address: Steve Ashby, MSU, sashby@ngi.msstate.edu

Project objectives and goals

Improve the availability and quality of data collected on NDBC platforms via statistical analysis and algorithm development. Mentor interns in the assessment of meteorological and oceanographic data and provide educational seminar experiences.

Description of research conducted during the reporting period and milestones accomplished and/or completed

Statistical comparisons for air temperature, relative humidity, anemometer, and wave sensors test data to standard sensor data sets.

Description of significant research results, protocols developed, and research transitions

Currently conducting statistical comparisons of meteorological and oceanographic test data to standard data sets.

Information on collaborators / partners:

Name of collaborating organization: Karen Grissom, NOAA/NWS/NDBC
Date collaborating established: July 2012
Does partner provide monetary support to project? Amount of support? None Reported
Does partner provide non-monetary (in-kind) support? Yes
Short description of collaboration/partnership relationship: Collaborated on developing data analysis.

Information on any outreach activities: None Reported

NOAA sponsor and NOAA office of primary technical contact: Karen Grissom, NOAA/NWS/NDBC

Related NOAA strategic goals: Climate Adaptation and Mitigation, Healthy Oceans

Related NOAA enterprise objectives: Engagement

NGI FILE #12-NGI2-23

Project Title: Analysis of Engineering Test Data

Project Lead (PI) name, affiliation, email address: Jane N. Moorhead, MSU, janem@ece.msstate.edu

Project objectives and goals

NOAA's National Data Buoy Center (NDBC) is continually attempting to improve the availability and quality of data collected on its platforms. Engineering is testing new modems, transmitters, antennae and acoustic communications. As new systems are tested, the results need to be compared to existing systems within the same environment to determine their benefit. The results of these analyses will lead to the improvement of the capability to return high quality data to shore and disseminate it to modeling centers and scientists to investigate oceanographic and meteorological phenomena.

Evaluations are needed for the GOES antenna modifications including the high data rate GOES transmitter changes. Evaluation is also needed for the anemometer and the DART test buoy Mid-frequency acoustic communication. During the past year, NOAA has collected data for the evaluations and provided the data for evaluation by NGI. Evaluations have been determined for the GOES transmitter and antenna modifications. Work is in progress for the anemometer evaluations.

The NGI activities focus primarily on NOAA Strategic Plan Goals of Climate Adaptation and Mitigation as well as Healthy Oceans by providing evaluations of data acquisition systems and resulting data to ensure continued access to accurate and timely results from the buoys.

The moored buoys of the National Data Buoy Center are an essential component of the global ocean observing system. They are equipped with data acquisition systems that continuously monitor and record meteorological information (wind speed, direction and gust; air temperature, barometric pressure), as well as surface and sub-surface ocean parameters (sea temperature, salinity, and wave energy spectra for wave speed, period and propagation direction). The buoys provide essential observations of the global ocean and transmission of the data through satellite communications systems to the research and operational communities so they can assess the results providing understanding of how the oceans impact the weather, and how weather systems evolve.

Description of research conducted during the reporting period and milestones accomplished and/or completed

Over the past year, we have evaluated data based on tests from the following equipment:

1) High Data Rate GOES Transmitter
2) GOES antenna modifications
3) Ultrasonic Anemometer
4) DART Test Buoy Mid-Frequency Acoustic Communication

Progress on these deliverables specifically target the program deliverables related to the quality of the data received from test beds that were specifically designed to test the equipment being altered and improved.

GOES Antenna and Transmitter Modifications Data Analysis [Deliverables 1,2]

NDBC engineers had concerns due to a number of recent issues with high data rate transmitters failing to perform frequency discipline. The decision was made to investigate the possibility interference to the GPS signal due to a PVC cover on the GPS antenna on weather buoy applications.

The Trimble Condor 2626 GPS module is used on the weather buoys to transmit payload information using the National Marine Electronics Association (NMEA) 0183 protocol for message data formatting and communication interfacing. The antenna used is an Antcom active L1 GPS antenna. The antenna encasement has an O-ring to hermetically seal the antenna RF connections from extreme environmental conditions. The case was designed to be mounted so that the underside would be within the supporting structure (as in aircraft), but in the NDBC buoy application, the supporting structure did not enclose the underside of the case, the RF connections were not sealed, but wrapped with electrical tape, possibly degrading the signal with exposure to UV radiation and extreme temperature cycles, and resulting in moisture leaks to the connector. To prevent the leaking, NDBC designed a cover for the antenna that completely sealed the RF connection from the environment. The cover is used in conjunction with the “AERO” GPS antenna cover. The RADOME cover was designed using schedule 60, grey PVC with the cover bolted with three stainless steel bolts. Due to the extremely small signal strength from the GPS satellites, there was concern that the PVC cover might be attenuating the signal causing intermittent signal outages, or causing destructive interference to the GPS signals.

NDBC engineers designed a test bench to determine the performance of the PVC cover. Analysis was done to determine if signal degradation was occurring due to the PVC cover. Two new, known good working AERO antennas, one with the PVC cover and one without, were placed side-by-side to monitor the C/N_0 from all GPS satellites passing overhead. The C/N_0 measurements from each antenna were compared for possible attenuation from the PVC cover.

The results of the data analysis did not show any signal attenuation from the PVC cover (Fig. 6). Nor was there any indication that the sandwich radome created by the dual dome covers over the antenna caused any multipath interference in the signal. The bolts used to hold the PVC cover in place also did not show any effects on the data received. There was no significant difference in the C/N_0 whether the antenna cover was installed or removed, or even when it was reinstalled. The results showed a recorded C/N_0 in a range of 45 dB to 51 dB where satellites were in relatively high elevations during their orbits. This is a relatively strong signal strength.

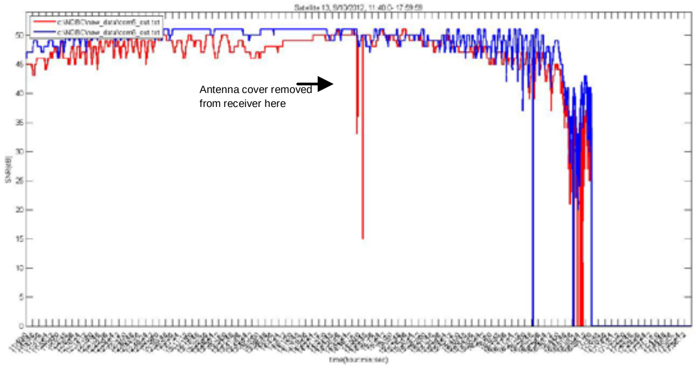


Figure 6. Example of results from the analysis of antenna-received data between a PVC-covered and uncovered AERO antenna. Very minimal dB differences existed between the two. The differences were less than 2 dB even with the sandwich radome. This difference should not present any problems in the analysis of data.

Recommendations from the analysis were to continue using the GPS antenna covers as they provide good protection to the RF connections from moisture invasion, and do not appear to have a major impact on GPS signal strength. The advantages of using the PVC cover which protects the connection from moisture outweigh the minimal signal differences. To reduce the possibility of RF interference due to the stainless steel bolts used to hold the PVC cover in place, the suggestion to use a more RF transparent material was advised.

Ultrasonic Anemometer [Deliverable 3]

Work is presently ongoing on the analysis of the ultrasonic anemometer. NDBC engineers have taken the ultrasonic antenna data that was collected during Hurricane Isaac to compare results. Initial analysis indicated the ultrasonic anemometer performed well during the hurricane. Analysis has revealed several periods that no data was collected. The analysis work will continue in the next two months to determine the accuracy of the ultrasonic anemometer.

Since the contract period extends through August, the analysis of the equipment test data will continue.

Description of significant research results, protocols developed, and research transitions

None Reported

Information on collaborators / partners: None Reported

Information on any outreach activities: None Reported

Publications and Presentations: None Reported

NOAA sponsor and NOAA office of primary technical contact: Karen Grissom, NOAA/NWS/NDBC

Related NOAA strategic goals: Climate Adaptation and Mitigation, Healthy Oceans

Related NOAA enterprise objectives: Science and Technology

NGI FILE #12-NGI2-24

Project Title: Assessing Statistical Climate Variability from the TAO Buoy Array

Project Lead (PI) name, affiliation, email address: Pat Fitzpatrick, MSU, fitz@gri.msstate.edu

Project objectives and goals

The objective is to determine the statistical oceanographic variability in the upper 500 meters of the water column in the Central Pacific Ocean over approximately the past two decades. A statistical analysis of equatorial Pacific data for 65 TAO/TRITON sites (Fig. 7) has been performed. The results have been provided to NDBC for guidance in their quality control assessments.

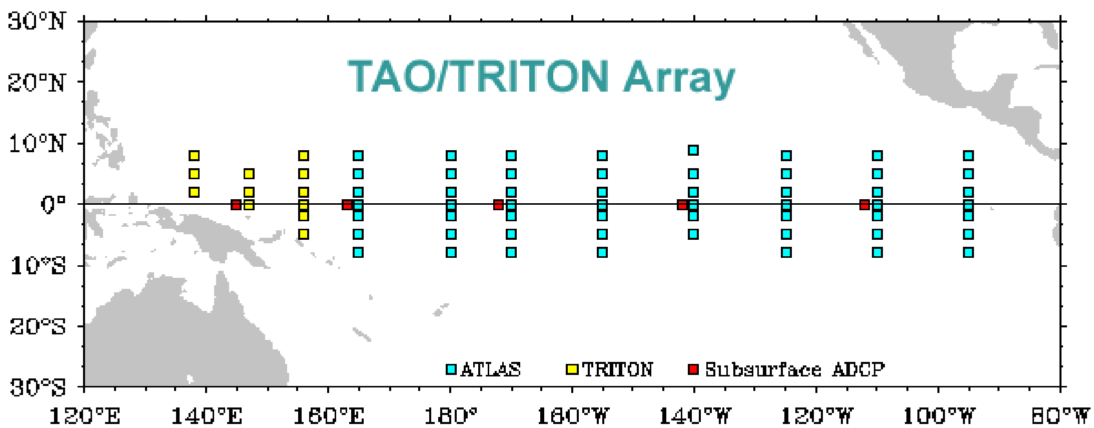


Figure 7. Locations of the buoys analyzed in this study. From http://tao.noaa.gov/images/tao-array-huge.gif

Description of research conducted during the reporting period and milestones accomplished and/or completed

The following is a list of milestones achieved during this project for longwave radiation, downwelling, shortwave radiation, precipitation, surface meteorology values (air temperature, wind speed and direction, air pressure, surface water temperature, relative humidity), subsurface salinity, and subsurface water temperature. Only data with quality codes of 1 (highest quality), 2 (default quality), or 3 (adjusted data) are used with source codes of 2 (derived from real-time), 5 (recovered from instrument, delayed mode), or 6 (derived from instrument, delayed mode). Most products are embedded in PowerPoints or Excel files and are mass-generated using a combination of Microsoft's Visual Basic for Application (VBA) code, GMT, R, and shell scripts. The products consist of:

i. Box plots and whiskers. The box ranges from the 25th to 75th percentiles, known as the interquartile range, with a line depicting the median. The arms of the box plot extend out to all observations within 1.5 times the interquartile range above the 75th percentile, and the same distance below the 25th percentile. Points outside those bands are outliers.
ii. Histograms.
iii. Temporal scatterplots

iv. Overlays of El Niño Climate Indices

v. Correlation matrices with bivariate scatter plots below the diagonal, histograms on the diagonal, and correlation values above the diagonal. Correlation ellipses are also show.

vi. Scatterplots of variables moderately to highly correlated (r>|0.7|) to Climate Indices, including correlation coefficient, regression equation, confidence intervals, and predictions intervals. The confidence interval provides the bounded values for the mean of all y(x), while the prediction interval gives the bounds of any future individual y(x). For large samples, the confidence interval closely corresponds to the predicted value ± twice the root mean square error, but is larger for small samples as in these buoy datasets.

vii. Spatial plots of ENSO teleconnection correlations, including depth patterns

viii. Tables of annual and monthly statistic metrics in Excel spreadsheets, with links to PowerPoints of ENSO correlations.

The climate indices include Niño 3, Niño 3.4, and Niño 4 (Fig. 8), as well as the Southern Oscillation Index (SOI), the Trans-Niño Index (TNI), and the Oceanic Niño Index (ONI), all downloaded from http://www.esrl.noaa.gov/psd/data/climateindices/list/.

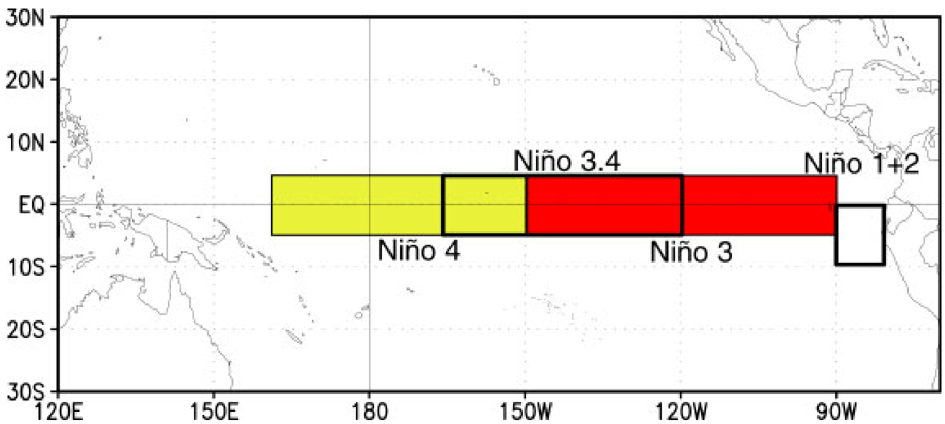


Figure 8. Locations of the Niño regions from http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/Niño_regions.shtml.

Milestones are:

Milestone A: *Longwave and downwelling shortwave radiation*: (11 buoys available for longwave, 23 for shortwave)

1) Box and whisker plots, summarized in one PowerPoint for all relevant buoys (Fig. 9).

2) Box and whisker plots two-minute observations with hour on x axis, summarized in a PowerPoint for each buoy (in a sub-directory). Nighttime values for shortwave (0 Wm^{-2}) are not included in the statistics (Fig. 9).

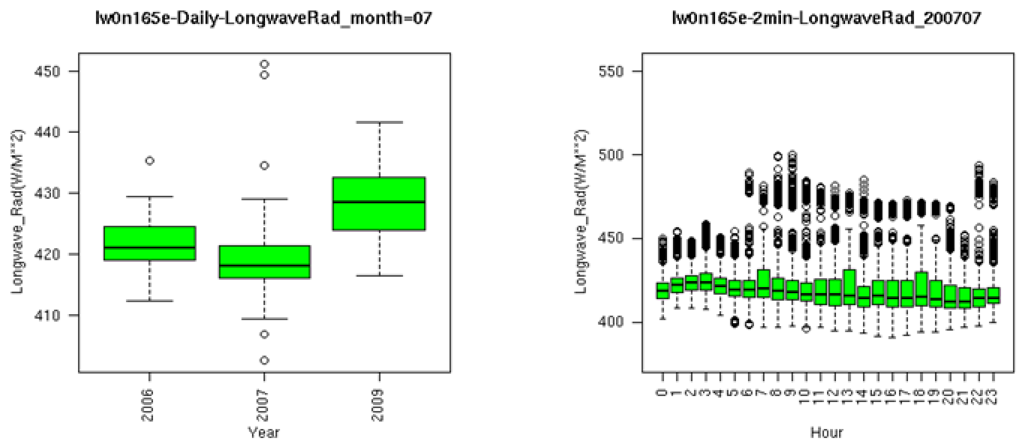


Figure 9. Example of longwave radiation box and whisker plots for the buoy located on the equator at 165°E. An instance of daily observations with year on x axis for July is shown on the left, and two-minute observations with hour on x axis for July 2007 is shown on the right. The box ranges are from the 25th to 75th percentiles, known as the interquartile range, with a line depicting the median. The arms of the box plot extend out to all observations within 1.5 times the interquartile range above the 75th percentile, and the same distance below the 25th percentile. Points outside those bands are outliers.

Milestone B: *Rain rate*: (28 buoys)

Histogram plots (Fig. 10) are performed for each buoy in sub-directories on:

1) 10-minute observations tallied in each year.
2) 10-minute observations tallied in each month.

Because many days are rain-free, the plots have a lognormal or gamma distribution. Unfortunately, a few observations contain contaminated negative values. Since the data quality is questionable, further analysis is not performed.

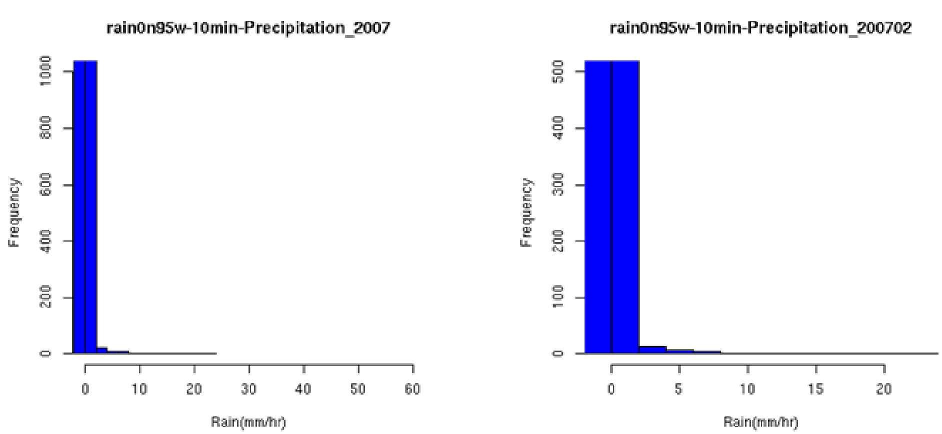


Figure 10. Example of histogram plots for rain rate (mm h-1) in ten-minute intervals for the buoy located on the equator at 95°W. An instance of annual data distribution in 2007 is shown on the left, and February 2007 shown on the right. Note the contaminated negative values.

Milestone C: *Surface meteorology* (65 buoys)

In main directory (all plots are done for 00 UTC and 12 UTC):

1) Excel spreadsheet of SST and air temperature climate index correlations when r>|0.7|, shown in Fig. 11. Figure 12 shows a scatterplot of these results.

K68 =AVERAGE(K2:K65)

	A	B	C	D	E	F	G	H	I	J	K
1	TAO stations - Surface Meteorogical Variables SST and AIRT Correlations with Climate Indices > 0.7										
2	1	met0n110w.NINO3.SST.00	0.93	met0n110w.NINO3.AIRT.00	0.94	-0.01		met0n110w.NINO3.SST.12	0.92	met0n110w.NINO3.AIRT.12	0.94
3	2	met0n125w.NINO3.4.SST.00	0.86	met0n125w.NINO3.4.AIRT.00	0.85	0.01		met0n125w.NINO3.4.SST.12	0.88	met0n125w.NINO3.4.AIRT.12	0.87
4	3	met0n125w.NINO3.SST.00	0.95	met0n125w.NINO3.AIRT.00	0.94	0.01		met0n125w.NINO3.SST.12	0.93	met0n125w.NINO3.AIRT.12	0.93
5	4	met0n140w.NINO3.4.SST.00	0.93	met0n140w.NINO3.4.AIRT.00	0.91	0.02		met0n125w.ONI.SST.12	0.76	met0n125w.ONI.AIRT.12	0.71
6	5	met0n140w.NINO3.SST.00	0.82	met0n140w.NINO3.AIRT.00	0.82	0		met0n140w.NINO3.4.SST.12	0.92	met0n140w.NINO3.4.AIRT.12	0.91
7	6	met0n140w.ONI.SST.00	0.85	met0n140w.ONI.AIRT.00	0.81	0.04		met0n140w.NINO3.SST.12	0.8	met0n140w.NINO3.AIRT.12	0.81
8	7	met0n155w.NINO3.4.SST.00	0.93	met0n155w.NINO3.4.AIRT.00	0.91	0.02		met0n140w.ONI.SST.12	0.85	met0n140w.ONI.AIRT.12	0.82
9	8	met0n155w.NINO4.SST.00	0.86	met0n155w.NINO4.AIRT.00	0.85	0.01		met0n155w.NINO3.4.SST.12	0.93	met0n155w.NINO3.4.AIRT.12	0.91
10	9	met0n155w.ONI.SST.00	0.92	met0n155w.ONI.AIRT.00	0.87	0.05		met0n155w.NINO4.SST.12	0.86	met0n155w.NINO4.AIRT.12	0.85
11	10	met0n170w.NINO3.4.SST.00	0.82	met0n170w.NINO3.4.AIRT.00	0.8	0.02		met0n155w.ONI.SST.12	0.92	met0n155w.ONI.AIRT.12	0.87
12	11	met0n170w.NINO4.SST.00	0.95	met0n170w.NINO4.AIRT.00	0.93	0.02		met0n170w.NINO3.4.SST.12	0.81	met0n170w.NINO3.4.AIRT.12	0.79
13	12	met0n170w.ONI.SST.00	0.88	met0n170w.ONI.AIRT.00	0.84	0.04		met0n170w.NINO4.SST.12	0.94	met0n170w.NINO4.AIRT.12	0.93
14	13	met0n180w.NINO4.SST.00	0.94	met0n180w.NINO4.AIRT.00	0.92	0.02		met0n170w.ONI.SST.12	0.88	met0n170w.ONI.AIRT.12	0.84
15	14	met0n95w.NINO3.SST.00	0.85	met0n95w.NINO3.AIRT.00	0.84	0.01		met0n180w.NINO4.SST.12	0.94	met0n180w.NINO4.AIRT.12	0.92
16	15	met2n110w.NINO3.SST.00	0.93	met2n110w.NINO3.AIRT.00	0.94	-0.01		met0n95w.NINO3.SST.12	0.86	met0n95w.NINO3.AIRT.12	0.86
17	16	met2n125w.NINO3.4.SST.00	0.84	met2n125w.NINO3.4.AIRT.00	0.8	0.04		met2n110w.NINO3.SST.12	0.93	met2n110w.NINO3.AIRT.12	0.94
18	17	met2n125w.NINO3.SST.00	0.94	met2n125w.NINO3.AIRT.00	0.94	0		met2n125w.NINO3.4.SST.12	0.87	met2n125w.NINO3.4.AIRT.12	0.81
19	18	met2n140w.NINO3.4.SST.00	0.94	met2n140w.NINO3.4.AIRT.00	0.92	0.02		met2n125w.NINO3.SST.12	0.93	met2n125w.NINO3.AIRT.12	0.93
20	19	met2n140w.NINO3.SST.00	0.78	met2n140w.NINO3.AIRT.00	0.8	-0.02		met2n140w.NINO3.4.SST.12	0.94	met2n140w.NINO3.4.AIRT.12	0.92
21	20	met2n140w.ONI.SST.00	0.82	met2n140w.ONI.AIRT.00	0.8	0.02		met2n140w.NINO3.SST.12	0.76	met2n140w.NINO3.AIRT.12	0.8
22	21	met2n155w.NINO3.4.SST.00	0.9	met2n155w.NINO3.4.AIRT.00	0.85	0.05		met2n140w.ONI.SST.12	0.83	met2n140w.ONI.AIRT.12	0.81
23	22	met2n155w.NINO4.SST.00	0.88	met2n155w.NINO4.AIRT.00	0.83	0.05		met2n155w.NINO3.4.SST.12	0.9	met2n155w.NINO3.4.AIRT.12	0.86
24	23	met2n155w.ONI.SST.00	0.87	met2n155w.ONI.AIRT.00	0.81	0.06		met2n155w.NINO4.SST.12	0.88	met2n155w.NINO4.AIRT.12	0.85
25	24	met2n170w.NINO3.4.SST.00	0.8	met2n170w.NINO3.4.AIRT.00	0.75	0.05		met2n155w.ONI.SST.12	0.88	met2n155w.ONI.AIRT.12	0.82
26	25	met2n170w.NINO4.SST.00	0.96	met2n170w.NINO4.AIRT.00	0.92	0.04		met2n170w.NINO3.4.SST.12	0.8	met2n170w.NINO3.4.AIRT.12	0.76
27	26	met2n170w.ONI.SST.00	0.86	met2n170w.ONI.AIRT.00	0.82	0.04		met2n170w.NINO4.SST.12	0.96	met2n170w.NINO4.AIRT.12	0.92
28	27	met2n180w.NINO4.SST.00	0.93	met2n180w.NINO4.AIRT.00	0.89	0.04		met2n170w.ONI.SST.12	0.86	met2n170w.ONI.AIRT.12	0.83

Figure 11. Portion of spreadsheet showing correlation comparisons of air temperature and SST when r≥|0.7|. for 00 UTC, the SST indicators are in columns B and C, and air temperature is in columns D and E. The differences (SST minus air temperature) are shown in column F. 12 UTC is done in the same method to the right, (image cutoff).

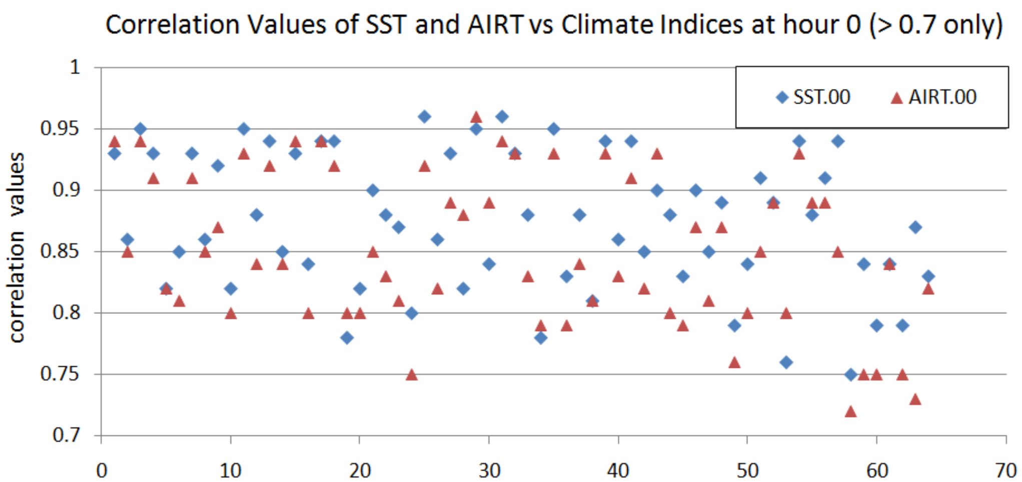
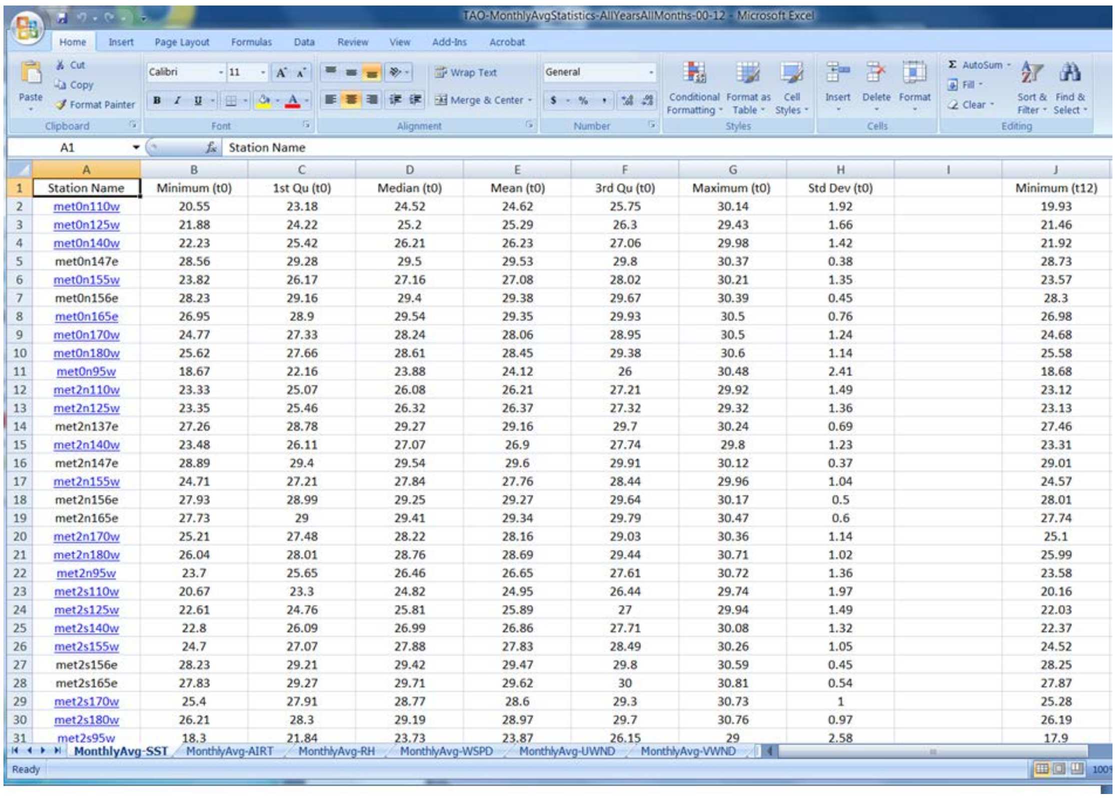


Figure 12. Comparison of 00 UTC SST and air temperature correlations for the 63 cases when r>|0.7|. On average, $(\overline{r_{SST}} - \overline{r_{Tair}})$=0.02, indicating that SST has 2% higher correlation on average than air temperature. $r_{SST} > r_{air}$ in 54 of the 64 cases. Twelve UTC gives similar results (not shown).

Excel spreadsheet of each buoy's lifetime minimum, 1st quartile, median, mean, 3rd quartile, maximum, and standard deviation, based on monthly averages of SST, air temperature, relative humidity, wind speed, zonal wind component, and meridional wind component (Fig. 13). A similar spreadsheet for monthly statistics for the entire buoy lifetime was requested by NDBC on 6/28/13. This spreadsheet contains similar metrics, but NDBC requested the removal of outliers before computing the statistics. The outliers are identified as data outside 1.5 times the interquartile range. Each monthly statistical spreadsheet contains two sets of calculations: all data included (for reference), and data minus outliers.

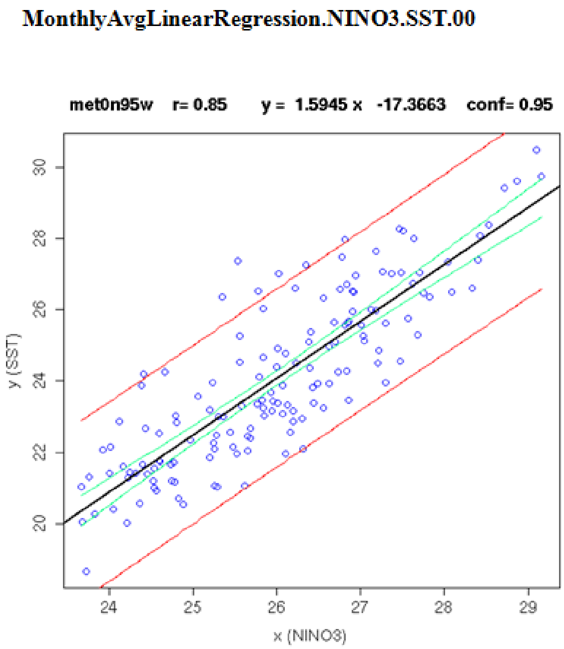


	Station Name	Minimum (t0)	1st Qu (t0)	Median (t0)	Mean (t0)	3rd Qu (t0)	Maximum (t0)	Std Dev (t0)		Minimum (t12)
2	met0n110w	20.55	23.18	24.52	24.62	25.75	30.14	1.92		19.93
3	met0n125w	21.88	24.22	25.2	25.29	26.3	29.43	1.66		21.46
4	met0n140w	22.23	25.42	26.21	26.23	27.06	29.98	1.42		21.92
5	met0n147e	28.56	29.28	29.5	29.53	29.8	30.37	0.38		28.73
6	met0n155w	23.82	26.17	27.16	27.08	28.02	30.21	1.35		23.57
7	met0n156e	28.23	29.16	29.4	29.38	29.67	30.39	0.45		28.3
8	met0n165e	26.95	28.9	29.54	29.35	29.93	30.5	0.76		26.98
9	met0n170w	24.77	27.33	28.24	28.06	28.95	30.5	1.24		24.68
10	met0n180w	25.62	27.66	28.61	28.45	29.38	30.6	1.14		25.58
11	met0n95w	18.67	22.16	23.88	24.12	26	30.48	2.41		18.68
12	met2n110w	23.33	25.07	26.08	26.21	27.21	29.92	1.49		23.12
13	met2n125w	23.35	25.46	26.32	26.37	27.32	29.32	1.36		23.13
14	met2n137e	27.26	28.78	29.27	29.16	29.7	30.24	0.69		27.46
15	met2n140w	23.48	26.11	27.07	26.9	27.74	29.8	1.23		23.31
16	met2n147e	28.89	29.4	29.54	29.6	29.91	30.12	0.37		29.01
17	met2n155w	24.71	27.21	27.84	27.76	28.44	29.96	1.04		24.57
18	met2n156e	27.93	28.99	29.25	29.27	29.64	30.17	0.5		28.01
19	met2n165e	27.73	29	29.41	29.34	29.79	30.47	0.6		27.74
20	met2n170w	25.21	27.48	28.22	28.16	29.03	30.36	1.14		25.1
21	met2n180w	26.04	28.01	28.76	28.69	29.44	30.71	1.02		25.99
22	met2n95w	23.7	25.65	26.46	26.65	27.61	30.72	1.36		23.58
23	met2s110w	20.67	23.3	24.82	24.95	26.44	29.74	1.97		20.16
24	met2s125w	22.61	24.76	25.81	25.89	27	29.94	1.49		22.03
25	met2s140w	22.8	26.09	26.99	26.86	27.71	30.08	1.32		22.37
26	met2s155w	24.7	27.07	27.88	27.83	28.49	30.26	1.05		24.52
27	met2s156e	28.23	29.21	29.42	29.47	29.8	30.59	0.45		28.25
28	met2s165e	27.83	29.27	29.71	29.62	30	30.81	0.54		27.87
29	met2s170w	25.4	27.91	28.77	28.6	29.3	30.73	1		25.28
30	met2s180w	26.21	28.3	29.19	28.97	29.7	30.76	0.97		26.19
31	met2s95w	18.3	21.84	23.73	23.87	26.15	29	2.58		17.9

Figure 13. Portion of spreadsheet showing statistical metrics for the lifetime of the each buoy, based on monthly averages. Spreadsheet tabs exist for SST, air temperature, wind speed, zonal wind, and meridional wind. Statistical metrics include minimum, 1st quartile, median, mean, 3rd quartile, maximum, and standard deviation. Columns B through H are for 00 UTC, while columns J through P are for 12 UTC (cutoff in figure). Each station is listed in Column A, and if it's highlighted in blue, the station has at least one moderate to strong correlation to a climate index (when r>|0.7|) with the surface variable. Clicking on these highlighted names will open a PowerPoint with correlation metrics, discussed in Fig. 14.

3) In the lifetime statistical metric spreadsheet (#2 above), if a buoy has one instance of a correlation in which r>|0.7| with a climate index, the spreadsheet contains a highlighted link to a PowerPoint in the buoy's corresponding subdirectory (Fig. 14). Each correlation PowerPoint shows a scatterplot of the surface value (y axis) versus the climate index (x axis), a regression line, confidence intervals and prediction intervals at the 95% level, the regression equation. The PowerPoint also shows a table of a range of climate index values versus the fitted surface

value, and the prediction interval values. The goal of the table is to provide quality control guidance for ENSO-related values depending on the phase of El Niño.



x (NINO3)	fitted y (SST)	Lower Prediction	Upper Prediction
22.6	18.66837	16.11382	21.22291
22.8	18.98726	16.43922	21.53530
23.0	19.30615	16.76424	21.84806
23.2	19.62504	17.08888	22.16120
23.4	19.94393	17.41314	22.47472
23.6	20.26282	17.73702	22.78862
23.8	20.58171	18.06051	23.10292
24.0	20.90060	18.38361	23.41760
24.2	21.21949	18.70632	23.73267
24.4	21.53839	19.02863	24.04814
24.6	21.85728	19.35056	24.36400
24.8	22.17617	19.67208	24.68025
25.0	22.49506	19.99321	24.99690
25.2	22.81395	20.31395	25.31396
25.4	23.13284	20.63428	25.63140
25.6	23.45173	20.95421	25.94925
25.8	23.77062	21.27375	26.26750
26.0	24.08951	21.59288	26.58615
26.2	24.40841	21.91161	26.90520
26.4	24.72730	22.22994	27.22465
26.6	25.04619	22.54787	27.54450
26.8	25.36508	22.86541	27.86475
27.0	25.68397	23.18254	28.18540
27.2	26.00286	23.49927	28.50645
27.4	26.32175	23.81561	28.82789
27.6	26.64064	24.13155	29.14973
27.8	26.95954	24.44710	29.47197
28.0	27.27843	24.76225	29.79460
28.2	27.59732	25.07702	30.11762
28.4	27.91621	25.39139	30.44103
28.6	28.23510	25.70538	30.76482
28.8	28.55399	26.01898	31.08900
29.0	28.87288	26.33220	31.41357
29.2	29.19177	26.64504	31.73851

Figure 14. Example of a PowerPoint image initiated by clicking on “met0n95w” in Row 11 in Fig. 13. This shows all correlations in which r>|0.7|. In this case, the equatorial buoy located at 95°W has a correlation coefficient of 0.85 between SST and the Niño 3 region at 00 UTC. The corresponding linear regression equation is SST=1.5945 Niño3-17.3663. The green line on the scatterplot on the left shows the confidence interval at the 95% confidence level. The red lines indicate the prediction level. A table showing the database range of Niño 3 values is shown in the first column, the linear regression computed value of SST in column 2, and the confidence level range in columns 3 and 4. These 4 columns can provide quality control guidance if an observation is highly correlated to ENSO patterns. In this example, SST at 12 UTC also possessed strong correlations to Niño 3, and was contained in Slide 2 of the PowerPoint (not shown). Some buoys can be moderately to highly correlated to multiple climate indices or regions, such as the buoy at 2°N and 170°W in which SST is correlated to ONI, Niño 3, and Niño 3.4 (not shown).

In individual buoy subdirectories (all plots are done for 00 UTC and 12 UTC), each PowerPoint contains (Fig. 15):

1) Scatterplot of daily values versus year (x axis) for each month.

2) Histogram frequency bin of each daily value versus magnitude (x axis) for lifetime of buoy, partitioned by month.
3) Box and Stem plots of daily values versus year (x axis) for each month.
4) Scatterplot of mean monthly values versus year (x axis) for each month.
5) Scatterplot of mean monthly values versus year (x axis) for each month, overlapped with the climate index SOI, TNI, or local Niño region.

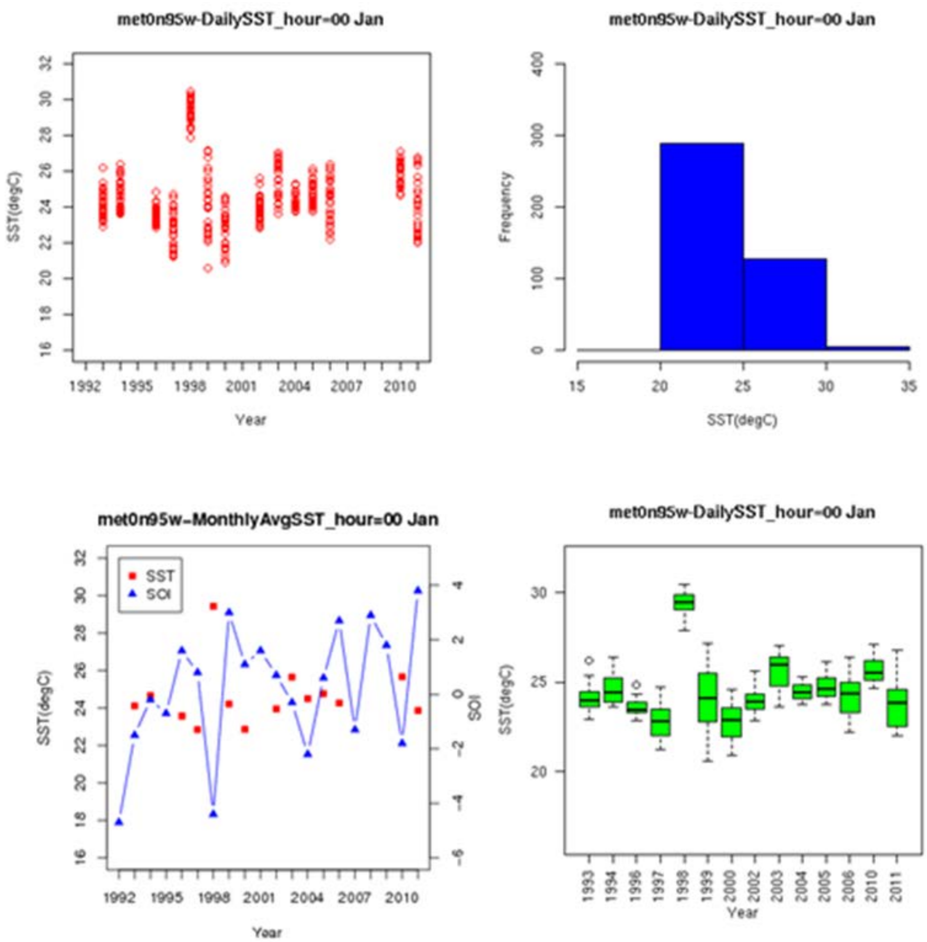


Figure 15. Examples of different types of monthly surface analysis plots for the equatorial buoy located at 95°W, all valid for 00 UTC SST data in January. Top left: Scatterplot for daily value on y axis and year on the x axis. Bottom left: Scatterplot of monthly averages of the data in the top left, superimposed with a trend line for a climate index (in this case, the Southern Oscillation Index, or SOI). Top right: histogram of frequency tallies versus SST. Bottom right: same dataset as in top left, but a box and whisker plot. Note how SOI and monthly mean SST are somewhat inversely correlated, but as will be seen, the correlation is a modest -0.26 (Fig. 16).

In individual buoy subdirectories (all plots are done for 00 UTC and 12 UTC), each PowerPoint also contains a correlation matrix for each climate index SOI, TNI, or local Niño region, using R routine SPLOM (scatterplot of matrices), consisting of (Fig. 16):

1) Scatterplots in lower left of matrix for all pairs of datasets, with a regression line and correltion ellipse. In general, the narrower the ellipse, the stronger the relationship. The ellipse is scaled as $\sqrt{1+r}$ and $\sqrt{1-r}$.
2) Histogram of relationship along the matrix diagonal, with a curve to qualitatively ascertain if the association is Gaussian.
3) Correlation coefficients of all pairs in upper right of matrix.

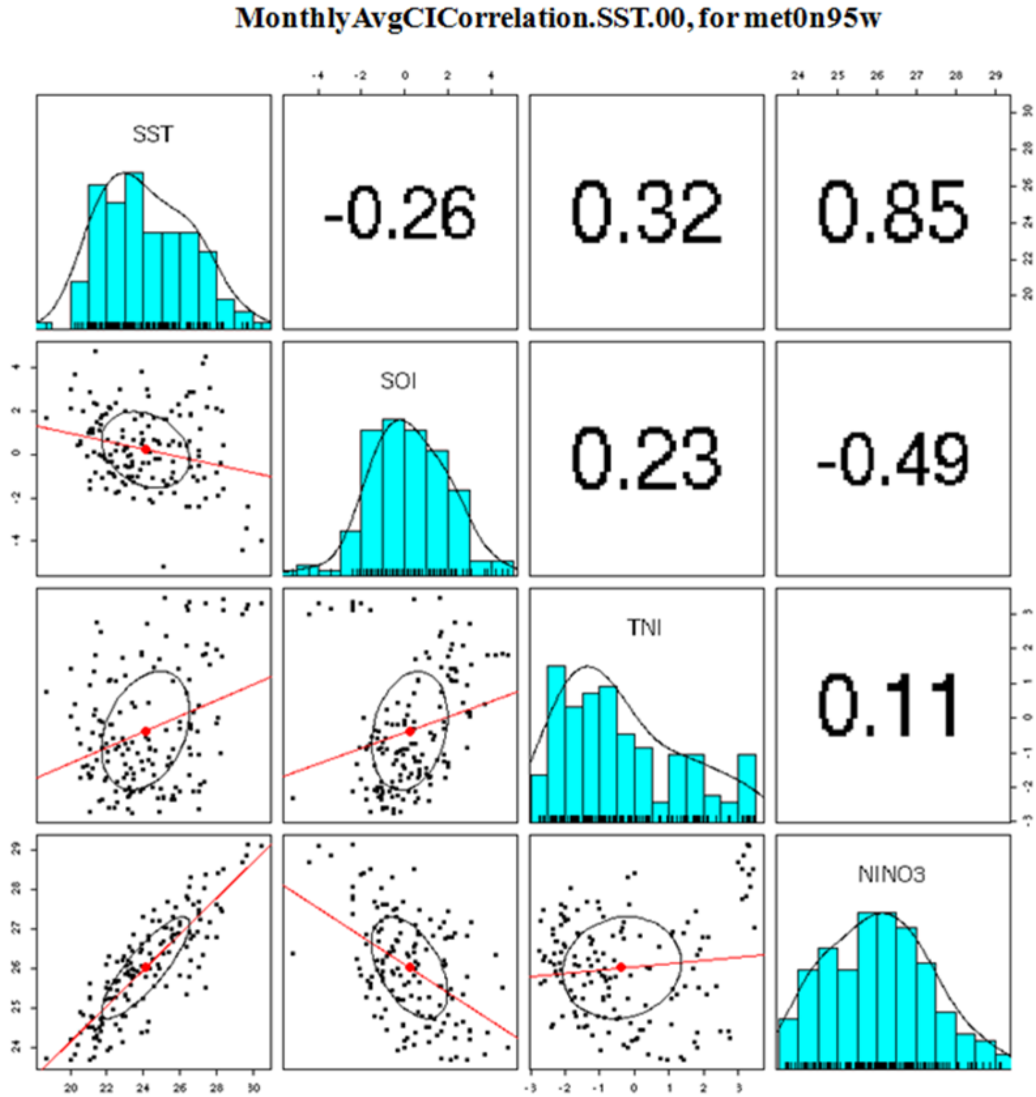
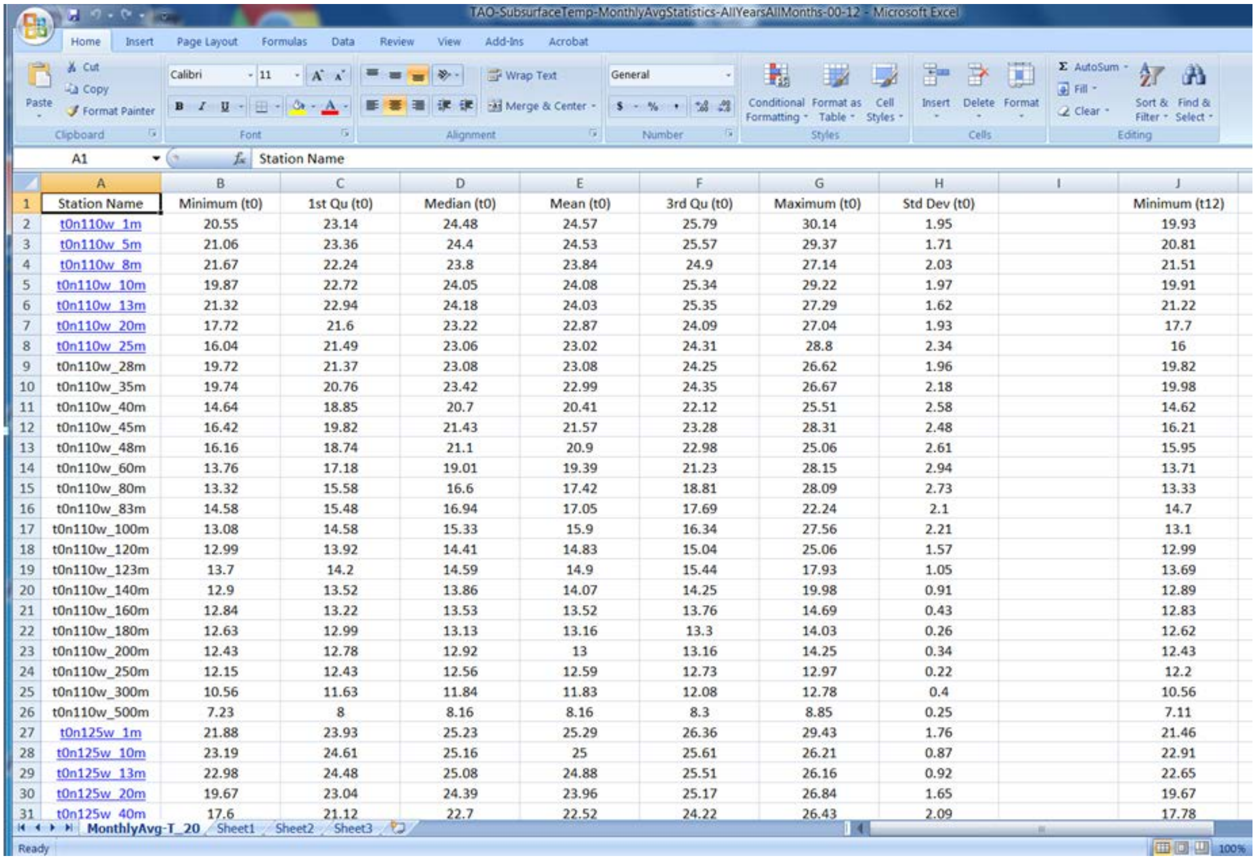


Figure 16. Correlation matrix for the equatorial buoy located at 95°W, valid for 00 UTC monthly averaged SST data. Scatterplots are shown in lower left of matrix for all pairs of datasets, and include a regression line and correlation ellipse. In general, the narrower the ellipse, the stronger is the relationship. Histograms of the relationship are shown along the matrix diagonal, with a curve to qualitatively ascertain if the association is Gaussian. The correlation coefficient of all pairs is shown in the upper right of the matrix. When available, overlapping Niño regions and/or ONI will also be shown in other columns.

Milestone D: S*ub surface water temperature* (58 buoys), and *sub surface salinity* (60 buoys)

In general, these products are the same as the surface plots. A spreadsheet example for sub surface water temperature is shown in Fig. 17.



Station Name	Minimum (t0)	1st Qu (t0)	Median (t0)	Mean (t0)	3rd Qu (t0)	Maximum (t0)	Std Dev (t0)		Minimum (t12)
t0n110w_1m	20.55	23.14	24.48	24.57	25.79	30.14	1.95		19.93
t0n110w_5m	21.06	23.36	24.4	24.53	25.57	29.37	1.71		20.81
t0n110w_8m	21.67	22.24	23.8	23.84	24.9	27.14	2.03		21.51
t0n110w_10m	19.87	22.72	24.05	24.08	25.34	29.22	1.97		19.91
t0n110w_13m	21.32	22.94	24.18	24.03	25.35	27.29	1.62		21.22
t0n110w_20m	17.72	21.6	23.22	22.87	24.09	27.04	1.93		17.7
t0n110w_25m	16.04	21.49	23.06	23.02	24.31	28.8	2.34		16
t0n110w_28m	19.72	21.37	23.08	23.08	24.25	26.62	1.96		19.82
t0n110w_35m	19.74	20.76	23.42	22.99	24.35	26.67	2.18		19.98
t0n110w_40m	14.64	18.85	20.7	20.41	22.12	25.51	2.58		14.62
t0n110w_45m	16.42	19.82	21.43	21.57	23.28	28.31	2.48		16.21
t0n110w_48m	16.16	18.74	21.1	20.9	22.98	25.06	2.61		15.95
t0n110w_60m	13.76	17.18	19.01	19.39	21.23	28.15	2.94		13.71
t0n110w_80m	13.32	15.58	16.6	17.42	18.81	28.09	2.73		13.33
t0n110w_83m	14.58	15.48	16.94	17.05	17.69	22.24	2.1		14.7
t0n110w_100m	13.08	14.58	15.33	15.9	16.34	27.56	2.21		13.1
t0n110w_120m	12.99	13.92	14.41	14.83	15.04	25.06	1.57		12.99
t0n110w_123m	13.7	14.2	14.59	14.9	15.44	17.93	1.05		13.69
t0n110w_140m	12.9	13.52	13.86	14.07	14.25	19.98	0.91		12.89
t0n110w_160m	12.84	13.22	13.53	13.52	13.76	14.69	0.43		12.83
t0n110w_180m	12.63	12.99	13.13	13.16	13.3	14.03	0.26		12.62
t0n110w_200m	12.43	12.78	12.92	13	13.16	14.25	0.34		12.43
t0n110w_250m	12.15	12.43	12.56	12.59	12.73	12.97	0.22		12.2
t0n110w_300m	10.56	11.63	11.84	11.83	12.08	12.78	0.4		10.56
t0n110w_500m	7.23	8	8.16	8.16	8.3	8.85	0.25		7.11
t0n125w_1m	21.88	23.93	25.23	25.29	26.36	29.43	1.76		21.46
t0n125w_10m	23.19	24.61	25.16	25	25.61	26.21	0.87		22.91
t0n125w_13m	22.98	24.48	25.08	24.88	25.51	26.16	0.92		22.65
t0n125w_20m	19.67	23.04	24.39	23.96	25.17	26.84	1.65		19.67
t0n125w_40m	17.6	21.12	22.7	22.52	24.22	26.43	2.09		17.78

Figure 17. As in Fig. 13, but for all subsurface levels of water temperature.

Milestone E: *Spatial correlation patterns when* r>|0.7|

Spatial plots of surface wind, temperature, and SST where r>|0.7| are shown in the TAO/TRITON region (Fig. 18). In addition, plot for sub surface water temperature of the depths reached for r>|0.7| is displayed (Fig. 19). Low sample numbers were removed from this analysis.

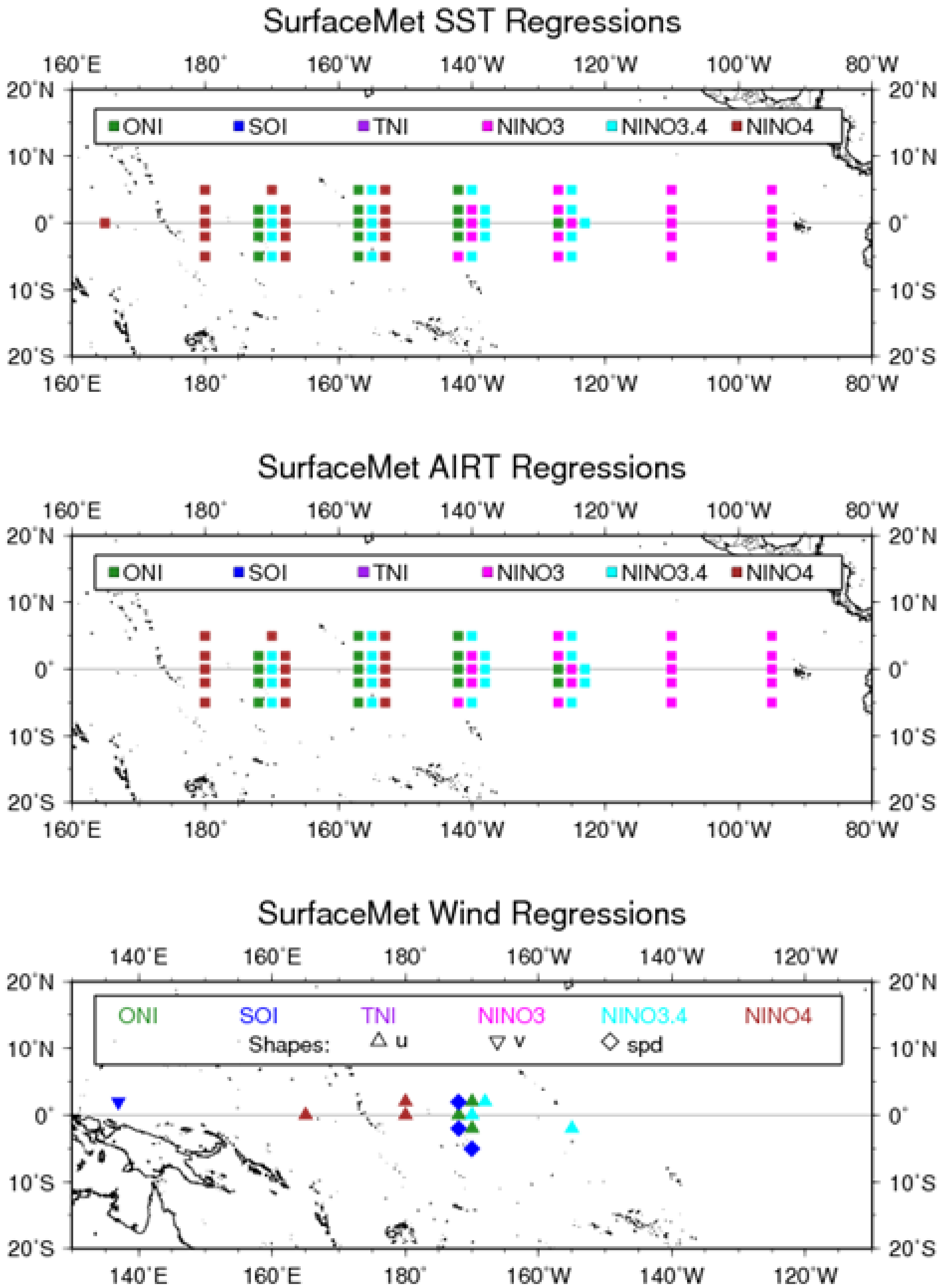


Figure 14. All buoys in which the correlation are r>|0.7|, color-coded for ONI, SOI, TNI, Niño 3, Niño 3.4, and Niño 4. Side by side symbols indicate multiple climate indices are r>|0.7|.

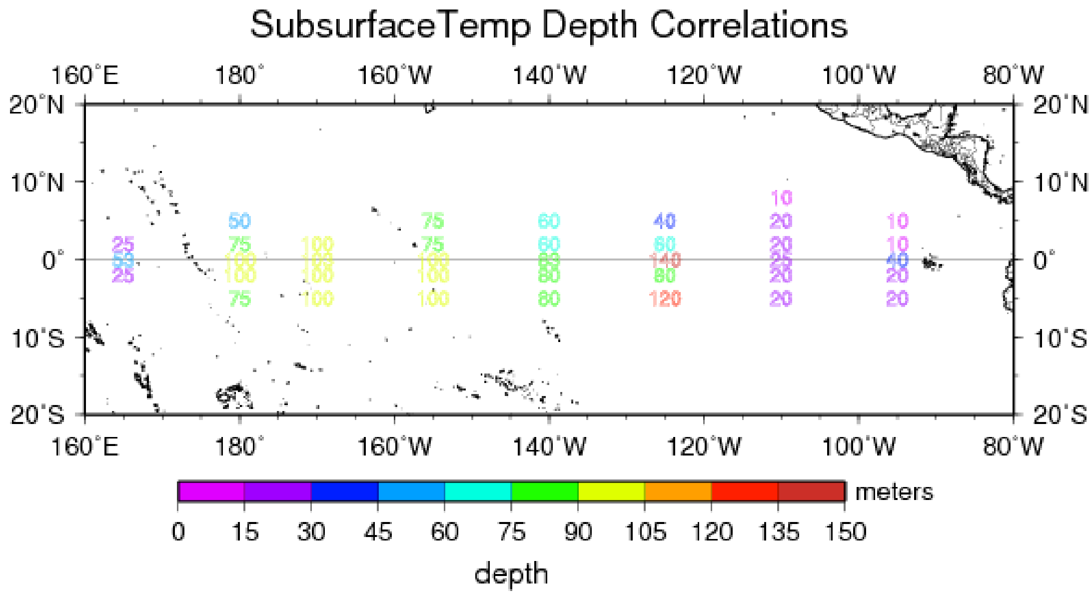


Figure 19. Color-coded depths at which the correlations reach r>|0.7|.

Description of significant research results, protocols developed, and research transitions

All statistical and graphical products have been delivered. These include statistics in Excel spreadsheet of each buoy's lifetime minimum for the 1st quartile, median, mean, 3rd quartile, maximum, and standard deviation, based on monthly averages of SST, air temperature, relative humidity, wind speed, zonal wind component, and meridional wind component, and salinity (Figs. 13 and 17). A similar spreadsheet for monthly statistics for the entire buoy lifetime was also provided, with outliers removed before computing the statistics. The outliers are identified as data outside 1.5 times the interquartile range. These monthly metrics are of the most interest to NDBC for their quality control algorithms.

In addition, ENSO correlation products have also been provided with regression equations and predictor intervals for better QC guidance, using r>|0.7| as a threshold. The ENSO signal is strongest for SST followed closely by air temperature. On average, ($\overline{r_{SST}} - \overline{r_{Tair}}$)=0.02 for cases exceeding the r>|0.7| threshold, indicating that SST has 2% higher correlation on average than air temperature. $r_{SST} > r_{air}$ in 54 of the 64 cases at 00 UTC. 12 UTC gives similar results (not shown).

Air and water temperature generally correlated best with their respective Niño regions. In addition, ONI relationships occur in the western side of the TAO domain from 170°W to 140°W for most locations, plus on the equator at 135°W. This is consistent with the ONI definition, which is related to a 3-month running mean of SST anomalies in the Niño 3.4 region (5°N-5°S, 120°W-170°W). However, ONI's correlation with SST is on average 0.08 less than the peak Niño region correlation. No correlations with air or water temperature met the r>|0.7| threshold for SOI or TNI. SOI is not too surprising since it's related to pressure and, indirectly, wind fields.

However, TNI is related to the difference in normalized anomalies of SST between Niño 1+2 and Niño 4 regions, so this result may be a bit surprising.

The ENSO signal penetrates deepest at the equator,from 125 m to 140 m. From 180°W to 140°W, the ENSO signal reaches from 50 to 105 m. The ENSO correlation is shallow on the far eastern and western edge of the TAO domain.

Most wind correlations occur in the center of the domain from 180°W to 170°W, with correlations to their respective Niño regions, SOI, or ONI. The correlations are for wind speed or zonal wind, with only a single meridional wind value correlated to SOI on the far western edge of the domain. It is likely that physical relationships regarding ongoing ENSO events with these wind variables exist, and should be explored in follow-up research. No RH-ENSO relationship was noted based on the r>|0.7| threshold except for a single buoy located at 125°W and 0°N (r=-0.72 with ONI, not shown). No TNI relationship is found with RH, wind, or salinity.

Some ENSO correlations are seen with salinity profiles, but in most cases the data sample is limited so the significance of the relationship is unclear. The following buoys met the r>|0.7| threshold with a marginally reasonable sample number: 140°W, 0°N, down to 60 m (Fig. 20); 165°E, 0°N, down to 50 m; and 170°W, 2°N (only observations are at 1 m depth).

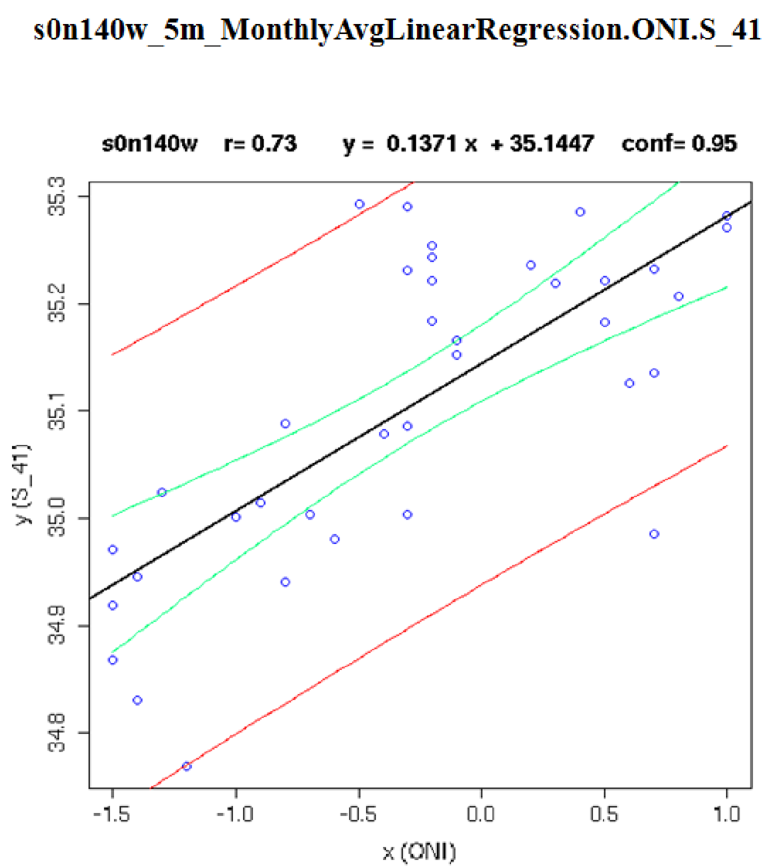


Figure 20. As in Fig. 18, but an example of a salinity correlation to ONI for the equatorial buoy located at 140°W. Note that the sample size is smaller, though.

Information on collaborators / partners: None Reported

Information on any outreach activities:

General description: Preliminary results were presented at NDBC 12/17/12, and final results will be presented 7/16/13 at NDBC.

NOAA sponsor and NOAA office of primary technical contact: Karen Grissom, NOAA/NWS/NDBC

Related NOAA strategic goals: Climate Adaptation and Mitigation

Related NOAA enterprise objectives: Science and Technology

NGI FILE #12-NGI2-25

Project Title: Evaluating Baseline Operational Ocean Surface Current Predictions and Low-Member Multi-Model Ensembles in the Gulf of Mexico.

Project Lead (PI) name, affiliation, email address: Pat Fitzpatrick, MSU, fitz@gri.msstate.edu

Project objectives and goals

In year 1, we are comparing the following multiple, retrospective operational (or near-operational) ocean modeling systems in the Gulf of Mexico: Global NCOM, global HYCOM, Gulf of Mexico/Caribbean NCOM (AMSEAS), and Gulf of Mexico HYCOM. Validation is being conducted with data from the AOML Global Drifter Program, and moored buoys from the Texas Automated Buoys System (TABS) from Texas A&M University, the Coastal Ocean Monitoring & Prediction System (COMPS) from the University of South Florida, and Acoustic Doppler Current Profiler (ADCP) from the oil and gas industry.

In year 2, we will continue the individual model comparisons with additional metrics, more monthly datasets, and dataset standardization for easier model comparison. We will also perform a multi-model ensemble from the above four prediction systems to evaluate the potential improvement in surface current representations of this low-member ensemble compared with the individual models by themselves. We will repeat the metric marks discussed above, and establish whether an ensemble system provides additional skill versus individual models. We will also submit the results to a journal.

Description of research conducted during the reporting period and milestones accomplished and/or completed

All graphical products are embedded in PowerPoints or Excel files, mass-generated using a combination of Visual Basic for Application (VBA) code, Generic Mapping Tools (GMT), java, and shell scripts. The netcdf files were manipulated using tools such as ncdump, NCO (netcdf operator), and the climate data operator (CDO).

<u>Ocean model datasets</u>

All data are in netcdf format, and subsetted where applicable to reduce file sizes for storage and download time. Occasionally, the server halted the download for unknown reasons and had to be started over. Missing data situations occurred, were reported, and fixed. Since each dataset has to be downloaded separately and sometimes through a web interface, and because some files are large, obtaining the datasets is a slow process.

1. NCOM Global Region 1, 1/8 deg (3-hourly data)
   http://ecowatch.ncddc.noaa.gov/erddap/griddap/NCOM_Region1_3D_agg.html
   This "Region 1" dataset was subsetted to the Gulf of Mexico (GOM) region. Some incorrect time-subsetted netcdf files were downloaded from the ERDDAP server, and subsequently discovered during data processing. The problem was reported to NCDDC. After NCDDC personnel determined that missing dates and time steps had caused the subsetting problem, they recovered the missing data from NAVO's archive to ERDDAP and solved the problem. Although NCDDC personnel were helpful and prompt, each data recovery took several days to be finished and downloaded again. The vertical levels

are: 0, 2, 4, 6, 8, 10, 12, 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100, 125, 150, 200, 250, 300, 350, 400, 500, 600, 700, 800, 900, 1000, 1250, 1500, 2000, 2500, 3000, 4000, and 5000 m.

2. NCOM AMSEAS, 1/30 deg (3-hourly data)
   http://edac-dap3.northerngulfinstitute.org
   No subsetting of variables was available at this website. Data was retrieved with an in-house shell script using wget. Missing dates and time steps were also found here. This problem was fixed using the same procedure as done for global NCOM. The vertical levels are the same as NCOM Global: 0, 2, 4, 6, 8, 10, 12, 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100, 125, 150, 200, 250, 300, 350, 400, 500, 600, 700, 800, 900, 1000, 1250, 1500, 2000, 2500, 3000, 4000, and 5000 m.

3. HYCOM Global, 1/12 deg (daily data)
   http://coastwatch.pfeg.noaa.gov/erddap/griddap/hycom_GLBa008_tdyx.html
   Subsetting of spatial domain at this website is not trivial because the user interface only allows subsetting using x and y indices instead of longitude and latitude bounds. After investigation, the following indices were extracted: X index from 2324 to 2599 (corresponding longitude from 260°W to 282°W), and Y index from 1733 to 1928 (corresponding latitude from 17.9395°N to 32.0285°N). The vertical levels are: 0, 10, 20, 30, 50, 75, 100, 125, 150, 200, 250, 300, 400, 500, 600, 700, 800, 900, 1000, 1100, 1200, 1300, 1400, 1500, 1750, 2000, 2500, 3000, 3500, 4000, 4500, 5000, and 5500 m.

4. HYCOM Gulf of Mexico (GOM), 1/25 deg (daily data)
   http://ncss.hycom.org/thredds/ncss/grid/GOMl0.04/expt_31.0/dataset.html
   This website was sometimes sluggish, but subsetting of time and variables worked fine. The vertical levels are: 0, 5, 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100, 125, 150, 200, 250, 300, 400, 500, 600, 700, 800, 900, 1000, 1100, 1200, 1300, 1400, 1500, 1750, 2000, 2500, 3000, 3500, 4000, 4500, 5000, and 5500 m.

<u>Observations datasets</u>

The validation data consisted:

1. Satellite-tracked surface drifting buoys ("drifters") from the Global Drifter Program, provided by NOAA/AOML's Environmental Data Server (ENVIDS) at http://www.aoml.noaa.gov/envids/gld/FtpInterpolatedInstructions.php. Metadata is described at http://www.aoml.noaa.gov/envids/gld/general_info/dir_table.php. Only data with a drogue attached was used.

2. Moored buoys which measured surface/sub-surface currents, downloaded from the historical data archive of the National Data Buoy Center at http://www.ndbc.noaa.gov/hmd.shtml.

Data comparison issues

Validation of multiple model and observation datasets creates certain challenges. One problem is the horizontal comparison of model grid points to in-situ data. Tests were performed using bilinear interpolation and near-neighbor. In general, both yielded similar results. Near-neighbor is done in this report.

In the context of "surface" currents, a variety of issues were noted. These include:

- Since HYCOM is a daily dataset, NCOM requires averaging to daily evaluations for the four-model comparison component. However, this is a desirable quantity since it reduces the influence of tide harmonics and inertial oscillations.
- Varying observation levels exist. For example, much of the available moored ocean current buoy data is only available at one surface level – typically, 1.6, 2.0, 2.5, or 3.8 m. The existing moored data with multiple vertical ocean levels lack level consistency.
- Some moored ocean current data lack temporal continuity, with monthly data gaps.
- Drifting buoys provide a unique perspective but obviously less precise means of estimating currents. Some literature suggests they represent the 15-m level.
- Varying "surface" model levels exist. Both NCOMs are at 0, 2, 4, 6, 8, 10, 12, 15, and 20 m.
  HYCOM Global contains data at 0, 10, and 20 m, and HYCOM GOM at 0, 5, 10, 15, and 20 m.

Because all models contain a 15-m level (except HYCOM Global, in which 10- and 20-m were averaged), and since the drifter-derived currents represent this level, initial comparisons are done at 15 m. The methodology is discussed below. However, this limited the moored buoy comparisons because: not all the multiple level buoys contain data near 15 m; 2) many of the moored buoys only contain "surface" data.

In August, we will perform the validation at 2-, 4-, and 15-m levels. Both model and buoy levels will be standardized by Akima Spline interpolation if a profile exists, or using near-neighbor within a distance tolerance threshold if a buoy is just a single level. An Akima spline is a local function which fits all datapoints with a smooth curve and contains no oscillations. The disadvantage of an Akima spline is their sensitivity to outliers which may be bad data. We will identify possible outliers with a monthly climatology of the datasets and flag any data which is more than 1.5 times the interquartile range.

Validation period

As a trial stage, validation is performed for the summer periods. Specifically, the models are evaluated against moored data for 5 months (June 2010, May 2011, June 2011, May 2012, and June 2012), and against drifting data for 4 months (June 2010, May 2011, May 2012, and June 2012). We find its best to first focus on a few months to refine/add algorithms, and also to examine daily plots for other nuances, or for further subsetting by synoptic regime or geographical territory.

This research will be expanded as the validation software is finalized, datasets are standardized, and more model datasets are downloaded. A winter period will also be added.

Validation methodology

The validation is being performed in two ways. One is classic statistical metrics. The other is with daily plots. Both will now be discussed.

Drifters

At the moment, the drifter dataset is the largest populated sample, and will serve as a template for this report. Speed was computed from the drifter based on the methodology of Blockley et al. (2012), in which pseudo-Eularian daily-mean values were computed by using the first and last position reports of each day to determine the distance traveled and the time taken to do so. It is assumed that each derived speed point is located at the mid-point between the first and last positions. It is a simple method that provides a decent number of data points and lessens the impacts of tides. Direction was inferred in a similar way.

Bias and absolute error relative to 15-m depth are computed for all four models. Drifting buoys were validated at the 15-m level, since Blockley et al. (2012) show that level best represents the drogue location. A histogram example is shown for 2010 June for 8 drifters in Fig. 21. Twenty-four drifters are analyzed for four summer months. While an overall error average by model may be useful, it doesn't differentiate between synoptic regimes, seasonal transitions, or geography. An alternative approach is a tally system by platform and month to partially capture some of those differences.

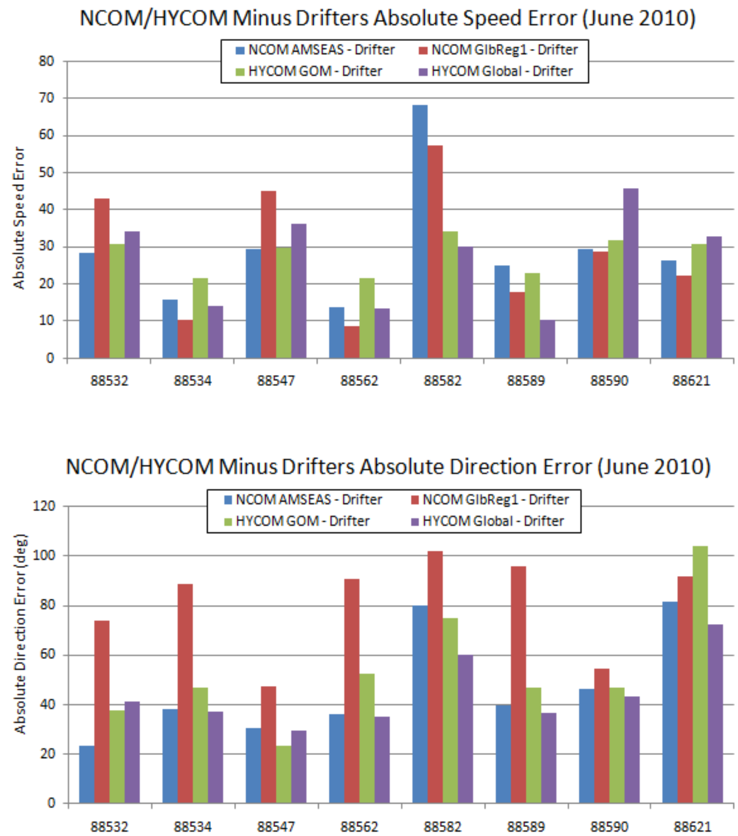


Figure 1 .Example of validation for eight drifter-derived ocean current speed and direction in 2010 June.

Each platform is ranked first, second, third, or fourth by absolute error, and a 4X4 matrix is generated (Table 4). A weight multiple of three is applied to each first place, two for second place, one for third place, and zero for fourth, and they are summed. Using this methodology, NCOM AMSEAS and HYCOM Global tie for the best ranking, with NCOM Global ranked fourth.

Table 4. Number of analyses errors ranked from smallest absolute error (first) to largest absolute error (fourth) based on four summer months for current speed. The overall rank is shown in last column by weighted sum. See text for details.

	First	Second	Third	Fourth		Weighted Sum	Rank
NCOM AMSEAS	8	4	10	2		42	1
NCOM Global	5	5	2	12		27	4
HYCOM GOM	4	8	5	7		33	3
HYCOM Global	7	7	7	3		42	1

Moored buoys

For a comparison, the same methodology is applied to the moored data, shown in Table 4. The database for moored buoys which measure ocean currents at 15 m unfortunately are rather sparse, further limited by our restricting nearby data until we apply the Akima Spline. These current results strictly use just observations at 15 m, which is eight profiles throughout the five months of data. However, they do provide a contrast to the drifter data in coverage. Most of the moored buoys during this time period are on the Texas and Florida coasts (associated with the TABS and COMPS programs), while most drifting buoys are confined to the central GOM, moving along the periphery of a loop current eddy. These results concur with a top ranking for NCOM AMSEAS, a lower ranking for NCOM Global (third), but flips the HYCOM models.

Table 5. As in Table 4, but for moored buoy in five summer months.

	First	Second	Third	Fourth		Weighted Sum	Rank
NCOM AMSEAS	2	3	3	0		15	1
NCOM Global	2	2	1	3		11	3
HYCOM GOM	3	0	3	2		13	2
HYCOM Global	1	3	1	3		10	4

A similar approach is done for current direction (Tables 6 and 7). These tentative calculations show no consensus results, other than NCOM AMSEAS ranks to half, and HYCOM GOM ranks bottom half.

Table 6. As in Table 4, but for drifter current direction in four summer months.

	First	Second	Third	Fourth		Weighted Sum	Rank
NCOM AMSEAS	9	11	3	1		52	1
NCOM Global	3	1	8	12		19	4
HYCOM GOM	3	7	7	7		30	3
HYCOM Global	9	5	6	4		43	2

Table 7. As in Table 6, but for current direction from moored buoys in five summer months.

	First	Second	Third	Fourth		Weighted Sum	Rank
NCOM AMSEAS	2	2	1	3		11	2
NCOM Global	4	4	0	0		20	1
HYCOM GOM	0	1	5	2		7	4
HYCOM Global	2	1	2	3		10	3

Plots for all individual cases were also done to identify model nuances that are not obvious in standard statistical metrics. An example is shown in Fig. 22, which shows four plots of each drifter with colored dots representing each day's bias. The left column depicts speed bias, while the right shows the direction bias. The top row and bottom row both show the same bias results, but are facilitated by two different scales. One scale (top row) notes values in the conventional style. The bottom row contains a scale in which errors within a reasonable tolerance are colored in grey. Speed error tolerances are defined to be within ±20 cm s^{-1}, while direction error tolerances are specified as ±40°. This is done for all four models. One reason for tolerance metrics is to allow an operational user to focus on the more significant areas of discrepancy between model and data.

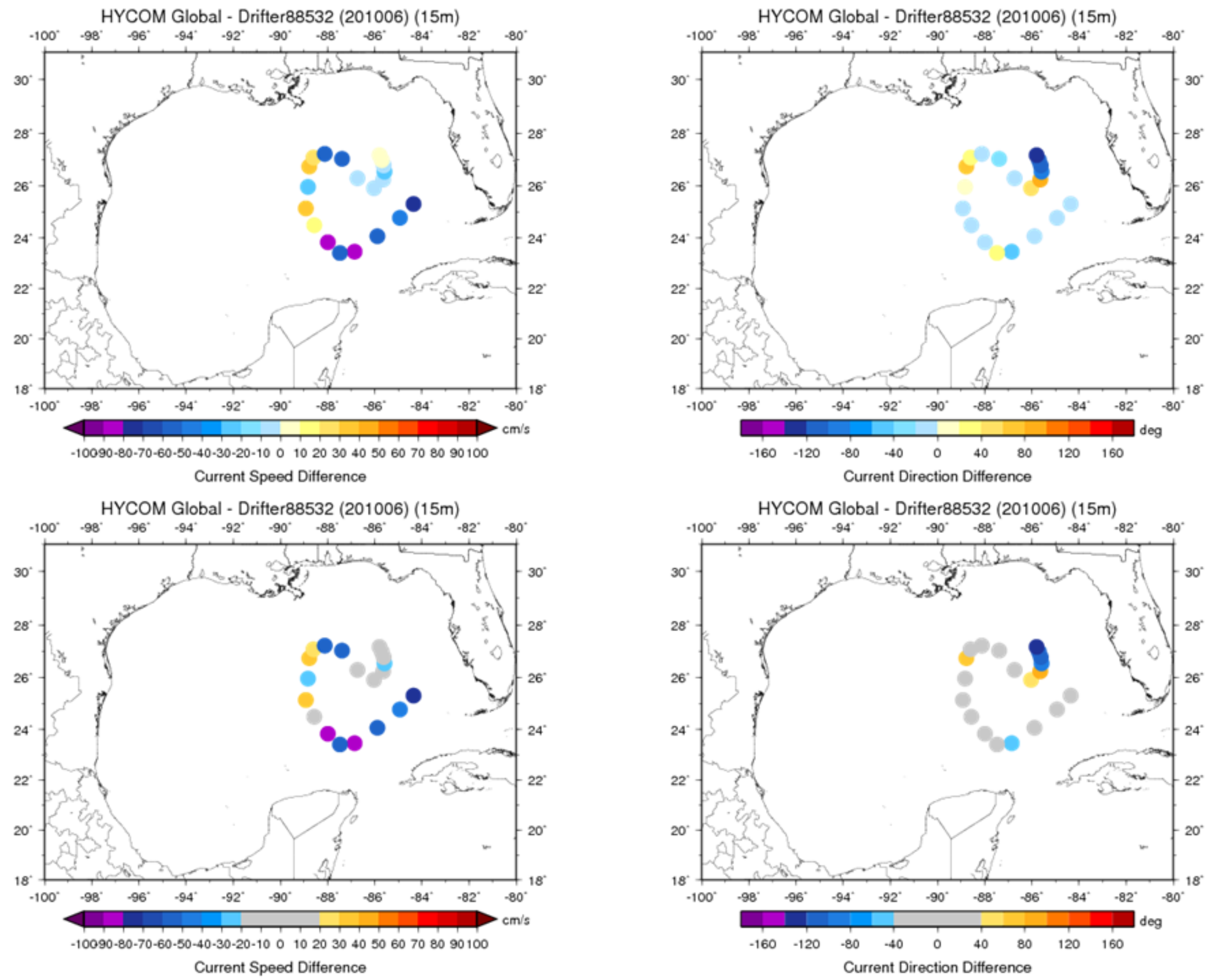


Figure 22. Example of an analyses for the global HYCOM subsetted in the GOM for 2010 June, validated against Drifter 88532 for 20 days (it was deployed 2010 9 June). Colored dots representing each day's bias. The left column depicts speed bias, while the right shows the direction bias. The top row and bottom row both show the same bias results, but are facilitated by two different scales. One scale (top row) notes values in the conventional style. The bottom row contains a scale in which errors within a reasonable tolerance are colored in grey. Speed error tolerances are defined to be within ±20 cm s-1, while direction error tolerances are specified as ±40°.

Another reason is to provide an additional ranking system. Average errors may be dominated by a few bad forecasts or analyses. Ranking by average errors also doesn't proportionately weight small or large model error differences. One could argue its best to determine models which produce the most really large errors. Tables 8-11 show these results, with top rankings for models with the highest percentage of errors within the defined tolerances.

Table 8. As in Table 4, but for percentage speed errors within tolerance (±20 cm s-1) for drifting buoys in four summer months.

	First	Second	Third	Fourth		Weighted Sum	Rank
NCOM AMSEAS	7	8	10	0		47	2
NCOM Global	7	3	5	10		32	4
HYCOM GOM	11	5	6	3		49	1
HYCOM Global	8	9	3	5		45	3

Table 9. As in Table 8 for percentage speed error tolerances, but for moored buoys in five summer months.

	First	Second	Third	Fourth		Weighted Sum	Rank
NCOM AMSEAS	8	0	0	0		24	1
NCOM Global	7	0	1	0		22	2
HYCOM GOM	7	0	0	1		21	3
HYCOM Global	7	0	0	1		21	3

Table 10. As in Table 8, but for percentage direction error within tolerance (±40 deg) based on drifter data.

	First	Second	Third	Fourth		Weighted Sum	Rank
NCOM AMSEAS	14	3	6	2		54	1
NCOM Global	5	5	6	9		31	4
HYCOM GOM	7	5	5	8		36	3
HYCOM Global	13	4	7	1		54	1

Table 11. As in Table 10, but for percentage direction error tolerance on moored data.

	First	Second	Third	Fourth		Weighted Sum	Rank
NCOM AMSEAS	2	2	2	2		12	3
NCOM Global	4	3	1	0		19	1
HYCOM GOM	0	3	2	3		8	3
HYCOM Global	2	4	1	1		15	2

From this perspective, the NCOM AMSEAS model still ranks first for lowest speed errors based on moored buoys and drifters, and for direction based on the drifters. However, all the models generally pass the threshold margin based on moored buoys (Table 9). It may be because coastal currents are slower, however, and perhaps the threshold margins should be modified. With regard to direction errors, the comparison are similar to those based on absolute error, with less consensus other than HYCOM GOM is in the bottom half and HYCOM global is in the top half. It should be noted that the difference between NCOM AMSEAS in Table 10 between 2nd and 3rd place is by 3 units. We will recompute these percentages based on daily values which will create more dispersion among the results and should improve the ranking process.

Statistics for model bias have also been generated. No pattern is obvious for ocean current speed or direction, but will be more closely scrutinized in the next few months. Analyses by speed thresholds or curvature may also be performed.

Case study plots

In addition to the drifter graphics, other types of plots have been created to facilitate the analysis. The goal of plots as shown in Figs. 23 and 24 is to identify regional or pattern-specific problems. These plots will now be described:

i. Validation times series of global NCOM and NCOM AMSEAS versus moored buoys at 2 m. The x axis represents the analysis time, 3-, 6-, 9-, 12-, 15-, 18-, and 21-h forecast. The y axis represented direction error and speed error. One line represents absolute error, and is shaded green. Another line represents bias; speed bias is shaded blue for negative values and red for positive values, while direction is shaded purple for negative values and magenta for positive values (Fig. 23).

ii. Time series as in Part iii, but no distinct shading for bias. Rather, positive and negative values are shown along the y axis (figure not shown)

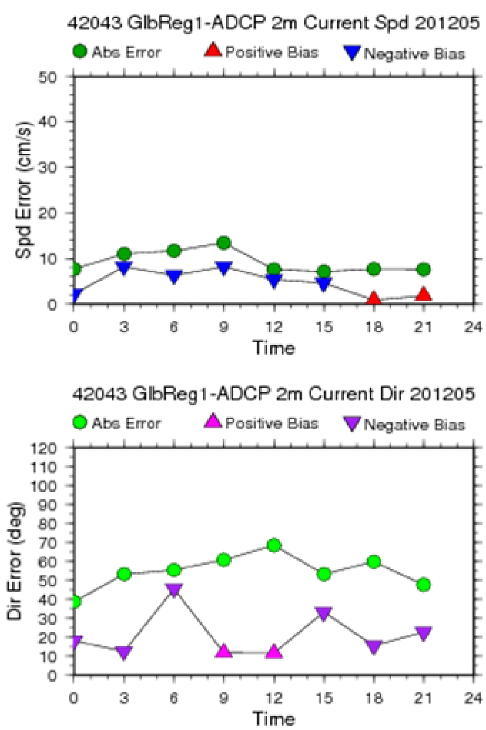


Figure 23. Example of a time series analysis for the global NCOM subsetted in the GOM for 2012 May, validated against buoy 42043 at 2 m. The x axis represents the analysis time, 3-, 6-, 9-, 12-, 18-, and 21-h forecast. The y axis represents speed and direction error. One line represents absolute error, and is shaded green. Another line represents bias; speed bias is shaded blue for negative values and red for positive values, while direction is shaded purple for negative values, and magenta for positive values.

iii. Four daily plots (Fig. 24) of each moored buoy validated against NCOM. The left column shows plots for the NCOM global GOM subset, while the right column gives plots for NCOM AMSEAS. The top column shows the model analyses for ocean currents, with vectors colored by speed. The location of the buoy is depicted by a star. The second row shows stick plots comparing each 3-h forecast ocean current vector against the observation. The bottom arrow in each stick plot shows the 24-h average for the observation and model. Note that the stick plots cannot be done with HYCOM since its data is daily.

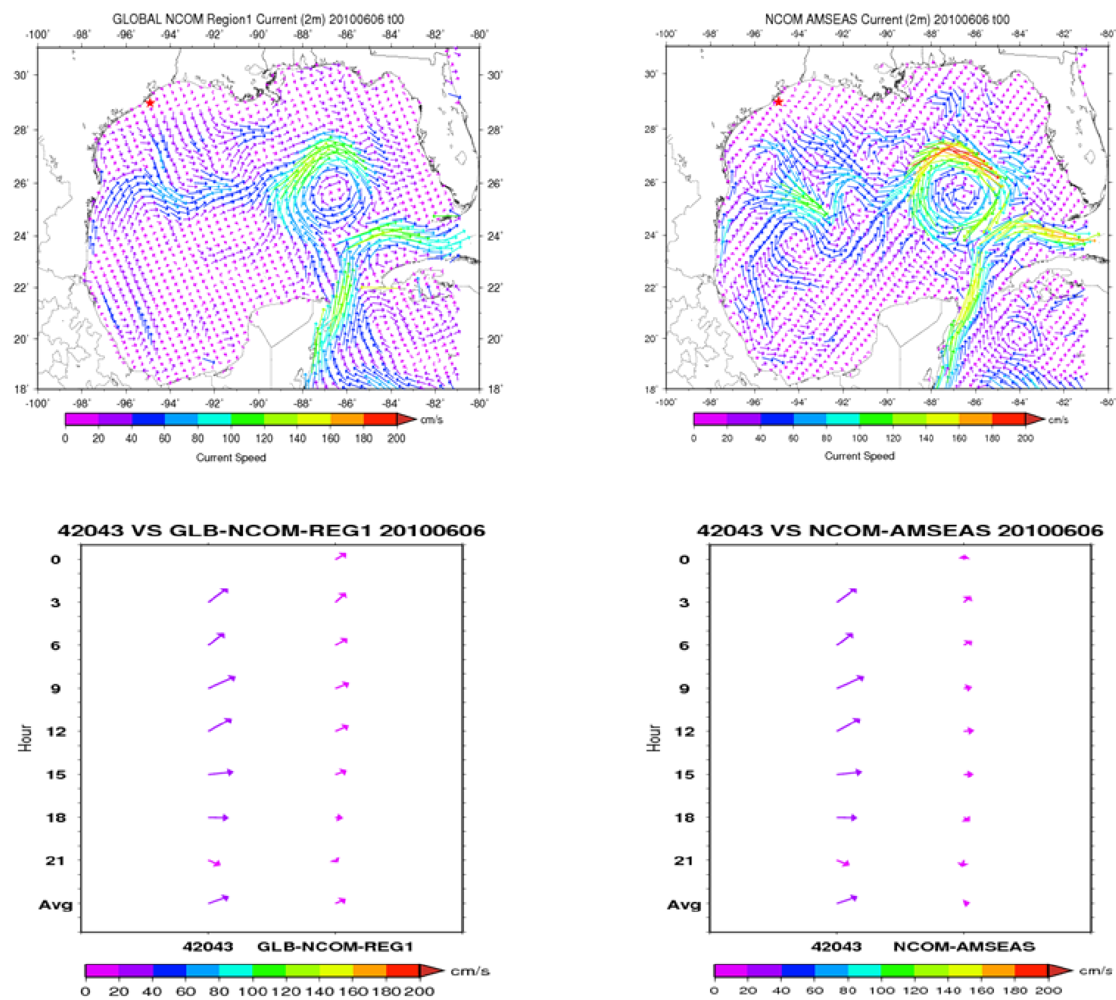


Figure 24. Example of a stick plot analyses for 3-h NCOM fields for 2010 6 June, validated against Buoy 42043. The left column shows plots for the NCOM global GOM subset, while the right column gives plots for NCOM AMSEAS. The top column shows the model analyses for ocean currents at 00 UTC, with vectors colored by speed. The location of the buoy is depicted by a star. The second row shows stick plots comparing each 3-h forecast ocean current vector against the observation. The bottom arrow in each stick plot shows the 24-h average for the observation and model.

Description of significant research results, protocols developed, and research transitions

After some tentative analysis, NCOM AMSEAS appears to be the most accurate model compared to NCOM Global, HYCOM GOM, and HYCOM Global. However, more in-depth work is required to populate the database and to add the winter season. The database will be increased at 2-, 4-, and 15-m levels using an Akima Spline. We will scrutinize the case study graphics for useful validation subsets. Year 2 will also include a multi-model ensemble to determine if such a consensus provides skill over individual models. In addition, the following issues require discussion:

- Drifting buoys – are levels other than 15 m representative? Should speed and direction be done by pseudo-Eularian techniques, or by other techniques? Should curvature effects be considered, and distance computed along an arc length instead?
- How should varying ocean speed and synoptic regimes be subsetted?
- Should other metrics be added? Possibilities include:
    - Vector correlation
    - Taylor diagrams
    - Amplitude fraction
    - Using Lagrangian methods on drifters, and perform metrics by distance separation, time in pre-defined circle, or normalized cumulative separation distance
    - Other tabular metrics such as percentage of model bias, percentage of absolute error, central frequency fraction, positive and negative outlier fraction, maximum duration of outliers, and/or model efficiency
    - Subsetted by curvature vorticity
- Other feedback from OAR and AOML

Information on collaborators/partners (if applicable): None Reported

Information on any outreach activities (if applicable):

Several teleconference calls were done this year with AOML and NOAA for information dissemination and research feedback.

NOAA sponsor and NOAA office of primary technical contact: John Cortinas, OAR

Related NOAA strategic goals: Weather-Ready Nation

Related NOAA enterprise objectives: Science and Technology

NGI FILE #12-NGI2-26

Project Title: Gulf Hypoxia Model Transition and Glider Implementation Panel Support

Project Lead (PI) name, affiliation, email address: Steve Ashby, MSU, sashby@ngi.msstate.edu

Co-PI(s) name(s), affiliation, email address: Stephen Howden, USM, stephan.howden@usm.edu

Project objectives and goals

Advance the science underpinning management of the large annual hypoxic zone ("dead zone") in the northern Gulf of Mexico. The Forum encompassed three separate meetings with intersecting objectives:

1. **Conduct a 4th Annual Hypoxia Research Coordination Workshop** to update scientific understanding of hypoxic zone causes and impacts, coordinate Gulf hypoxic zone research, monitoring and modeling activities in preparation for the 2013 sampling season, and facilitate information exchange between the research and management communities;
   a. Output: *FY13 Gulf Hypoxic Zone Monitoring Matrix*
   b. Output: *FY13 Gulf Hypoxic Zone Modeling Matrix*
   c. Output: *Workshop Report* for Gulf Hypoxia Task Force
2. **Gulf Hypoxia Glider Application Meeting** to develop an implementation plan for use of autonomous underwater vehicles (AUVs) for monitoring the hypoxic zone;
   a. Output: Pre-meeting *Framework for Developing Glider Implementation Plan* by Steering Committee
   b. Output: White Paper on *Implementation Plan for Glider Application to Hypoxia Monitoring and Modeling* by Glider Implementation Plan Panel
3. **Gulf Hypoxia Modeling Technical Review Meeting** to assess the state of scenario forecast models targeting hypoxic zone dynamics in the Northern Gulf of Mexico, and develop recommendations on modeling approaches to most effectively meet the Hypoxia Task Force management directive to mitigate hypoxia;
   a. Output: Pre-meeting *Terms of Reference* to provide guidance for the Modeling Technical Review Panel
   b. Output: White Paper on *Recommended Modeling Approaches for Scenario Forecasts of Gulf Hypoxia* by Modeling Technical Review Panel

Description of research conducted during the reporting period and milestones accomplished and/or completed

Sponsored the Gulf Hypoxia Model Transition and Glider Implementation Panel Support Workshop, April 17-19, 2013.

Description of significant research results, protocols developed, and research transitions

Workshop was designed to improve university/ federal & state agency coordination of monitoring and modeling for the 2013 Gulf Hypoxic Zone and beyond and facilitate management of the Hypoxic Zone by identifying research findings for incorporation into the Gulf Hypoxia Task Force Annual Progress Report and Annual Operating Plans. Emphasis was on opportunities to transition hypoxia models into operational applications, determine gaps in current hypoxia models used in the Gulf of Mexico, and applicability for the use of gliders to expand measurements relevant to determining the extent of the hypoxic zone. Two white papers will be produced. One will include an evaluation of models currently used to predict the extent of the hypoxic zone in the Gulf of Mexico, identification of technical gaps, and an assessment to transition various models for operational applications. A second white paper will be developed to determine the applicability of gliders for expanded measurement and monitoring activities. Dr. Howden and Dr. Ashby participated as members of the Steering Committee for the Forum, helping to set the Forum agenda and chose participants for writing teams for the two plans. Dr. Howden helped facilitate some of the sessions and he is co-leading (with David Kidwell) the writing team for the Hypoxia Monitoring Glider Implementation Plan. An outline of the plan has been written and writing team members have been assigned as leads for each of the sections. Dr. Ashby helped facilitate some of the sessions and is serving as a reviewer for the White Paper on Recommended Modeling Approaches for Scenario Forecasts of Gulf Hypoxia by Modeling Technical Review Panel.

Information on collaborators / partners:

Name of collaborating organization: The Steering Committee members for the Forum were all collaborators on this project. The membership of the committee is: Alan Lewitus (NOAA National Centers for Coastal Ocean Science), Becky Baltes (NOAA Integrated Ocean Observing System), John Harding (NGI), Dave Kidwell, NOAA National Centers for Coastal Ocean Science), Julien Lartigue NOAA Coastal Services Center/ NGI), Troy Pierce (EPA Gulf of Mexico Program), Dave Scheurer (NOAA National Centers for Coastal Ocean Science), Beth Turner (NOAA National Centers for Coastal Ocean Science).
Date collaborating established: July 2009
Does partner provide monetary support to project? Amount of support? None Reported
Does partner provide non-monetary (in-kind) support? Yes
Short description of collaboration/partnership relationship: Workshop co-sponsor

Information on any outreach activities:

General Description: Workshop to coordinate Gulf of Mexico hypoxic zone research
Hosted speakers, workshops and/or any training:

Type (speaker, workshop, training): Workshop
Name of event: Gulf Hypoxia Model Transition and Glider Implementation Panel Support
Date: April 17-19, 2013
Location: Stennis Space Center, MS
Description: Workshop was designed to improve university/ federal & state agency coordination of monitoring and modeling for the 2013 Gulf Hypoxic Zone and beyond and facilitate management of the Hypoxic Zone by identifying

research findings for incorporation into the Gulf Hypoxia Task Force Annual Progress Report and Annual Operating Plans.
Approximate Number of Participants: 95

NOAA sponsor and NOAA office of primary technical contact: Alan Lewitus, NOS

Related NOAA strategic goals: Climate Adaptation and Mitigation, Healthy Oceans

Related NOAA enterprise objectives: Science and Technology

NGI FILE #12-NGI2-27

Project Title: Engineering Studies for NOAA UAS Program

Project Lead (PI) name, affiliation, email address: Robert Moorhead, MSU, rjm@ngi.msstate.edu

Project objectives and goals

An engineering study on the sensors, payloads, and UAS platforms necessary to meet the requirement identified at the NOAA UAS Rivers Workshop held at the NOAA Facility in Boulder, Colorado in February 2012. The result will be a report on the sensors and payloads available (visible, video, hyperspectral, multispectral, and lidar) to conduct the missions identified by the River Forecast Centers (RFCs). The focus will be on small UASs, but medium to large UAS platforms will be addressed.

The initial focus will be identifying the optimal visible + lidar payload suite, given the initial prioritization of the RFCs. Issues that will be addressed will include weight, size, power, cost, robustness, and availability. We will study what platforms have been used for missions similar to the ones required by the RFCs and what sensors have been flown on those missions.

Description of research conducted during the reporting period and milestones accomplished and/or completed

- A visit with numerous vendors at various conferences and meetings to obtain latest information on UAS payloads and sensors, as well as to hear talks on and discuss the latest applications. Initiated analysis of payloads and sensors appropriate for RFC requirements.
- Studied Puma capabilities to determine ability to effectively obtain data to meet RFC requirements; determined necessary flight hours to obtain coverage based on data from AV Inc.

Description of significant research results, protocols developed, and research transitions
None Reported

Information on collaborators / partners:

Name of collaborating organization: NWS LMRFC
Date collaborating established: May 2008
Does partner provide monetary support to project? Amount of support? No
Does partner provide non-monetary (in-kind) support? Yes, their time and advice. They assist in providing requirements.
Short description of collaboration/partnership relationship: We have worked with the LMRFC in the past to design and build a software tool called “FloodViz” that allows 3D visualizations of river data. It allows one to see the depth of the water in context.

Information on any outreach activities: None Reported
NOAA sponsor and NOAA office of primary technical contact: Senita Hill, OAR
Related NOAA strategic goals: Climate Adaptation and Mitigation, Weather-Ready Nation, Healthy Oceans
Related NOAA enterprise objectives: Science and Technology

NGI FILE #12-NGI2-28

Project Title: Persistence of microbial indicators, source tracking markers, pathogens, and their molecular signatures in Gulf beach waters

Project Lead: Shiao Y. Wang, USM, Shiao.Wang@usm.edu

Project objectives and goals

The main goal of the project was to compare the persistence of viable enterococci to the persistence of molecular signatures of enterococci. The first objective was to assess the effectiveness of the microcosm used to measure bacterial persistence and die-off in natural waters typical of the Gulf of Mexico. The second objective was to use the microcosms to better define the relationships between the environmental persistence of microbial water quality indicators and their molecular signatures. The third objective was to use the microcosms to test hypotheses about the role of different environmental parameters onn the persistence of molecular signatures for fecal indicators.

Description of research conducted during the reporting period and milestones accomplished and/or completed

Experiments were carried out at beaches in Long Beach and Pass Christian to assess the effectiveness of the microcosm for determining the persistence of fecal indicating bacteria and the reproducibility of the data collected. Field experiments were carried out in July, August, September and October 2012 and January 2013. To determine the variability among microcosms in terms of bacterial persistence, ten microcosms were tested each time. The same sample was brought back to the lab and the same volume used in the microcosms in the field was incubated in each of ten flasks with gentle shaking in a lab incubator to determine whether there is a difference in the variability of the survival rates between samples in microcosms in the field and the same samples incubated in flasks in the lab. To determine the persistence of sewage enterococci over time, four microcosms were used at each of the two sites. Sewage was first mixed with natural beach water at a ratio of 1:1 and then added to the microcosms. The microcosms and the surrounding beach water were sampled at regular intervals to determine viable enterococci concentration and enterococcal DNA concentration. Samples were taken on Days 0, 1, 2, 3, 4, and 8. In general, 1.5, 2, 2.5, 3, and 45 ml were sampled on Days 0 and 1, 2, 3, 4, and 8, respectively. To obtain sufficient enterococci for reliable enumeration, actual sample volumes were adjusted slightly with each experiment depending on the initial sewage enterococci concentration. For surrounding beach water, 250 ml was sampled each time. Samples were transported back to the laboratory on ice in sterile tubes or bottles and processed within six hours of collection. DNA was extracted from one milliliter of each sample and assayed using qPCR (EPA Method 1611) for the molecular detection of enterococcal DNA. Viable enterococci were enumerated from the remaining sample using EPA Method 1600.

Description of significant research results, protocols developed, and research transitions

Our results showed that the microcosms are highly reliable for determining the survival rate or persistence of enterococci. Table 13 shows the data concerning variability in enterococci counts among microcosms inoculated with identical samples. Also shown are the counts in comparison to identical samples maintained in flasks. The mean number of isolates in 5 uL of sample, 60

CFU, was identical in the microcosms and flasks (Fig. 25 and Table 13). This was expected as the same sample was placed in the two containers. The variability in terms of standard deviation among plate counts for the microcosm samples was lower compared to the flask samples.

Table 12. The number of CFU counted on mEI plates among microcosm and flask samples after four days of incubation at 24° C. The counts were obtained by plating 5 uL of sample diluted in 15 mL PBS.

	Microcosms			**Flasks**		
	Rep 1	Rep 2	Avg	Rep 1	Rep 2	Avg
# 1	45	60	53	70	79	75
# 2	43	44	44	40	44	42
# 3	72	137	105	191	213	202
# 4	57	57	57	40	48	44
# 5	69	80	75	34	64	49
# 6	47	69	58	29	31	30
# 7	55	69	62	28	54	41
# 8	64	65	65	29	31	30
# 9	33	38	36	34	50	42
# 10	49	51	50	42	54	48
	Microcosm Avg		60	Flask Avg		60
	Microcosm Std Dev		19	Flask Std Dev		51
	Microcosm Std Err		6	Flask Std Err		16

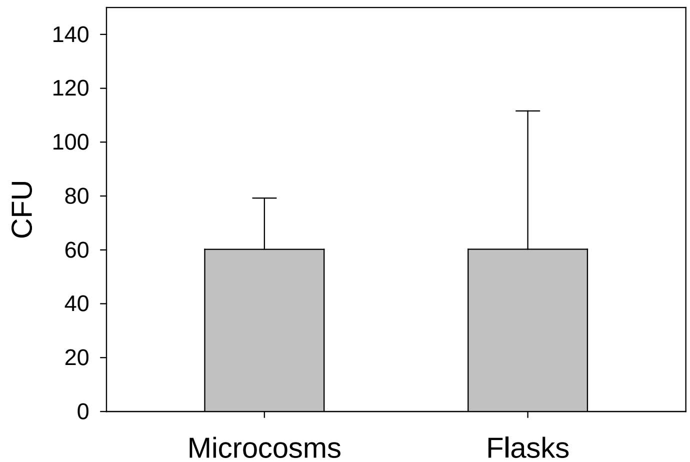


Figure 25. CFU in 5 uL of samples from microcosms and flasks after 4 days incubation at 24° C. Mean ± standard deviation.

Sewage enterococci do not appear to persist in the water column as their concentration quickly declined over time. Enterococci counts dropped an average of 0.8 logs with a range of 0.1-1.6 logs after two days in environmental waters, at both sites. By the fourth day, counts declined further by an average of 2.1 logs with a range of 0.7-3.5 logs. Enterococci counts had declined even further after eight days by an average of 3.8 logs and a range of 2-5.2 logs. An example of the results obtained is shown in Fig. 26 for a field experiment conducted in October 2012. Amongst initial enterococci concentration, <0.5% were still viable on the eighth day.

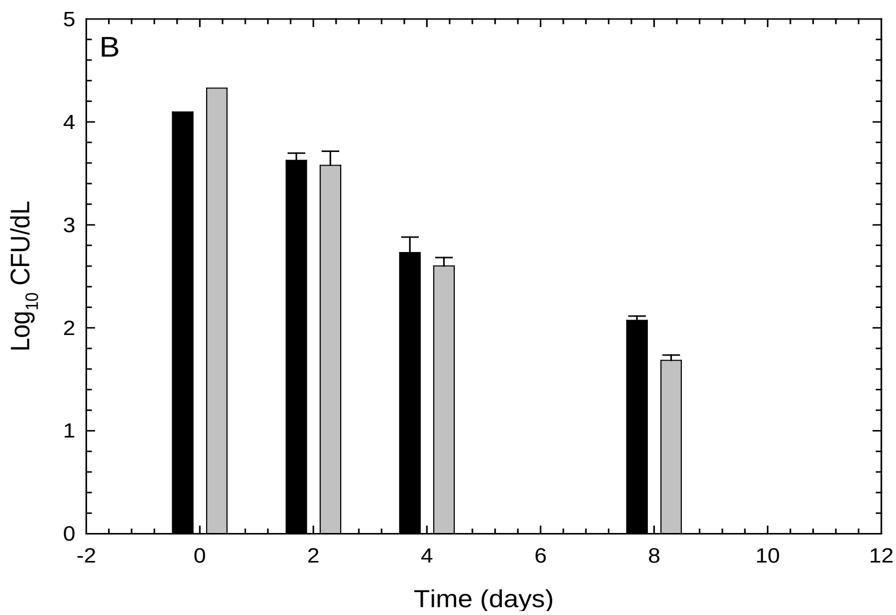


Figure 26. Survival of sewage enterococci in October 2012 at a public beach in Pass Christian. Black bars are filtered beach water and sewage and grey bars are natural beach water and sewage. Error bars are standard errors of four replicates.

Similarly, enterococcal DNA does not persist in the water column as their concentration also declined quickly. After two days, initial DNA concentration had decreased an average of 30% with a range of 30-76%. DNA concentration declined even further to an average of 84% with a range of 55-98%. On the eighth day of field studies, DNA concentration declined an average of 88% with a range of 86-99%. An example of the results obtained using enterococci DNA as a marker is shown in Fig. 27 for a field experiment conducted in October 2012. Note that the units used indicating bacterial cell numbers and DNA levels are quite different. For bacterial cells numbers, results are in CFU/mL and changes are shown on a log scale. For DNA levels, results are shown as percentage decline relative to the amount of DNA at the beginning of the experiment. The DNA results support the conclusion reached using viable counts data indicating that enterococci in general do not survive or persist over time in the surface water at beaches.

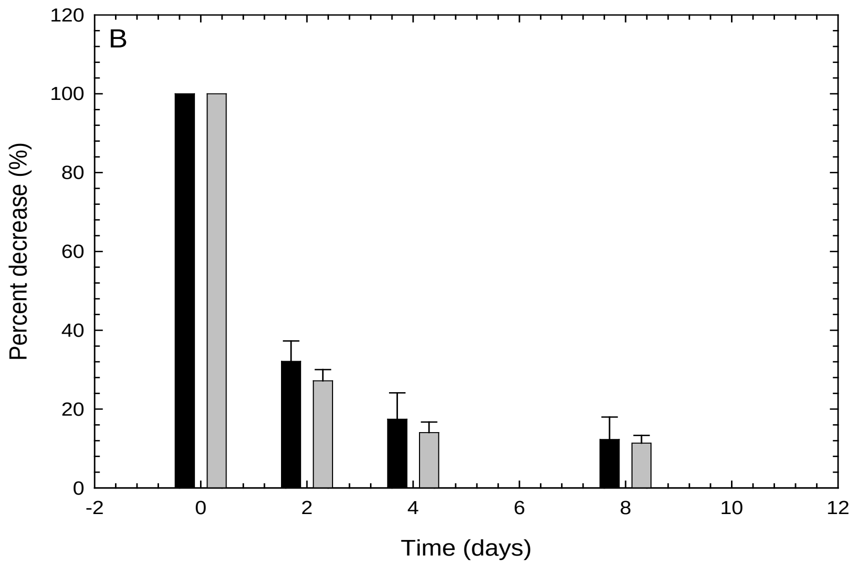


Figure 27. Percent decrease of sewage enterococcal DNA in October 2012 at a public beach in Pass Christian. Black bars are filtered beach water and sewage and grey bars are natural beach water and sewage. Error bars are standard errors of four replicates.

A regression analysis of the viable cell count data and qPCR data showed a positive correlation but the coefficient of determination was weak (r2 = 0.39) (Fig.28). This suggests that although both are indicators of enterococci, results obtained using the two should not be inter-converted or interpreted in the same way.

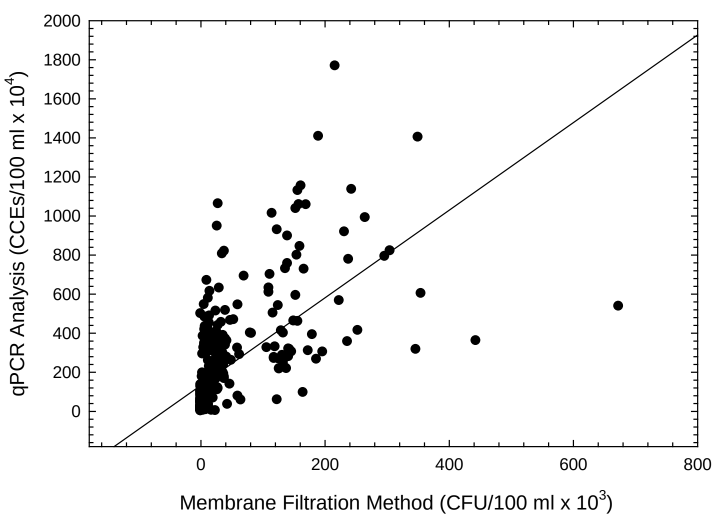


Figure 28. Regression analysis comparing results obtained using two methods of determining enterococci concentration in water. One is a culture-based using membrane filtration and the other is molecular-based using qPCR. Y = 2.2411X + 133.7; r2 = 0.3881

Information on collaborators / partners:

Name of collaborating organization: Chris Sinigalliano, NOAA/AOML
Date collaborating established: None reported
Does partner provide monetary support to project? Amount of support? None reported
Does partner provide non-monetary (in-kind) support? None reported
Short description of collaboration/partnership relationship: None reported

Information on any outreach activities: None Reported

NOAA sponsor and NOAA office of primary technical contact: Alan Leonardi, OAR

Related NOAA strategic goals: Healthy Oceans

Related NOAA enterprise objectives: Science and Technology

NGI FILE #12-NGI2-29

Project Title: Northern Gulf Institute Diversity Internship Program

Project Lead (PI) name, affiliation, email address: Tina Miller-Way, DISL, tmiller-way@disl.org

Co-PI(s) name, affiliation, email address: JoAnn M. Moody, DISL, jmoody@disl.org

Project objectives and goals

To support work experiences for undergraduate and graduate students of diverse backgrounds, ethnicities and experiences in the Gulf of Mexico region at NOAA line offices and other NOAA-affiliated organizations.

Contributions to specific NOAA Goals/Objectives:

One of NOAA's Objectives is 'Diverse and constantly evolving capabilities in NOAA's workforce'. To achieve this objective, NOAA stated they will "increase collaboration with academia and create opportunities to support undergraduate and graduate students' participation in NOAA activities that foster their interest in NOAA-related scientific study and a future career within the Agency". The Strategic Plan states that over the next 5 years, evidence of progress toward this objective will include "increased numbers of underrepresented groups in the NOAA workforce". This Diversity Internship Program provides opportunities for undergraduate and graduate students from underrepresented groups to participate in NOAA activities either directly at NOAA labs or indirectly on NOAA-funded projects or interest areas. In addition, through program activities, participants become aware of NOAA's missions, objectives and its various Line Offices.

The Diversity Internship Program places interns at various organizations and laboratories throughout the Northern Gulf coast. Potential mentors indicate intern projects on the mentor application form (http://ngi-internship.disl.org/**)**. Mentors are selected based in part on the relevance of proposed projects to regional issues as delineated in the Gulf of Mexico Research Plan, the Gulf of Mexico Alliance Action Plan and the NGI Strategic Plan.

Description of research conducted during the reporting period and milestones accomplished and/or completed

The NOAA-NGI Diversity Internship Program supported 10 interns at 9 academic and federal locations across the Gulf coast in Summer 2012). Interns were from 2 demographic groups underrepresented in NOAA's workforce (African-American and Asian) and included undergraduate students, Master's and PhD candidates. Internship activities and focus areas were very diverse and ranged from offshore field work to computer based modeling to surveying people, and from fisheries to ecosystem valuation to river stage forecasting. A two-day orientation session at the beginning of the program provided interns with an introduction to NOAA, NGI, oral presentation skills, and the Gulf the

Mexico as well as metadata training. An Internship Summit, held at the conclusion of the program, gave interns an opportunity to speak to NOAA and NGI staff and other federal agency personnel about career opportunities and to deliver a presentation about their research. Pre and post-program assessments were conducted and interns reported high levels of overall satisfaction with the program. Specific knowledge gain occurred in their fields of study as well as with research, presentation and data skills and Gulf of Mexico literacy. Current efforts are focused on maintaining connections with all interns and building the program through blogging, webpage listings, support for interns attending professional meetings and outreach.

Project Results:

The NGI Diversity Internship program supported 10 internships during the summer of 2012. Table 1 lists the names, educational level, home institutions, internship locations, internship mentors and internship focus area of this year's interns. A total of 35 applications were received for these 10 positions. Five of the 10 interns were undergraduate students, 4 were Master's candidates and one was working on a PhD. Half were female. Three interns were African-American; the rest were Asian. Interns were placed at 9 different locations across the Gulf ranging from Texas to Alabama. Internships included both academic institutions (DISL, MSU, Texas A&M, USM) and NOAA Line Offices (NWS, NMFS, NOAA Coast Survey). Focus areas were very diverse including fishery surveys, bathymetric surveying, ecosystem valuation, GIS, biogeochemistry, hydrology, toxicology and oyster reef restoration.

A two day orientation session was held at the Dauphin Island Sea Lab at the beginning of the summer internship period (May 31-June 1, 2012). During this time, the interns received training in data management and metadata by Ms. Kathy Martinolich of NCDDC. Mr. Fred Zeile of NCDDC introduced the interns to NOAA as an organization and discussed the missions of NOAA's various line offices. Additionally, interns received training in oral presentation skills. Interns were also introduced to Gulf of Mexico coastal and nearshore marine habitats during the orientation program through field trips around Dauphin Island and a cruise aboard the Sea Lab's research vessel.

Each of the 10 Diversity interns as well as 2 EDAC interns based at Stennis participated in the Internship Summit held at Stennis Space Center in August 2012. At the Summit, each intern presented a summary of their internship experience and participated in both a NOAA Career Roundtable and an introduction to the non-NOAA agencies at Stennis Space Center. Electronic copies of these presentations have been submitted to the NGI Program Office. The agenda for the Summit is included in Appendix B.

One measure of program impact was quantified using pre-and post-program assessments and post-program evaluations. Gulf of Mexico literacy, organizational awareness, presentation, research and data skills were assessed. Satisfaction with the program, mentors, projects and orientation and Summit experiences were evaluated. Prior to the program, most interns had visited the NGI website, most reported feeling neutral when asked if they had an understanding of NGI's or NOAA's missions, themes or organization or when asked about their awareness of career opportunities at NOAA, and none had worked on a NOAA project. With respect to presentation, research and data skills, most interns felt comfortable with entry level skills (preparing a PowerPoint presentation, doing basic data analysis, research experience, finding credible scientific information), however, levels of comfort declined with increasing specificity (training in experimental design, writing a research paper, use of databases, awareness of, accessing and using metadata, professional meeting experience, comfort with graphing software). None of the 10 interns considered themselves knowledgeable about the Gulf of Mexico or followed information about the Gulf in the news, however, half indicated that they understood the importance of the Gulf to the nation. Post-program assessment and evaluation revealed specific program impacts. Notable changes were indicated in the understanding of NOAA and NGI missions, themes and organization; comfort level in use of presentation software; use of federal data; metadata awareness; knowledge of, recognition of the importance, and tracking of news of the Gulf of Mexico. Smaller changes were noted in intern comfort with experimental design, research papers, data analysis, visual depiction of data and with the use of metadata. On a scale of 1 to 5, nine of the ten interns rated the overall experience a 5, one rated it a 4. Intern projects were a mix of pre-planned and intern-directed. Almost all interns reported helpful mentors, team/lab members, and were pleased with the amount of guidance they received. Additionally, most interns (9/10) indicated that the internship experience affected their career plans. Statements such as "helped me decide if working in a lab is really what I want", "increased my motivation", "did not really know what I wanted to do before the experience. Now I have an idea", and "gave me an alternate view of civil engineering" attest to this impact.

DISL has continued efforts to maintain connections to previous interns and to build and advertise this program. An existing database allows us to distribute job opportunities, calls for submissions to professional meetings that include student activities and other items of potential interest. The NOAA-NGI Diversity Internship Program is currently listed on the Pathways to Science website (http://www.pathwaystoscience.org/programhub.asp?sort=SUM-NorthernGulfInst-DiversityInternship), and was posted on both the Association for the Sciences of Limnology and Oceanography and Coastal and Estuarine Research Federation webpages during the recruitment phase. Additionally, we now have a NGI Diversity Intern blog (http://blogs.disl.org/ngi/) that served to keep interns connected during the 10 week period and will now serve as an additional communication mechanism. Lastly, efforts to build the program are beginning to result in action. The Deep-C GOMRI consortium has agreed to support at least 2 intern positions in Year 3 of their program.

Description of significant research results, protocols developed, and research transitions

Given the educational nature of this grant, there are no research results, protocols developed or research transitions. However, we did complete an evaluation of the internship program. These results are provided in the project summary above. Electronic copies of each of the 10 interns' presentations at the NOAA-NGI Internship Summit (which include pictures and other graphics) have been submitted to the NGI Program Office and are available for viewing on the website.

Information on collaborators/partners (if applicable):

Name of collaborating organization: NOAA – NESDIS, NCDDC
Date collaborating established: January 2010
Does partner provide monetary support to project? Amount of support? Yes, NESDIS - $40,000, NCDDC - $25,000
Does partner provide non-monetary (in-kind) support? NGI – in kind support
Provide a short description of collaboration/partnership relationship: Several NOAA line offices support these internships through financial contributions under the program's

umbrella designation. These contributions are facilitated by Mr. Russ Beard, our NOAA Liaison. NGI supports these internships with time and resources (e.g. hosting the Summit, advertising the program, etc.)

Information on any outreach activities (if applicable):

General Description: None Reported

Type (speaker, workshop, training): Training
Name of event: An Introduction to Metadata (Ms. Katy Martinolich, NCDDC)
Date: May 31, 2012
Location: Dauphin Island Sea Lab
Description: An introduction to metadata –what is it, why do we have it, where is it and how do you access it
Approximate Number of Participants: 12

General Description: None Reported

Type (speaker, workshop, training): Speaker
Name of event: NOAA Career Roundtable
Date: August 6, 2012
Location: Stennis Space Center
Description: A discussion of experiences, opportunities and career advice among NOAA personnel and interns
Approximate Number of Participants: 15

NOAA sponsor and NOAA office of primary technical contact: Russ Beard, NESDIS

Related NOAA strategic goals: Climate Adaptation and Mitigation, Weather Ready Nation, Healthy Oceans, Resilient Coastal Communities and Economies

Related NOAA enterprise objectives: Science and Technology, Engagement

NGI FILE #12-NGI2-30

Project Title: Development of Multibeam Data Processing Procedures and Techniques for Fisheries Applications

Project Lead (PI) name, affiliation, email address: David Dodd, USM, usmhydro.david.dodd2gmail.com

Co-PI(s) name, affiliation, email address: Kenneth Barbor, USM, ken.barbor2usm.edu

Project objectives and goals

The Hydrographic Science Research Center (HSRC) at The University of Southern Mississippi has a well-established expertise in hydrographic data collection and processing in shallow water. Using state-of-the-art multibeam and phase differencing swath bathymetry systems, the HSRC has efficiently collected shallow water bathymetry, side scan sonar imagery, and acoustic characterization of the sea bottom in support of graduate education, grant supported research and coastal zone management contracts. The use of modern acoustic sensors for hydrographic data collection, while predominantly focused on determining bathymetry, can provide information on bottom characteristics suitable for habitat mapping.

The National Marine Fisheries Service (NMFS), Southeast Fisheries Science Center Laboratory (SEFSCL) at Stennis Space Center, routinely employs singlebeam and multibeam echo sounders for fish stock assessments. Specifically, newer NOAA ships employed by NMFS are equipped with Simrad ME70 multibeam echo sounders that are optimized for the detection of fish in the water column. An optional processing suite offered by the manufacturer can be used for bottom mapping and sea floor characterization, but this option was not procured with the original purchase of the systems. However, the acoustic information necessary for bottom mapping and sea floor characterization is inherently present in the recorded data and can be processed by other software routines to produced bathymetry and seafloor characterization products.

The goal of the HSRC is to evaluate existing multibeam data processing and analysis software and techniques, and develop a set of procedures for using Simrad ME70 for habitat mapping. The initial focus will be on benthic substrate mapping, with longer term goals of water column mapping for species assessment. The end result will be the procedures and techniques for processing Simrad ME70 multibeam data to access bathymetry and bottom backscatter information to produce habitat maps.

Description of research conducted during the reporting period and milestones accomplished and/or completed

The initial efforts of the HSRC were to conduct a literature search of existing efforts in processing ME70 data for bathymetric and habitat mapping applications. Telephone and email dialogues were initiated with the developers of these applications to formulate the approach to be taken for implementation for SEFSCL. Specifically, Dr. Tom Weber, at the University of New Hampshire Center for Coastal and Ocean Mapping, and Dr. Randy Cutter, at the Southwest Fisheries Science Center, were consulted regarding their implementation of bathymetry and habitat mapping capabilities on the ME70 multibeam. Dr. Dodd (HSRC) attended a two-day fisheries data processing workshop in Panama City, FL to further discuss methods using ME70 data for bathymetry and habitat mapping.

The HSRC selected a MatLab® code developed by Dr. Tom Weber to translate the Simrad data format (.RAW) to a Generic Sensor Format (.GSF). The GSF data were then ingested into CARIS HIPS for the editing process of removing spurious and outlying acoustic returns. CARIS HIPS was then used to generate a bathymetric surface from the cleaned multibeam data. The GeoCoder engine within CARIS HIPS evaluated backscatter intensity and bathymetric parameters to produce habitat maps. The HSRC used small tracklines of ME70 data provided by SEFSCL to validate the efficacy of this procedure.

With the efficacy of this procedure demonstrated, the HSRC created a stand-alone executable for the MatLab® converter and obtained a CARIS HIPS license for use by SEFSCL personnel at sea. HSRC conducted a training session on the use of the converter and data processing within CARIS HIPS.

Description of significant research results, protocols developed, and research transitions

A stand-alone capability to access ME70 data, convert these data to GSF, and ingest GSF data into CARIS HIPS was assembled and delivered to SEFSCL.

Information on collaborators / partners: None Reported

Information on any outreach activities: None Reported

NOAA sponsor and NOAA office of primary technical contact: Christopher Gledhill, NMFS

Related NOAA strategic goals: Healthy Oceans

Related NOAA enterprise objectives: Science and Technology

NGI FILE #12-NGI2-31

Project Title: Determination of Habitat Use and Movement Patterns for Adult Smalltooth Sawfish

Project Lead (PI) name, affiliation, email address: R. Dean Grubbs, FSU, dgrubbs@bio.fsu.edu

Project objectives and goals

The primary goal of this project is to investigate movements and migration of subadult and adult smalltooth sawfish (*Pristis pectinata*), particularly those captured in areas of elevated interaction with fisheries, using satellite telemetry in order to develop life-history information on the species that will help to identify localized areas of aggregation, potential mating sites, and areas with high likelihood of shrimp trawl interaction. We sought to conduct up to 36 days of fishery-independent sampling to capture and tag adult smalltooth sawfish.

Sampling locations are based on known records of interactions with commercial shrimp and longline fisheries, recreational fisheries, or research surveys. The shelf edge at water depths of 40-55 meters from offshore of Key West the Marquesas Keys is a known area of sawfish interactions with commercial longline and shrimp trial fisheries. Our data suggest this is also an aggregation site for adult smalltooth sawfish, at least during summer. In addition, Florida Bay is a known area of high interaction with charter fisheries. These are the two primary areas of sampling.

To capture sawfish, bottom longlines consisting of nylon or 3.5 mm monofilament mainline and 50-100 gangions are deployed. Gangions are terminated with non-offset, baited circle hooks (≥ 16/0) and longlines are anchored and marked with a buoy and/or highflier at each end. Soak times are typically one hour but do not exceed two hours. Once brought alongside the boat, each sawfish is restrained by placing a line around the rostrum and the caudal peduncle. Sex and length measurements are recorded. Fin clips are collected for population genetics studies and blood samples are collected to assess reproductive status. A pop-off archiving satellite transmitter (PSAT) is attached to the first dorsal fin using a harness technique developed by the principal investigator. On all adult and large juvenile sawfish capture, we wither deploy one of the following: MK-10 or MK-10PATF tags manufactured by Wildlife Computers® or X-tag manufactured by Microwave Telemetry Inc. These tags record pressure (depth), temperature, light, and light-based location estimates at intervals predetermined by the. PAT tags will be programmed to release after 2 to 5 months. Light-based geolocation data are notoriously noisy; therefore, a form of the Kalman filter incorporating sea-surface temperature will be applied to the location data. The MK-10PATF tags have an added advantage of logging real-time location data using an onboard GPS during intervals when sawfish are near the surface (e.g., in shallow water). Comparisons of the real-time location data to the raw and filtered light-based geolocation data will provide a measure of the variability and reliability of the light-based data. We are currently analyzing the data using Kernal analyses on location data to define areas of concentrated use, potential adult aggregation sites, and activity space as a function of temporal cycles (e.g., diel, lunar, seasonal). Site fidelity and indices of reuse will be applied as appropriate. We will examine temperature and depth data for patterns and preferences and will compare the data as functions of diel and seasonal patterns as well as sex and size of sawfish.

Description of research conducted during the reporting period and milestones accomplished and/or completed

During the reporting period, three research trips (17 total days, 12 days at sea) were completed and 59 total fishery independent longline sets were made, all aboard an FSU research vessel (a 26' Calcutta) and six adult or large juvenile sawfish were tagged (Fig. 29). The contract for the project was not completed until September; therefore a trip scheduled for August 2012 was cancelled. A trip planned for October was also canceled due to weather. In January we completed six days at sea based out of the Keys Marine Lab. During this trip, we conducted 29 demersal longline sets in the middle Keys. However, due to high winds, only two sets were made in offshore areas on the Atlantic side of the Keys where interactions with commercial longline fisheries have occurred. The remaining sets were distributed in shallow waters on both the Atlantic and Gulf sides of the middle Keys and in Florida Bay in areas with reported sawfish encounters in the NSED. We captured 72 sharks and one sawfish (in Conchie Channel in Florida Bay), an adult and likely term-pregnant female, during this trip. During February 2013, we made a five-day trip to Everglades National park and Ten Thousand Islands National Wildlife Refuge to set longlines in hopes of capturing adult female sawfish in the area prior to or following parturition. We conducted 16 longline sets between Coon Key near Goodland, FL to Lostman's River in the southern ENP and captured 22 sharks and no sawfish. During April 2013 we embarked on a planned 8-day sampling trip to the middle Florida Keys. We spent three days at sea (of 6 planned days) sampling for adult sawfish. In total, we made 14 sets, capturing and tagging 50 sharks and 5 large sawfish. Due to high winds, effort was limited in offshore areas of the middle Florida Keys, so we concentrated sampling in Florida Bay due to

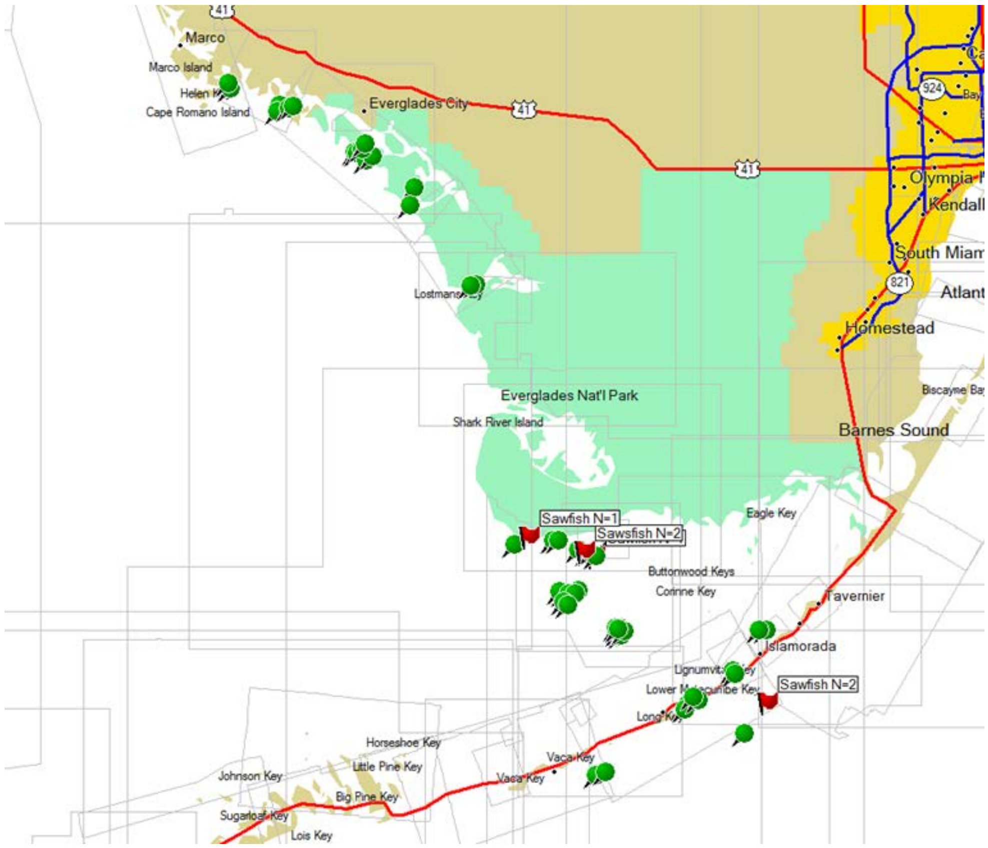


Figure 29. Distribution of fishery-independent longline stations (N=59) sampled during the reporting period to capture and tag endangered smalltooth sawfish. Red flags = sawfish capture locations

high encounter rates with charter fishers. Due to negative attitudes of charter fishers regarding longline sampling and the desire to maintain positive working relationships with the fishers, we did not set longlines in the areas with the highest concentrations of sawfish encounters. We fished with rod and reel on one afternoon in the mouth of East Cape Canal, capturing and tagging an immature female sawfish. We also made 12 longline sets in Florida Bay and captured and tagged two adult male sawfish on a single set in Conchie Channel. Sampling day 3 was the only day with conditions that allowed setting gear on the edge of the continental shelf where interactions with commercial fishers occur. We captured and tagged two adult male sawfish on a single set offshore of Alligator Reef (40 meters deep). Having deployed all available satellite tags, the trip was ended three days early since the numbers of adult captures on the ESA permit are extremely limited.

Description of significant research results, protocols developed, and research transitions

During the reporting period we captured and tagged six large individuals of the endangered smalltooth sawfish. Using NGO funds and previous funds from the NOAA Section 6 Program, we have completed 171 demersal longline sets during the last three years between in the Middle to Lower Florida Keys, off the Marquesas Keys and Dry Tortugas, between Ten Thousand Islands National Wildlife Refuge and Florida Bay (Fig. 30). We captured 18 adult or large juvenile smalltooth sawfish (10 males and 8 females). Eleven of these sawfish were captured in relatively deep water (40-55 meters) on the edge of the continental shelf in the lower Florida Keys and seven adults were caught in the shallow waters of Florida Bay. Data to date suggest adult smalltooth sawfish do not leave U.S. waters and primarily remain in Florida waters. They use very shallow flats and channels in Florida Bay from January through May, but also occur in deeper water along the edge of the continental shelf at least from March through August (Fig. 31).

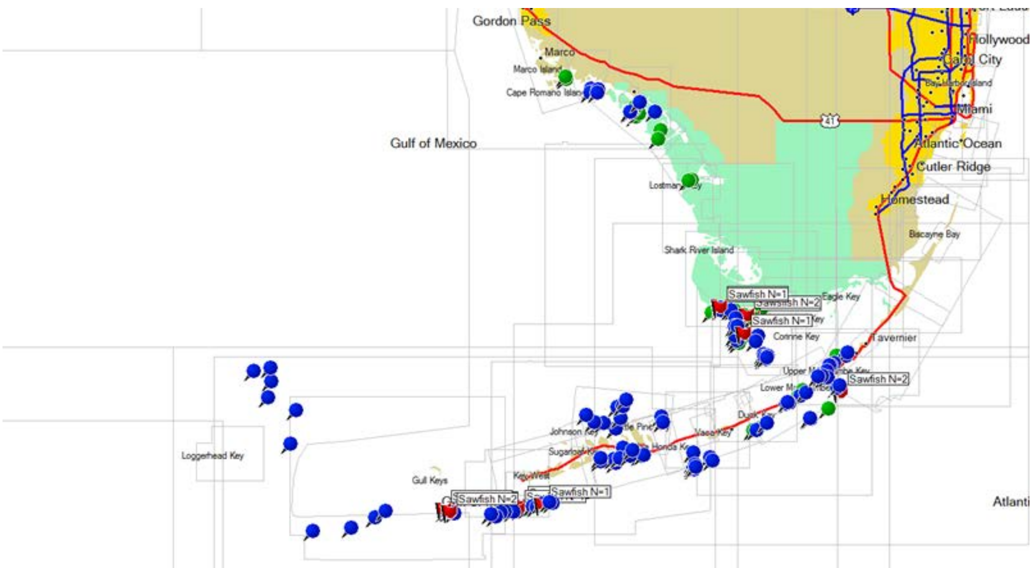


Figure 30. Distribution of fishery-independent longline stations (N=171) sampled between 2011 and 2013 to capture and tag endangered smalltooth sawfish. Red flags = sawfish capture locations.

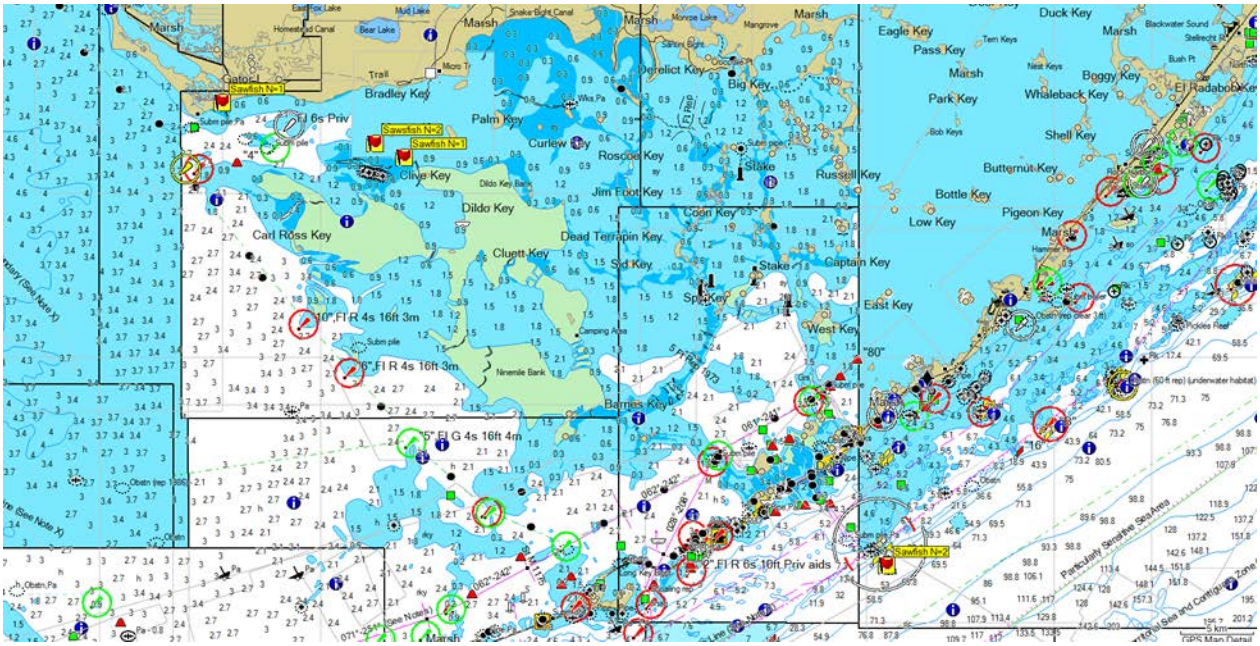


Figure 31. Locations of captured sawfish during the reporting period illustrating areas of primary use in Florida Bay and on the edge of the continental shelf along the Florida Keys.

Information on collaborators/partners (if applicable):

Name of collaborating organization: Dr. John Carlson, Dr. Shelley Norton - NOAA Southeast Fisheries Science Center and Office of Protected Resources
Date collaborating establishing: November 2009
Does partner provide monetary support to project? Amount of support? Monetary support through NGI. Amount not reported.
Does partner provide non-monetary (in-kind) support? Yes, satellite transmitters and satellite time.
Short description of collaboration/partnership relationship: Our colleague from NOAA Fisheries supplies the satellite transmitters we deploy and the satellite time needed to download the data.

Name of collaborating organization: Dr. Jim Gelsleichter, University of North Florida
Date collaborating establishing: November 2009
Does partner provide monetary support to project? Amount of support? No
Does partner provide non-monetary (in-kind) support? No
Short description of collaboration/partnership relationship: Our colleague from UNF provides a field assistant to collect blood from sawfish in the field and analyzes blood samples for sex hormone concentrations.

Name of collaborating organization: Gregg Poulakis, Dr. Phil Stevens, Florida Fish and Wildlife Conservation Commission
Date collaborating establishing: November 2009
Does partner provide monetary support to project? Amount of support? No

Does partner provide non-monetary (in-kind) support? No
Short description of collaboration/partnership relationship: Our colleagues from FWC are conducting stable isotope analyses using samples we collected. They were also our collaborators on work previously funded through the NOAA Section 6 program.

Name of collaborating organization: George Burgess, Florida Museum of Natural History, University of Florida
Date collaborating establishing: November 2009
Does partner provide monetary support to project? Amount of support? No
Does partner provide non-monetary (in-kind) support? No
Short description of collaboration/partnership relationship: Our colleagues from the FMNH have been collaborators on related work previously funded through the NOAA Section 6 program.

Information on any outreach activities (if applicable):

I gave a numerous invited presentations to public schools, the general public, and university groups that highlighted NGI support research on smalltooth sawfish.

NOAA sponsor and NOAA office of primary technical contact: Shelley Norton, NMFS

Related NOAA strategic goals: Healthy Oceans

Related NOAA enterprise objectives: Science and Technology

NGI FILE #12-NGI2-32

Project Title: Advanced Developmental Server for the NGI/NCDDC Ecosystems Data Assembly Center (EDAC)

Project Lead (PI) name, affiliation, email address: William B. (Trey) Breckenridge III, Mississippi State University, trey@hpc.msstate.edu

Co-PI(s) name, affiliation, email address: John Harding, Mississippi State University, jharding@ngi.msstate.edu

Project objectives and goals

The NOAA NCDDC and Northern Gulf Institute jointly created the Ecosystems Data Assembly Center (EDAC) in 2006. Through this partnership, the THREDDS-enabled retrospective OceanNOMADS system was developed to provide access to ecosystem-related observations, databases and ocean forecast output relevant in and around the Gulf of Mexico region and other areas. This service was initially deployed on an old compute server loaned to the project by the Mississippi State University High Performance Computing Collaboratory. This proposal requested a new server to replace the older equipment so that the valuable datasets could continue to be served to the research community.

Description of research conducted during the reporting period and milestones accomplished and/or completed

The server was procured and deployed to replace the older equipment. The system has been used extensively by the broader research community as a primary repository for the Gulf of Mexico data served via the system. In fact, the system is regularly listed among the highest throughput servers, in terms of network utilization, at Mississippi State University.

Description of significant research results, protocols developed, and research transitions

Modernized compute server to provide greater service and higher performance.

Information on collaborators/partners (if applicable):

Name of collaborating organization: NOAA National Coastal Data Development Center
Date collaborating establishing: 2006
Does partner provide monetary support to project? Amount of support? No
Does partner provide non-monetary (in-kind) support? Yes
Short description of collaboration/partnership relationship: Information on NOAA data management needs, metadata training

Information on any outreach activities (if applicable): None Reported

NOAA sponsor and NOAA office of primary technical contact: Rost Parsons, NESDIS

Related NOAA strategic goals: Climate Adaptation and Mitigation, Weather-Ready Nation, Healthy Oceans, Resilient Coastal Communities and Economies

Related NOAA enterprise objectives: Science and Technology

NGI FILE #12-NGI2-33

Project Title: Increasing our Understanding of the Interaction between Physical and Ecological Processes in the Gulf of Mexico and Carribean

Project Lead (PI): Eric Chassignet, FSU, echassignet@fsu.edu

Project objectives and goals:

The Big Bend region (BBR) of Florida in the northeastern Gulf of Mexico (NEGOM) exists at the juncture of the Florida Peninsula and the Florida Panhandle, and where the coastline orientation changes by roughly 90°. The BBR contains both spawning sites and nursery habitats for many key species of the region, and has thus been studied as a source habitat for fisheries production. With over 60% of annual landings of certain fish species taken by recreational fishing, considerable pressure is placed on properly managing the NEGOM fisheries. However, while fishing affects the abundance of adult fish, density-independent processes that occur during their egg, larval, and early juvenile stages determine the interannual variations in recruitment. Thus, understanding recruitment processes of fish species is crucial for their effective management.

The physical oceanographic state can largely impact the egg and larval stages of reef fish development by setting dispersion patterns of their egg and early-stage (pre-settlement) larvae. Since the circulation is important for moving fish eggs and larvae to or from areas that are conducive for survival, the circulation can directly influence the recruitment and year-class strength of given species.

This project uses the gag grouper (*Mycteroperca microlepis*) as a representative for the plethora of reef fish species in the BBR. Gag are among the most valuable finfish in the region, providing over $100 million in value added and over $60 million in income to the southeastern United States from recreational fishing alone. Adult gag spawn on offshore reefs along the continental shelf break each spring (February - April). Pelagic gag larvae are transported across the shelf until eventually settling as juveniles in seagrass habitats along the coast 30-60 days later.

The physical mechanisms responsible for this onshore larval transport remain unknown. Thus, this work investigates the contribution of physical transport mechanisms to variations in population size of gag larvae, using a high-resolution numerical ocean model. The use of a numerical ocean model to study the physics of the region allows for the different transport processes to be assessed in high spatial and temporal resolution. This is not possible using the sparse observational data currently available for the region. Numerical models also provide a fully three-dimensional analysis of the physical ocean, which allows one to assess the impact of currents at various depths. In particular, the role Ekman transport and upwelling dynamics are analyzed for their contribution to the cross-shelf transport in the BBR. This analysis includes both Eulerian and Langrangian methods for understanding the coastal ocean dynamics.

Description of research conducted during the reporting period and milestones accomplished and/or completed:

This research conducted during the reporting period used a four-dimensional, high-resolution approach to understand the dynamics governing the BBR circulation and transport during the spring months. The coastal circulation is found to respond barotropically to large-scale, low-frequency variations in the wind stress in conjunction with atmospheric frontal passages, which generate oscillations between phases of southeasterly and northwesterly-directed wind stress. The shelf circulation responds asymmetrically to the oscillating winds, resulting in a rectification of the flow with mean currents that are directed across-shelf in the area offshore CSB and CSG. The flow tends to conserve potential vorticity on time scales less than 12 hours, but over longer time scales the nonconservation of potential vorticity enhances the ability for onshore movement. The primary pathway for onshore transport exists to the southeast of CSG, and a preferred origin for materials to successfully arrive inshore coincides with a known gag spawning aggregation.

Milestone: Ph.D. defense of Austin Todd

Description of significant research results, protocols developed, and research transitions:

The ocean responds to large-scale, low-frequency winds and not to smaller temporal or spatial scale variations in the winds. This is evident from the limited differences between the seven-year mean circulations from each contemporaneous simulation, despite the differences in spatial and temporal resolutions between each atmospheric forcing product. The main flow features observed in the seven-year mean springtime BBR circulation include a northwestward-flowing slope jet, a southeastward-flowing coastal jet, and several areas of cross-shelf velocities offshore of CSB and CSG. The slope jet flow toward the northwest is set primarily by the deep ocean, but the flow on the shelf is set by the large-scale, low-frequency wind stress and generally responds barotropically to these winds. The mean cross-shelf velocities form a banded structure of offshore-directed flow adjacent to onshore-directed flow.

The hydrodynamic fields from the ocean model simulations are compared to several types of observations across the region. The model simulations all reproduce sea levels and surface temperatures that closely match the variability from observations at tide gauges ($R > 0.8$) or regional buoys ($R > 0.96$), respectively. When modeled velocities are compared to observed velocities at two different current meters located in depths of 19 m, the models capture the variability of subinertial velocities at both sites well ($R > 0.7$). The exception is the NARR-forced run, which poorly captures the variability demonstrated by the observed currents, a result of the systematic weak bias in the NARR winds. Therefore, even though the NARR-forced simulation captures the mean oceanic features well, its variability does not match that of the observed currents.

The mean shelf circulation in the BBR is composed almost entirely of flow during two opposing wind regimes: winds from the northwest and winds from the southeast. Winds from easterly quadrants are much more frequent during the spring months, but northwesterly winds are stronger. These stronger, yet less frequent, northwesterly winds drive a correspondingly strong southeastward flow that is able to cross isobaths over regions where the isobaths exhibit tight curvature. Contrastingly, the flow during southeasterly winds is more frequent, but generally weaker. This weaker flow is able to more closely follow isobaths as it moves toward the northwest. The rectification of these two asymmetric yet opposite oscillating flows provides a mean flow that is directed cross-shore in the regions of tightly curving isobaths and is weak elsewhere.

Shallow-water conservation of potential vorticity governs the flow over the BBR shelf on time scales shorter than roughly 12 hours. Advecting Lagrangian particles in the circulation demonstrates that the flow responds to changing ocean depths by inducing a compensatory change in relative vorticity. This indicates that, following PV conservation, the flow is able to cross isobaths during northwesterly winds. The strong flow during this wind regime quickly encounters shallower (deeper) depths and is forced to turn to the right (left) in the offshore (onshore) direction to add a compensating negative (positive) relative vorticity. However, flow from the southwest is weaker and quickly adjusts to changing isobaths without the need to induce a significant amount of relative vorticity. Over longer time scales (greater than ~12 hrs), PV may be extracted from the system through the frictional boundary layers, leading to nonconservation of PV. The frictional damping is enhanced in shallower waters, thereby enhancing the transport onshore. Therefore, nonconservation of PV provides a ratcheting mechanism that enhances the ability of particles to move into shallower water and comparatively restricts their offshore movement.

The Lagrangian particle trajectories also reveal the primary pathways that particles follow during their advection in the springtime circulation. Higher particle densities along the shelf break reveal that the primary pathway for advection is along the northwest-flowing slope jet, with advection away from the shelf break occurring because of the cross-isobath flow during northwesterly winds. There is considerable interannual variability in particle density patterns, particularly the distance onshore that particles are able to reach. However, the cross-isobath movement is limited, and only a small percentage of particles are able to make significant progress inshore. The years when higher percentages of particles are advected away from the shelf break correspond to years when the strength and width of mean cross-shore current features are increased.

Fifty to eighty percent of successful particles travel south of Apalachicola Bay at some point during their advection. This indicates that successful particles are carried inshore through this primary pathway to the south of CSB and CSG and farther alongshore via the coastal jet. More particles follow this onshore tongue in the two positive ENSO phase years within this study (2005 and 2010), indicating that the strength and sign of ENSO phase could have an impact on the magnitude of cross-shore transport in the BBR. However, a larger time record is needed to make any definitive conclusions of the impact of interannual or interdecadal oscillations on transport patterns in the BBR.

Finally, a preferred origin for successful particles exists to the southwest of CSB. This preferred origin for successful particles is immediately adjacent to the region of high successful particle density, to the locations with mean cross-shore currents, and to a known gag spawning site, the Madison Swanson Marine Reserve (MSMR). The location of this preferred origin for successful particles could lead to some interesting biological questions, including whether or not gag have chosen this location as a preferred spawning site because of the increased ability of materials originating from this area to arrive inshore.

The findings reiterate the importance of the MSMR as a spawning aggregation site. The MSMR provides an area where fishing pressure on gag is reduced, as fish species that form spawning aggregations and those that change sex are more susceptible to overexploitation. However, the results suggest that the MSMR is also an important area because it is a preferred source region for transport into the shallow waters of the BBR. Therefore, the existence of preferred particle origins near MSMR suggests that this location could have been evolutionarily chosen as a spawning aggregation site because it provides shelf-break spawning gag with the highest chance for their offspring to arrive in nursery environments conducive for their survival. These results therefore provide, for the first time, a description of mechanisms capable of providing transport from the shelf break to the nearshore portions of the BBR from a fully 4D perspective. In addition, it is the first successful attempt at describing the role of the physical ocean circulation in setting the transport from adult gag spawning grounds to juvenile gag nursery habitats in the BBR.

Information on collaborators / partners: None Reported

Information on any outreach activities: None Reported

NOAA sponsor and NOAA office of primary technical contact: Gustavo Goni, NMFS

Related NOAA strategic goals: Healthy Oceans

Related NOAA enterprise objectives: Science and Technology

NGI FILE #12-NGI2-34

Project Title: Bias Characterization and Hurricane Initialization using ATMS, SSMIS, and AMSR-2

Project Lead (PI) name, affiliation, email address: Xiaolei Zou, FSU, xzou@fsu.edu

Project objectives and goals

This project will focus on the bias characterization of satellite data of ATMS, SSMIS and AMSR-2, and satellite data after bias correction will be used to improve hurricane vortex initialization.

Description of research conducted during the reporting period and milestones accomplished and/or completed

- Estimate the absolute accuracy of antenna brightness temperatures (TDR) from the Advanced Technology Microwave Sounder (ATMS) based on the Constellation GPS RO and the U.S. Joint Center of Satellite Data Assimilation community radiative transfer model (CRTM).
- Estimate the ability of ATMS observations in capturing detailed thermal structures for the improved monitoring and forecasting of tropical cyclones.
- Assess the added benefits of assimilating the ATMS radiances to forecasts of four Atlantic hurricane cases the made landfall in 2012 using the Hurricane Weather *Research and Forecasting (HWRF) system.*

Description of significant research results, protocols developed, and research transitions

- Estimate the ability of ATMS observations in capturing detailed thermal structures for the improved monitoring and forecasting of tropical cyclones.

  There are increasing interests for enhanced satellite data assimilation efforts for improved tropical cyclone track, intensity and structure forecasts. The ATMS data over deep Atlantic and Pacific oceans are extremely valuable where the hurricane aircraft reconnaissance missions are usually not planned to those locations far from the coast. Since the ATMS scan angle ranges within ±52.77°, which is significantly larger than that of AMSU-A (e.g., ±48.33°), the ATMS provides data with no orbital gap poleward of 20° and also significantly reduces the unobserved regions within 20S–20N as demonstrated in this study. Many unique features of ATMS make its data most suitable for capturing detailed thermal structures for the improved monitoring and forecasting of tropical cyclones. The new additions and modifications in channel frequency, resolutions, and swath width will allow better initialization and satellite data assimilation for tropical cyclones. Our next task is to develop advanced algorithms for further quantification and removal of the errors of ATMS brightness temperatures contributed from various sources such as antenna spill-over effects and cross-polarization.

Information on collaborators / partners:

Name of collaborating organization: NOAA NESDIS
Date collaborating established: Aug 2010

Does partner provide monetary support to project? Amount of support? No
Does partner provide non-monetary (in-kind) support? Yes
Short description of collaboration/partnership relationship Help mentor graduate students and postdoctoral fellow; provide data support

Information on any outreach activities:

General Description: During the reporting period, we attended the 2012 American Geophysical Union (AGU) Fall meeting and the 2013 American Meteorological Society (AMS) annual meeting to present our recent research results.
Hosted speakers, workshops and/or any training:
Type (speaker, workshop, training): Speaker
Name of event: 2012 AGU Fall meeting
Date: December 3-7, 2012
Location: San Francisco, CA
Description: Oral Presentation
Approximate Number of Participants: 20,000
Hosted speakers, workshops and/or any training:
Type (speaker, workshop, training): Speaker
Name of event: 2013 AMS annual conference
Date: January 6-10, 2013
Location: Austin, TX
Description: Oral Presentation
Approximate Number of Participants: 2000

NOAA sponsor and NOAA office of primary technical contact: Fuzhong Weng, NESDIS

Related NOAA strategic goals: Weather-Ready Nation, Resilient Coastal Communities and Economies

Related NOAA enterprise objectives: Science and Technology

NGI FILE #12-NGI2-35

Project Title: Geospatial Data Visualization and Access for NOAA's Exploration Data Collection

Project Lead (PI) name, affiliation, email address: Scott P. Milroy, USM, scott.milroy@usm.edu

Project objectives and goals

Pursuant to NOAA's strategic goal of maintaining critical support for NOAA's mission (e.g. science and technology enterprise), this project serves primarily in the continued development of geospatial data visualization and access capabilities for the large and diverse collection of scientific data and information resulting from NOAA-sponsored ocean exploration expeditions. Currently, exploration data passes from ship to shore through the NODC/NCDDC Stennis field office, where documentation and archive preparation are completed. NCDDC provides a GIS infrastructure, but recent upgrades to ESRI ArcServer technology have not been optimized to meet requirements for integrated data visualization or for access to data through the Federal Enterprise Architecture. Of course, geospatial database design, geospatial visualization tools and data products must be operational on NOAA systems.

To accomplish these goals, workflow processes for integrating new data into the geodatabase for visualization and production are being transitioned to the OER data management team at NCDDC/Stennis. Through the support of this project, a dedicated GIS Technologist has been assigned to these specific tasks, augmenting geospatial data visualization capabilities for the large and diverse collection of scientific data and information resulting from NOAA-sponsored ocean exploration expeditions.

Description of research conducted during the reporting period and milestones accomplished and/or completed

- Goal 1: Assess the exploration geospatial data collection and plan a new strategic approach to managing these data collections.

  Progress: COMPLETED, with on-going improvements to geodatabase design that will support end user visualization and data access needs, as well as the Federal Enterprise Architecture.

- Goal 2: Plan and implement improvements to the geospatial mapping technology currently in place. (9 months).

  Progress: COMPLETED, with enhanced GIS capabilities of data visualization and integration, with support for end-user planning and decision support. This work included an optimization of the OE "end-to-end' data management strategy, to include GIS operations as part of the standard workflow.

- Goal 3: Assess needs regarding continuing GIS operations support and implementation of mapping technology currently in place.

  Progress: ON-GOING, with continued dedication to enhanced GIS capabilities, enabling data visualization and integration. This on-going work also supports maintenance of core human resource support for end-user planning and decision support.

- Milestones: Original project milestones were to hire an appropriate candidate (by June 2012), with completion of Goals 1-2 by June 2013. Beyond June 2013, the on-going nature of NOAA GIS workflow requires maintenance of Goal 3.

  Progress: ALL MILESTONES MET by preferred completion date(s). Milestone for Goal 3 is on-going.

Description of significant research results, protocols developed, and research transitions

Protocols include working within the Integrated Products Team (IPT) to continually update NOAA's Okeanos Atlas, an interactive, geospatial application that provides access to data information corresponding to exploration missions conducted aboard the R/V Okeanos Explorer (OKEX). Typically, these protocols involve Google map overlays which are created from a geotif using bathymetric (multibeam) and CTD data products collected from OKEX missions (accomplished using ArcMap to create a .png product). It is a cumulative product, where the geotif being overlaid is updated manually every day during a cruise and added to the map (i.e. Okeanos Atlas). Standard protocols also include working with the chief programmer to write a Standard Operating Procedure (SOP) for thinning raw SCS ship track navigation data. This procedure produces a thinned ship track .kml overlay in Google Earth. The process initiates a python script to reduce data points along a cruise track, which greatly reduces the .kml file size. This is a high priority for OER and currently, there is no standard operating procedure to implement the thinning algorithm. This project, in part, serves to rectify that shortfall.

Information on collaborators / partners:

None beyond the NGI/NOAA collaboration with the University of Southern Mississippi (USM), as the grantee.

Information on any outreach activities: None Reported

NOAA sponsor and NOAA office of primary technical contact: Russ Beard, NESDIS

Related NOAA strategic goals: Healthy Oceans, Resilient Coastal Communities and Economies

Related NOAA enterprise objectives: Science and Technology, Engagement

NGI FILE #12-NGI2-36

Project Title: Enhancing the Mississippi Digital Earth Model

Project Lead (PI) name, affiliation, email address: Scott A. Samson, GRI, ssamson@gri.msstate.edu

Co-PI(s) name(s), affiliation, email address: Robert Moorhead, GRI, rjm@gri.msstate.edu

Project objectives and goals

The Mississippi Digital Earth Model (MDEM) comprises two components: (1) geospatial education and outreach and (2) spatial data compilation.

The GEO (Geospatial Education and Outreach) Project was charged with the development and implementation of educational programs throughout local and state government agencies in Mississippi. The government workforce is becoming increasingly technologically competent in the utilization of the geospatial applications derived from NGI research activities.

The majority of the funding for this project is used in support of the development of a seamless, state-wide road centerline GIS database. The road centerline database is one of seven framework layers as defined by the Federal Geographic Data Community's National Spatial Data Infrastructure.

Description of research conducted during the reporting period and milestones accomplished and/or completed

The Geospatial Education and Outreach (GEO) Project was developed in response to the limited availability of geospatial data needed by first responders immediately following Hurricane Katrina of August 29, 2005. An assessment was conducted of the educational needs of Mississippi's local governments, especially the localities in the southern portions of the state most susceptible to the effects of hurricanes. A series of intensive 2, 3 and 5 day workshops were compiled that would provide a strong foundation in the fundamentals and applications of GIS. Courses offered range from basic concepts of GIS to advanced, enterprise database management systems. Technical assistance is provided to local governments following classroom preparation as a means to increase the success rate of implementation of GIS in the work place.

Mississippi legislation adopted in 2003 allocates public sector responsibilities for (1) research and education and (2) implementation in remote sensing and geographic information systems. The law's coordination has uniquely positioned Mississippi to leverage federal, state, and local funds to become the national leader in this rapidly evolving technology. The law created the Mississippi Coordinating Council for Remote Sensing and Geographic Information Systems to "set and assure enforcement of policies and standards to make it easier for remote sensing and geographic information system users around the state to share information and to facilitate cost-sharing arrangements to reduce the costs of acquiring remote sensing and geographic information system data." The law requires the Mississippi Department of Environmental Quality (MDEQ) to develop seven base data layers of geographic information for the state, referred to as the Mississippi Digital Earth Model (MDEM).

The Mississippi Digital Earth Model is composed of seven framework layers as defined by the Federal Geographic Data Community's National Spatial Data Infrastructure. Data for the MDEM is acquired and managed through joint operations between the Mississippi Department of Environmental Quality and the Mississippi Department of Information Technology Services. The on-going program will be largely self-funded in the long term because of coordinating regular governmental and agency data acquisition plans and efficiencies in coordinating statewide data purchases. In the near term, however, federal funding to help transition research results into an operational implementation in developing the initial data layers and an efficient data delivery system will be necessary.

Milestones Accomplished:

a. Since July 1, 2011, 59 workshops were delivered to 553 participants representing municipalities, counties and state agencies across Mississippi. Technical assistance in the implementation and use of geospatial technologies was provided to many of the workshop participants who established GIS and associated technologies in their respective workplaces.
b. Mobile GIS applications are currently in development for Mississippi state and local governments. After software is tested and evaluated by end users the source code will be made available to the public. The intent of the mobile GIS applications is (1) take GIS out of the office and into the field and (2) provide source code to other potential end users.
c. The Mississippi Department of Environmental Quality has been acquiring, processing and assessing the QA/QC of over 23,000 miles of high-resolution road centerline geospatial data from 24 counties in Mississippi. The completed databases are made available to the public through the Mississippi Geospatial Clearinghouse (http://www.gis.ms.gov).

Description of significant research results, protocols developed, and research transition
This project is focused on outreach, education and data acquisition. There is no research component.

The Extension Service model of the land-grant university is used to assist in technology transfer. Workshops, presentations and on-site assistance have been proven to be effective in educating the citizens of Mississippi. A network of county extension offices and state-level specialists provide efficient support in a wide range of areas, such as crop production, youth development through 4-H and geospatial technologies.

Information on collaborators / partners:

Name of collaborating organization: Mississippi Department of Environmental Quality
Date collaborating established: July 1, 2009
Does partner provide monetary support to project? Amount of support? None reported
Does partner provide non-monetary (in-kind) support? Yes
Short description of collaboration/partnership relationship: The Mississippi Department of Environmental Quality (MDEQ) has been given the charge by the State of Mississippi to develop the 7 National Spatial Data Infrastructure (NSDI) layers for the Mississippi

Digital Earth Model (MDEM). A subcontract was issued from this project to support MDEQ with their tasks.

Information on any outreach activities:

Workshops and training: The GEO Project curriculum consists of 8 courses in GIS applications and geospatial database management. Thirty-one, 2 and 3 day workshops with 290 participants were held at 10 locations across the state (Table 13). A detailed listing of the workshops is presented on the following pages.

NOAA sponsor and NOAA office of primary technical contact: Nicholas (Miki) Schmidt, NOS

Related NOAA strategic goals: Weather-Ready Nation, Resilient Coastal Communities and Economies

Related NOAA enterprise objectives: Engagement

Table 13. Workshops presented during reporting period, July 1,2012-June 30, 2013.

Course Name	Date	Location	Number of Participants
Working with ArcGIS Spatial Analyst	June 13, 2013	NASA Stennis Space Center	6
ArcGIS I: Introduction to GIS	June 5, 2013	Holmes Community College	6
Building Geodatabases	May 23, 2013	NASA Stennis Space Center	8
ArcGIS II: Essential Workflows	May 23, 2013	NASA Stennis Space Center	6
ArcGIS I: Introduction to GIS	May 7, 2013	Mississippi Emergency Management Agency	9
Introduction to Geoprocessing Scripts Using Python	May 1, 2013	NASA Stennis Space Center	12
ArcGIS I: Introduction to GIS	April 24, 2013	NASA Stennis Space Center	5
ArcGIS II: Essential Workflows	April 16, 2013	Holmes Community College	12
Introduction to ArcGIS Server	March 19, 2013	NASA Stennis Space Center	10
ArcGIS I: Introduction to GIS	March 5, 2013	Holmes Community College	12
ArcGIS II: Essential Workflows	February 22, 2013	Desoto County Extension Service Office	12
ArcGIS I: Introduction to GIS	February 21, 2013	Copiah-Lincoln Community College	12
ArcGIS II: Essential Workflows	February 7, 2013	NASA Stennis Space Center	10
ArcGIS I: Introduction to GIS	January 31, 2013	Desoto County Extension Service Office	11
ArcGIS I: Introduction to GIS	January 23, 2013	NASA Stennis Space Center	8
Building Geodatabases	January 10, 2013	Desoto County Extension Service Office	6
ArcGIS Desktop III: Workflow and Analysis (10)	December 5, 2012	NASA Stennis Space Center	9
ArcGIS Desktop III: Workflow and Analysis (10)	December 5, 2012	Mississippi Gulf Coast Community College	7
Working with ArcGIS Spatial Analyst	November 29, 2012	NASA Stennis Space Center	9

Table 13. (Continued) Workshops presented during reporting period, July 1,2012-June 30, 2013.			
ArcGIS Desktop II: Tools and Functionality (10)	November 21, 2012	Tupelo City Hall	12
ArcGIS Desktop III: Workflow and Analysis (10)	November 1, 2012	Desoto County Extension Service Office	10
Introduction to Geoprocessing Scripts Using Python	October 26, 2012	Desoto County Extension Service Office	12
Introduction to Geoprocessing Scripts Using Python	October 24, 2012	Desoto County Extension Service Office	12
ArcGIS Dekstop II: Tools and Functionality (10)	October 18, 2012	Desoto County Extension Service Office	11
ArcGIS Dekstop I: Getting Started with ArcGIS (10)	October 17, 2012	MGCCC Estuarine Education Center	9
ArcGIS Dekstop II: Tools and Functionality (10)	October 4, 2012	MSU Science and Technology Center	6
ArcGIS Dekstop I: Getting Started with ArcGIS (10)	September 27, 2012	Desoto County Extension Service Office	12
ArcGIS Desktop I: Getting Started with ArcGIS (10)	September 12, 2012	MSU Science and Technology Center	9
ArcGIS Dekstop I: Getting Started with ArcGIS (10)	August 15, 2012	Tupelo City Hall	12
ArcGIS Dekstop I: Getting Started with ArcGIS (10)	August 1, 2012	Mississippi Museum of Naural Science	9
ArcGIS Desktop II: Tools and Functionality (10)	July 12, 2012	Mississippi Emergency Management Agency	6
			Total: 290

NGI FILE #12-NGI2-37

Project Title: Time-Series and Underway Assessments of Ocean Acidification and Carbon System Properties in Coastal Waters

Project Lead (PI) name, affiliation, email address: Stephan D. Howden, USM, stephan.howden@usm.edu

Co-PI(s) name(s), affiliation, email address: Robert Byrne, USF, byrne@marine.usf.edu, Wei-jun Cai, UGA, wcai@uga.edu

Project objectives and goals

This project involves a close collaboration with NOAA scientists to provide information critical to NOAA's mission and global concerns regarding ocean acidification and its impacts on ecosystems. Time-series observations of coastal ocean pH and carbon system properties in the Gulf of Mexico (GoM) and the South Atlantic Bight (SAB) are being conducted by partnerships between NOAA and the University of Southern Mississippi (USM) and the University of Georgia (UGA) (Fig. 32), augmented by a more extensive mapping of pCO2 in the GoM and the southeastern U.S. coast via underway measurements using ships of opportunity by the University of South Florida (USF).

Figure **32**. Locations of buoys with NOAA/PMEL MAPCO$_2$ systems. USM operates a buoy in the GoM, UGA collaborates with the NOAA/NDBC buoy in the SAB, and UNH and NOAA/PMEL operate a buoy in the GoME. The UNH project is now funded separately

Description of significant research results, protocols developed, and research transitions

Buoy Reconditioning

During the reporting period the CenGOOS buoy USM3m01 underwent extensive reconditioning including painting, wiring, new batteries, new solar panels, and new or refurbished and recalibrated instruments. The two 3-m discus buoys had originally been delivered to USM without a standard wiring system. This made for more difficult troubleshooting and repairs. More importantly at-sea troubleshooting was more difficult. An extensive re-wiring was done, and it was done in such a way that if components use the same connector then any cable with the same connectors can be used. All new cabling was made. Among the previous problems, there was no standard use of male and female connectors along wiring runs from instruments to the data-logging computer.

At various times in the reconditioning process we had failure of components in the old power system. All of the regulators for the solar panels were found to have some problems during burn-in testing and had to be replaced. All of the solar panels required replacement.

A serial-port expansion board failed in early April. This is a circa 2003 board and a replacement took a few weeks to obtain. This was preferable to revising the buoy code.

The refurbished buoy undergoing burn-in testing is shown in Fig. 33. The entire USM instrument package is in operation with the CTD in a bucket of water on the buoy deck. The ADCP is behind the buoy in this photo. The NOAA/PMEL MAPCO2 system is not running during this testing. It is completely self-contained with its own battery, telemetry and data logger.

Figure 33. Buoy running a burn-in test at the USM Oceanographic Support Facility at Stennis Space Center, MS

Scheduling a vessel to deploy the buoy has been problematic. The R/V Pelican is booked through October. We were able to get on the schedule of Matthews Brothers, Inc to deploy the buoy during the second week of May, but they recently postponed until late June. They have done two deployment/recovery cruises for us and do a very good job. We are looking at some other alternatives for May, but the fall-back plan is to deploy in June. It is important to ensure that the recovery/deployment vessel can do so in a safe manner. Matthews Brothers has demonstrated that they are very competent in buoy operations, especially with buoys outfitted with scientific equipment.

Water Sampling

During the reporting period three sampling cruises were taken to the CenGOOS buoy location. These were 15 October 2012, 27 February 2013 and 14 May 2014. On each cruise, water samples were collected using a horizontal Niskin water sampler. We sample from surface waters, the mid section (sampling depth 10 m) and 0.5 m above bottom (sampling depth 19.5 m). From each depth, Winkler DO and DIC (+pH and alkalinity) samples are collected first, followed by salinity samples. The remaining water is collected in a 2 L bottle, transferred and processed in the lab for Chl-a and nutrient samples. Concurrent with the water samples, a SeaBird CTD profile (S, T, DO) and a Troll 9500 depth profile (pH, Turbidity) is run between surface and bottom. Ancillary measurements of net primary productivity (netPP) and respiration (RESP) are also measured during the visit to the buoy site, using the Optode DO incubator method (Gundersen & Vandermeulen, in prep). The next scheduled sampling will be done on the buoy deployment cruise.

University of Georgia Subcontract

The University of Georgia team has continued to maintain the MAPCO2 system (including a pH instrument) on the NDBC buoy at Gray's Reef. The entire time series of xCO2 on either side of the air-sea interface, and subsurface pH, are shown in Fig. 34. The same data for the 30 d period ending on 08 June, 2013 is shown in Fig. 35. Due to Dr. Cai's move from UGA to the University of Delaware during the reporting period, there were delays in completing the other aspects the UGA portion of the project. A description of the delays and how the work will be completed are included in a No-Cost Extension (NCE) request that is one file and has been approved.

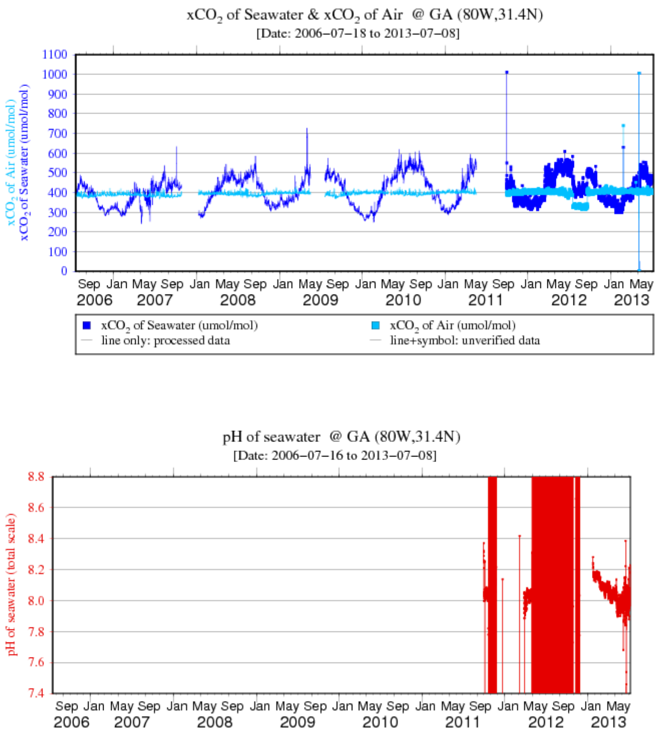


Figure 34. Data from Gray's Reef from 2006, through the reporting period, and up until 08 June 2013.

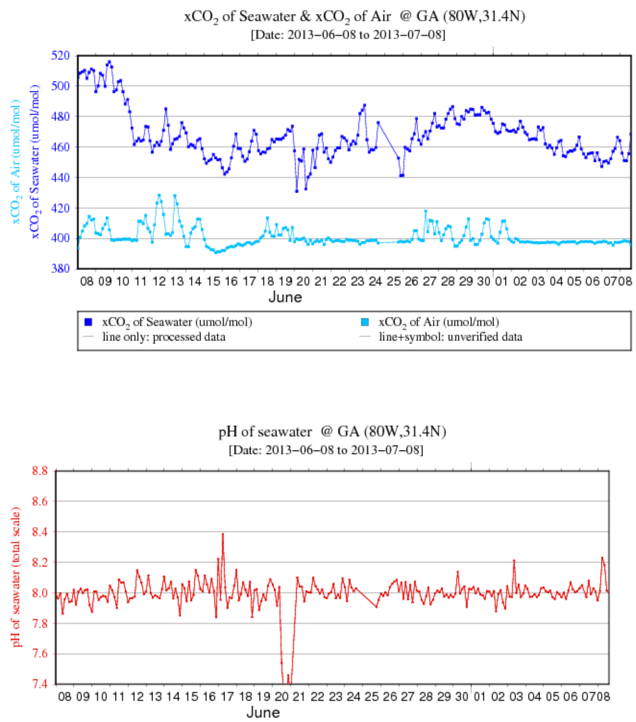


Figure 35. Data from Gray's Reef for 30 day period ending on 08 June 2013.

University of South Florida Subcontract

Dr. Robert Byrne, the Co-I from USF requested NCE for his shipboard work. The NCE request on file details the reasons for the delay and how the work will be accomplished.

Information on collaborators / partners:

The USM-NOAA/IOOS-GCOOS project *Central Gulf of Mexico Ocean Observing System* (PI Stephan Howden) provides buoy platforms for the NOAA/PMEL MAPCO2 systems in the Mississippi Bight. That project paid NOAA/NDBC to modify a 3-m discus buoy aluminum hull to house the MAPCO2 system, and pays for most of the O&M for the buoy platform. This collaboration has existed since the beginning of the project.

Oceanic, Coastal and Estuarine Observing Networks: North Atlantic Ocean, East and Gulf Coasts. PI: Dr. Rik Wanninkhof (NOAA/AOML). Co-I's: Dr. Anne Michelle Wood (NOAA/AOML), Dr. Christopher Sabine (NOAA/PMEL), Dr. Richard Feely (NOAA/PMEL) and Dr. Jon Hare (NOAA/NMFS/NEFSC).

- Gulf of Mexico and East Coast Carbon Cruise -2 July 21-August 13. AOML Chief Scientists: Rik Wanninkhof (AOML) Michele Wood (AOML).
- Funding for present project through the Northern Gulf Institute

This collaboration has existed since the beginning of the project. The collaborators provide in-kind support through data sharing and contributions to analyses (AOML and PMEL) as well as in-kind support through supplying and maintaining the MAPCO2 system for the buoy.

The NASA funded project *Assessing Impacts of Climate and Land Use Change on Terrestrial-Ocean Fluxes of Carbon and Nutrients and Their Cycling in Coastal Ecosystems,* (PI: Stephan Howden) provides partial funding for ship-time for buoy recovery and deployment.

The NOAA/NGI project *Waveglider Pilot Project in Support of the NOAA Ocean and Great Lakes Acidification Research Implementation Plan* (PI: Stephan Howden) resulted in two deployments of the MBARI/Liquid Robotics Ocean Acidification Wave Glider. The mission track (Figure 4) was chosen to partially follow stations of the GOMECC-2 cruise (Figure 3). The first deployment was on October 15, 2012 at the CenGOOS buoy mooring site. A couple of days after deployment the pH sensor failed, but the other instruments continued to work properly (Figure 5). On October 27 the Wave Glider mast was damaged by a vessel, rendering the CO_2 system ineffective, but navigation was not affected. After that time the sensors were turned off and the glider made its way back to the buoy and was recovered on December 7, 2012. After refurbishment the Wave Glider was redeployed in January 2013 and recovered on February 25, 2013, after making successfully making measurements around the Mississippi River delta and back to the mooring site. This collaboration has existed since the beginning of the Wave Glider project (7/1/2012). In-kind support is provided by supplying pH, CO2 and ancillary data over a portion of the northern Gulf, including the CenGOOS buoy location.

Information on any outreach activities: None Reported

NOAA sponsor and NOAA office of primary technical contact: Libby Jewet, OAR

Related NOAA strategic goals: Climate Adaptation and Mitigation, Healthy Oceans, Resilient Coastal Communities and Economies

Related NOAA enterprise objectives: Science and Technology

NGI FILE #12-NGI2-38

Project Title: Assessing and Coordinating NDBC's Strategic Initiatives Relating to Marine Observing systems

Project Lead (PI) name, affiliation, email address: Monty Graham, USM, monty.graham@usm.edu

Co-PI name, affiliation, email address: Landry Bernard, USM, landry.bernard@usm.edu

Project objectives and goals

As technology continues to evolve at a rapid pace, how does an organization sustain marine observations in a reliable and cost effective manner? There is a need to assess and coordinate the strategic initiatives of NDBC as it relates to Marine Observing Systems. In this era, our dominance in the global economy depends on our ability to understand the ocean and to provide guidance from sustained marine observations on warning and forecasts for a Weather-Ready Nation. Results from these analyses will be incorporated into NDBC's plans.

Description of research conducted during the reporting period and milestones accomplished and/or completed

During this period, two significant strategic planning documents were prepared and currently are being implemented as funding is authorized.

The first strategic document prepared was an update to the 2009 U.S. IOOS National Operational Wave Observations Plan. This new plan was a collaboration between the U.S. Army Corps of Engineers, the Commander Naval Meteorological and Oceanography Command, and the National Data Buoy Center. A paper titled "Revising the IOOS National Wave Observation Plan" by; William A. Birkemeier[1], Landry J. Bernard[3], Robert E. Jensen[1], and Richard Bouchard[2] (U.S. Army Corps of Engineers, Engineer Research and Development Center[1], National Oceanic and Atmospheric Administration, National Data Buoy Center[2], University of Southern Mississippi[3]) was prepared for the U.S. IOOS Summit. This wave plan was updated in to reflect the present state of the wave observation network and revised to better define priority placements and upgrades, and to identify the stations with the longest data records. The revised wave plan, which is based on the existing 200 locations, defines a perimeter Backbone network of observing sites and proposes adding 47 new locations and upgrading the directional wave measurement of 87 stations. Ten Rover Buoys are recommended to be used with one year deployments to evaluate regional wave models so that they can be used as virtual wave gauges. The plan also identifies 60 of the existing US backbone locations with record lengths of 20 years or longer (the longest record is 38 years). These Sentinel Stations are critical to understanding climatic changes to the Nation's wave conditions. In this plan, we also reviewed the status of the nation's wave observation network, present a number of proposed changes and describe a process using wave models and short-term wave sensor deployments to optimize the wave observations in a particular region.

Though not an implementation plan, revising the IOOS Waves plan raised a number of significant issues that will have to be addressed by the ocean observing community and data providers, including:

- How to sustain the existing system in the present economic climate? Long-term 24/7 operational observations at sea are expensive.
- How to prioritize the observations based on an overall network design? The observations serve a wide community but are often funded by individual partners. When funding is cut, an important sensor which many depend on may simply disappear.
- What are the appropriate metrics for prioritization? Distance to ports? Length of data record? Importance to ocean wave forecasting? A process is required to reconcile the priorities of individual sponsors into national priorities.
- How best to capture the use of the existing wave locations so that information can be incorporated into the prioritization and decision making process?
- How to identify and take advantage of new and evolving observation and software technology to increase reliability and accuracy while minimizing costs (capital investment, O&M, and data handling)?
- How to reconcile local and national wave observing requirements?

Many of these questions are not specific to wave observations but apply equally to other IOOS observations.

The second strategic document prepared was a document on NDBC's support to the IOOS Project. This document highlights the results of increased observations over the past 10 years and describes "The Way Forward for the Next Ten Years" in a high level system architectural diagram from data ingest, to data aggregation, through data dissemination.

A paper titled "The NOAA National Data Buoy Center" by; Helmut H. Portmann[1], Landry J. Bernard[2], Joseph Swaykos[1], and Richard L. Crout[1] (National Oceanic and Atmospheric Administration, National Data Buoy Center[1], University of Southern Mississippi[2]) was prepared for the U.S. IOOS Summit. Results of the IOOS and NDBC collaboration are highlighted as follows:

The National Data Buoy Center (NDBC) is a leader in the Federal Backbone efforts of the Integrated Ocean Observing System (IOOS). The network has expanded from approximately 100 to 250 NDBC-owned platforms and an additional 500 IOOS Partners platforms that provide additional data. The expansion of the data capacity allows for more data to be available to users. Plans are in place to continue to support IOOS by expanding the number of IOOS Partners, as well as the services provided by the Partners.

The Way Forward for NDBC for the Next Ten Years is described below:

With data available to all in a standard format, provided at regular intervals at a reliable location, users can build their own products and services to provide to local and regional customers (Fig. 36). NDBC will continue to support US IOOS objectives. Core variables useable by NOAA will continue to be acquired, quality controlled, and disseminated. NDBC has shown the capability to take data that are not necessarily "core" to the NOAA mission and provide them on a non interference basis. The infrastructure will be used to produce an economy of scale, where data can be transported because the system exists and can handle additional data.

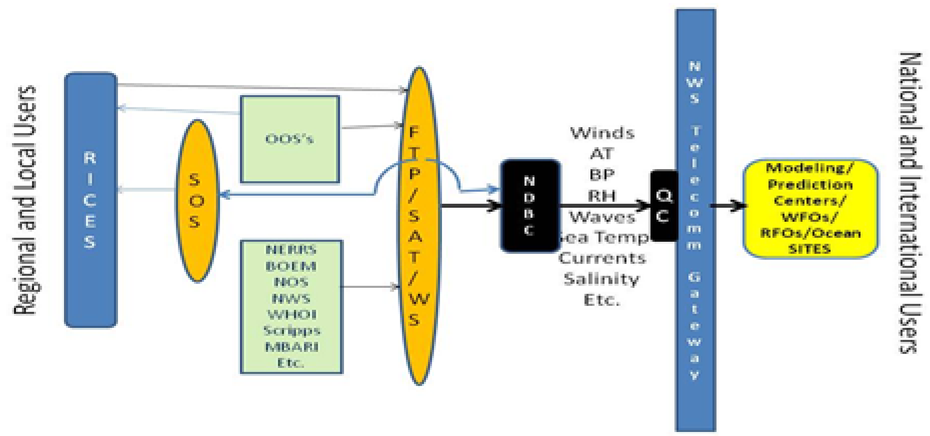


Figure 36. The functional diagram of NDBC's data aggregation and dissemination architecture.

Description of significant research results, protocols developed, and research transitions

Over the past several years, NDBC has worked the Research to Operations (R2O) of the Tropical Atmosphere Ocean (TAO) Array. The TAO Array was developed by NOAA's OAR Lab, PMEL, and is being transitioned to NOAA's NWS NDBC for operational usage. This R2O transition has followed a modified spiral approach in addition to following the Ten Climate Principles for all systems used to measure, collect, and analyze climate quality data.

To document some aspects of the TAO R2O results using the Climate Principles, a paper titled "Internal Wave Signatures in the Tropical Atmosphere Ocean Array from Paired Moorings" by Richard Crout[1], Lex LeBlanc[1], Dawn Petraitis[1], and Landry Bernard[2] (National Oceanic and Atmospheric Administration, National Data Buoy Center[1], University of Southern Mississippi[2]) was published for the MTS/IEEE OCEANS 2012 Conference. The approach and results of this research were as follows:

In order to replace obsolescent sensors in the Tropical Atmosphere Ocean (TAO) array and comply with the Ten Climate Principles, twenty-nine TAO Refresh buoys were deployed near paired TAO Legacy buoys for approximately one year each. At the end of each deployment, a statistical comparison of the daily averaged data was conducted for each pair of sensors. The results are summarized elsewhere. The subsurface ocean temperature sensor comparisons provided some unexpected results. While the average ocean temperature differences within the mixed-layer and at depth were nearly identical, average temperature differences in the thermocline were higher than expected and not within the statistical accuracy of the sensors. A comparison of the variability of the paired ocean temperature sensors and the amount of drift that occurred during each deployment led to the conclusion that the TAO Refresh sensors were reporting the same oceanographic phenomena as the TAO Legacy sensors.

Closer examination of the high resolution (10-minute interval) ocean temperature data within the thermocline exhibited internal wavelike signatures. At some locations within the water column, the temperature at a single depth changes 10 Kelvins over a period of 10 minutes. Although this is an extreme example, it indicates the difficulty in comparing the data from sensors on moorings which were generally less than 5 kilometers apart. The internal wavelike signatures range from small to greater than 100 meter amplitudes. Attempts to apply a phase shift to the data to compensate for the movement of these features were unsuccessful, suggesting that the internal wave signatures were arriving from different directions at various times. These phenomena are prevalent throughout the TAO array.

The deployment of Refresh buoys adjacent to TAO Legacy buoys provides the opportunity to investigate other phenomena in the central Pacific Ocean, in addition to the El Nino and La Nina. Internal waves are found at all TAO mooring locations investigated. They are most prevalent in the late summer, but do occur throughout the year at most locations.

A total of 27 operational refresh systems have been deployed. Three have been recovered and replaced, resulting in 24 operational Refresh sites of the 55 TAO locations. One buoy was vandalized and is adrift and three are not currently transmitting. The remainder of the TAO array will be refreshed over the 2013-2015 time period. These Refresh deployments will continue the accumulation of information for investigation of the equatorial Pacific Ocean and how it interacts with the global system.

Information on collaborators / partners:

In order to assess and coordinate NDBC's strategic initiative, several documents and numerous meeting with strategic partners were conducted. Collaboration with all NOAA Line Officers, other government both Federal and State Officers, and the private sector were conducted in the review and comment portion of the preparation of the research documents discussed above.

Information on any outreach activities:

To facilitate the review of the updated National Wave Plan, two papers were prepared and presented.

This paper was presented at the IOOS Summit.

1. "Revising the IOOS National Wave Observation Plan" by; William A. Birkemeier[1], Landry J. Bernard[3], Robert E. Jensen[1], and Richard Bouchard[2]

    (1) U.S. Army Corps of Engineers, Engineer Research and Development Center[1]

    (2) National Oceanic and Atmospheric Administration, National Data Buoy Center[2]

    (3) University of Southern Mississippi[3]

This paper was presented at the MTS/IEEE Oceans 2012 Conference.

2. “IOOS Wave Observations, a National Perspective” by; William A. Birkemeier[1], Landry J. Bernard[3], Robert E. Jensen[1], and Richard Bouchard[2]

   (1) U.S. Army Corps of Engineers, Engineer Research and Development Center,

   (2) National Oceanic and Atmospheric Administration, National Data Buoy Center[2]

   (3) University of Southern Mississippi[3]

In the “significant research” section of this report, the R2O transition of TAO was discussed. In addition to the TAO paper, which was also presented at the MTS/IEEE Oceans 2012 Conference, the results of the R2O transition status were briefed at the DBCP XXVIII Science & Technology Workshop.

1. “Progress in Refreshing the Tropical Atmosphere Ocean (TAO) Array” by; Richard Crout[1], Dawn Petraitis[1], Lex LeBlanc[1], Landry Bernard[2], Karen Grissom[1]

   (1) *U.S. Army Corps of Engineers, Engineer Research and Development Center[1]*

   (2) *National Oceanic and Atmospheric Administration, National Data Buoy Center[2]*

NOAA sponsor and NOAA office of primary technical contact: Kathleen O’Neil

Related NOAA strategic goals: Climate Adaptation and Mitigation, Weather-Ready Nation, Resilient Coastal Communities and Economies

Related NOAA enterprise objectives: Science and Technology

APPENDIX A. PUBLICATION DOCUMENTATION

All items listed are under award number NA11OAR4320199.

Table 14. Publications and presentations completed during the reporting period

Amend Number	Forum	Date	Vol	Pages	Citation
08	***Project Title: Applications of Advanced Satellite Microwave Radiances and Retrieval Products to NWP and Climate Studies***				
	J. Atmos. Sci.	Jul 2012	69	3670-3682	10.1175/JAS-D-11-0199.1
	IEEE Trans. Geosci. Remote Sens.	Dec 2012	50	4994-5003	10.1109/TGRS.2012.2191792
	Antarct. Sci.	Jan 2013	24	507-513	10.1017/S0954102012000417
	Appl. Opt.	Jan 2013	52	505-508	10.1364/AO.52.000505
	IEEE Trans. Geosci. Remote Sens.	Feb 2013	99	1-10	10.1109/TGRS.2012.2230634
09	***Project Title: Toward Operational Uses of Geostationary Imagery and FY-3 Polar Orbiting Microwave Radiance Data in the GIS Analysis System***				
	IEEE Trans. Geosci. Remote Sens.	Dec 2012	50	4892-4902	10.1109/TGRS.2012.2202122
	IEEE Trans. Geosci. Remote Sens.	Dec 2012	50	4986-4993	10.1109/TGRS.2012.2197003
	IEEE Trans. Geosci. Remote Sens.	Dec 2012	50	4860-4874	10.1109/TGRS.2012.2200687
	IEEE Trans. Geosci. Remote Sens.	Dec 2012	50	4875-4884	10.1109/TGRS.2012.2196438
	Mon. Weather Rev.	Jan 2013	141	75-92	10.1175/MWR-D-12.00079.1
18	***Project Title: Ecosystem Approach to Management for the Northern Gulf***				
	Indicators/DPSER Analyses-NGI	Jul 2012	-	-	-
	NGI's Ecosystem Modeling Vision and Plans	Jul 2012	-	-	-
	TroSim Modeling	Jul 2012	-	-	-
	IEA for the Northern Gulf	Feb 2012	-	-	-
	TroSim Modeling of Mississippi Sound	Feb 2012	-	-	-
19	***Project Title: Wave Glider Pilot Project in Support of the NOAA Ocean and Great Lakes Acidification Research Implementation Plan***				
	Gulf of Mexico Oil Spill and Ecosystem Science Conference	Jan 2013	-	-	-
	Arctic Monitoring ad Assessment Programme	May 2012	-	-	-
20	***Project Title: Climate Variability in Ocean Surface Turbulent Fluxes***				
	Bulletin of the American Meteorologica Society	Mar 2013	94	403-423	10.1175/BAMS-D-11-00244.1
	Joural of Atmospheric and Oceanic Technology	Jul 2012	29	822-833	10.1175/JTECH-D-11-00165.1
	CLIVAR Workshop Summary Report	Jun 2012	-	-	-
	Atmospheric Observation Panel on Climate XVIII	Apr 2013	-	-	-
	CLIVAR Global Synthesis and Observations	Nov 2012	-	-	-
	Fall American Geophysical Union Meeting	Dec 2012	-	-	-

Amend Number	Forum	Date	Vol	Pages	Citation
21	***Project Title: U.S. Reserch Vessel surface Meteorology Data Assembly Center***				
	Sea Technology	Jun 2013	53	21-24	0093-3651
	2012 SAMOS Data Quality Report	Apr 2013	-	-	-
	NOAA Ocean Climate Observation 8th Annual PI Meeting	Jun 2013	-	-	-
	Deep-C All Hands Meeting	Aug 2013	-	-	-
	AGU Annual Meeting	Dec 2013	-	-	-
	7th session of the JCOMM Ship Observation Team	Apr 2013	-	-	-
	Bulletin of the American Meteorological Society	Mar 2013	94	403-423	10.1175/BAMS-D-11-00244.1
26	***Project Title: Gulf Hypoxia Model Transition and Glider Implementation Panel Support***				
	Gulf Hypoxia Model Transition and Glider Implementation Panel Support Workshop	Apr 2012	-	-	-
28	***Project Title: Persistence of Microbial Indicators, Source Tracking Markers, Pathogens, and their Molecular Signatures in Gulf Beach Waters***				
	Annual Meeting of the American Society of Microbiology	May 2013	-	-	-
31	***Project Title: Determination of Habitat Use and Movement Patterns between Physical and Ecological Process in the Gulf of Mexico and Caribbean***				
	Annual Banquet of the American Fisheries Society East Carolina University Student Subunit	Mar 2013	-	-	-
	Coastal Resource Management Seminar Series, East Carolina University	Mar 2013	-	-	-
	Biology Seminar, University of West Florida	Mar 2013	-	-	-
	Science Café, Thomas University, Thomasville, FL	Feb 2013	-	-	-
	Panhandle Area Educational Consortium-Florida Learns, Tallahassee Community College	Feb 2013	-	-	-
	Project Learning Tree, Riversink Elementary, Crawford, FL	Nov 2012	-	-	-
	WIMSE (Women in Math, Science, and Engineering)	Oct 2012	-	-	-
	Science Café sponsored by National High Magnetic Field Laboratory, Tallahassee, FL	Oct 2012	-	-	-
	Franklin County Library Presentation	Sep 2012	-	-	-
	The Nest- Franklin County Learning Center, East Point, FL	Sep 2012	-	-	-

Amend Number	Forum	Date	Vol	Pages	Citation
33	***Project Title: Increasing our understanding of the interaction between physical and ecological processes in the Gulf of Mexico and Carribean***				
	Deep-C All Hands Meeting	Aug 2012	-	-	-
	Physical Oceanography Dissertation Symposium	Oct 2012	-	-	-
	NOAA-AOML	Oct 2012	-	-	-
	FSU Oceanography Thalassic Society Student Symposium	Oct 2012	-	-	-
	Departmental semiar and dissertation defense, FSU	Feb 2013	-	-	-
	Deep-C All Hands Meeting	Feb 2013	-	-	-
	Invited speaker at North Carolin State University	Feb 2013	-	-	-
	Fish and Wildlife Conservation Commission Division of Marine Resources	Apr 2013	-	-	-
	Gordon Research Seminar	Jun 2013	-	-	-
	Gordon Research Conference	Jun 2013	-	-	-
34	***Project Title: Bias Characterization and Hurricane Initialization using ATMS, SSMIS, and AMSR-2***				
	J. Geophys. Res.	Oct 2012	117	D19112	10.1029/2012JD018144
	IEEE Trans. Geosci. Remote Sens.	Feb 2012	99	10-Jan	10.1109/TGRS.2013.2250981
37	***Project Title: Time-Series and Underway Assessments of Ocean Acidification and Carbon System Properties in Coastal Waters***				
	NASA Carbon Monitoring System Science Team Meeting	Nov 2012	-	-	-
	American Geophysical Union Fall Meeting	Dec 2012	-	-	-
	Gulf of Mexico Oil Spill and Ecosystem Science Conference	Jan 2013	-	-	-
	North American Carbon Program All-Investigators Meeting	Feb 2013	-	-	-
	ASLO 2013 Aquatic Sciences Meeting	Feb 2013	-	-	-
38	***Title Project: Assessig and Coordinating NDBC's Strategic Initiatives Relating to Marine Observing Systems***				
	IOOS Summit	Nov 2012	-	-	-
	MTS/IEEE OCEANS 2012	Nov 2012	-	-	-
	DBCP XXVIII Science and Technology Workshop	Nov 2012	-	-	-

Table 15. Summary of publications and presentations reported in Table 14

	Institute Lead Author	NOAA Lead Author	Other Lead Author
*Peer-reviewed (18)**	1	3	14
*Non peer-reviewed (80)**	20	8	52

*Numbers are not directly additive from Table 14 because in some instances a single record for a conference represents multiple presentations

APPENDIX B. EMPLOYEE SUPPORT

Northern Gulf Institute Employee Support July 1, 2012 - June 30, 2013 Personnel (DISL, FSU, LSU, MSU, USM combined)				
Category	**Number**	**B.S.**	**M.S.**	**Ph.D.**
>= 50% Support				
Research Scientist	5	1	2	2
Visiting Scientist	4	0	0	4
Postdoctoral Fellow	0	0	0	0
Research Support Staff	7	2	5	0
Administrative	1	0	1	0
Total (>= 50% support)	**17**	**3**	**8**	**6**
Category	**Number**	**B.S.**	**M.S.**	**Ph.D.**
Employees w/ <50% support	29	3	10	15
Category	**Number**	**B.S.**	**M.S.**	**Ph.D.**
Undergraduate Students	7	7	0	0
Graduate Students	18	1	3	14
Category	**Number**	**B.S.**	**M.S.**	**Ph.D.**
Employees/students that receive 100% of their funding from an OAR lab	0	0	0	0
Obtained NOAA employment within the last year	0	0	0	0

APPENDIX C. OTHER AGENCY AWARDS

PI Name	Project Title	Lead NOAA Collaborator	Awarding Agency	Funding Amount
Ritchie, Jarryl B.	Ecosystem Services Provided by Gulf of Mexico Habitats: Tools, Valuation, and Application	N/A	National Oceanic and Atmospheric Administration (NOAA) (DOC) (MSU has a subcontract with Texas A&M)	$9,250.00
Ritchie, Jarryl B.	GOMA web support project	N/A	BP America	$65,000.00
Ritchie, Jarryl B.	GOMA BP Gulf of Mexico Research Initiative Web Support Project	N/A	BP America	$801,105.00
Moorhead, Robert J.	Modeling and Ocean Color Remote Sensing in Oceanic and Coastal Waters	N/A	Naval Research Laboratory (NRL) (NAVY) (DOD)	$295,000.00
Moorhead, Robert J.	Physics-based Ocean-Color Algorithms for Water-Quality Products of Coastal and Inland Waters	N/A	NASA HQ	$54,893.00
			Total	**$1,225,248.00**