



NGI
NORTHERN GULF INSTITUTE
a NOAA cooperative institute

Annual Progress Report

Reporting Period
July 1, 2013 - June 30, 2014

This report was prepared under award NA110AR4320199 to the Northern Gulf Institute by NOAA's Office of Oceanic and Atmospheric Research, U.S. Department of Commerce

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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, 2013 to June 30, 2014. The items in this report cover the research conducted under NOAA 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 a list of all the awards to the NGI of projects that were active during the reporting period. 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 and operational centers in the northern Gulf of Mexico region.

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.

NGI hosts an important conference on an annual basis bringing together NGI researchers and educators with NOAA and other stakeholders in the northern Gulf region. 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).

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 staff is currently exploring the development of distance learning degree and certificate programs targeted at NOAA professionals working on Gulf of Mexico related programs.

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/strategic_plan.php). 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 and meetings.

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 and key stakeholder groups including the NOAA Gulf of Mexico Regional Collaboration Team, regional Sea Grant programs, and the Gulf of Mexico Alliance. The Mississippi State University Science and Technology Center at Stennis Space Center, which houses NGI and NOAA activities, provides NGI with the foundation and the building blocks to maintain and grow its role in northern Gulf of Mexico environmental research and education. NGI increased its international engagement in the Gulf of Mexico with a Memorandum of Agreement with the Consorcio de Instituciones de Investigación Marina del Golfo de México (CiiMar-GoM). Additionally, NGI and the Harte Research Institute signed a Letter of Intent in support of research being conducted by CiiMar-GoM to evaluate ecosystem response to coastal management activities in Mexico.

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 \$12,081,801 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.

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.

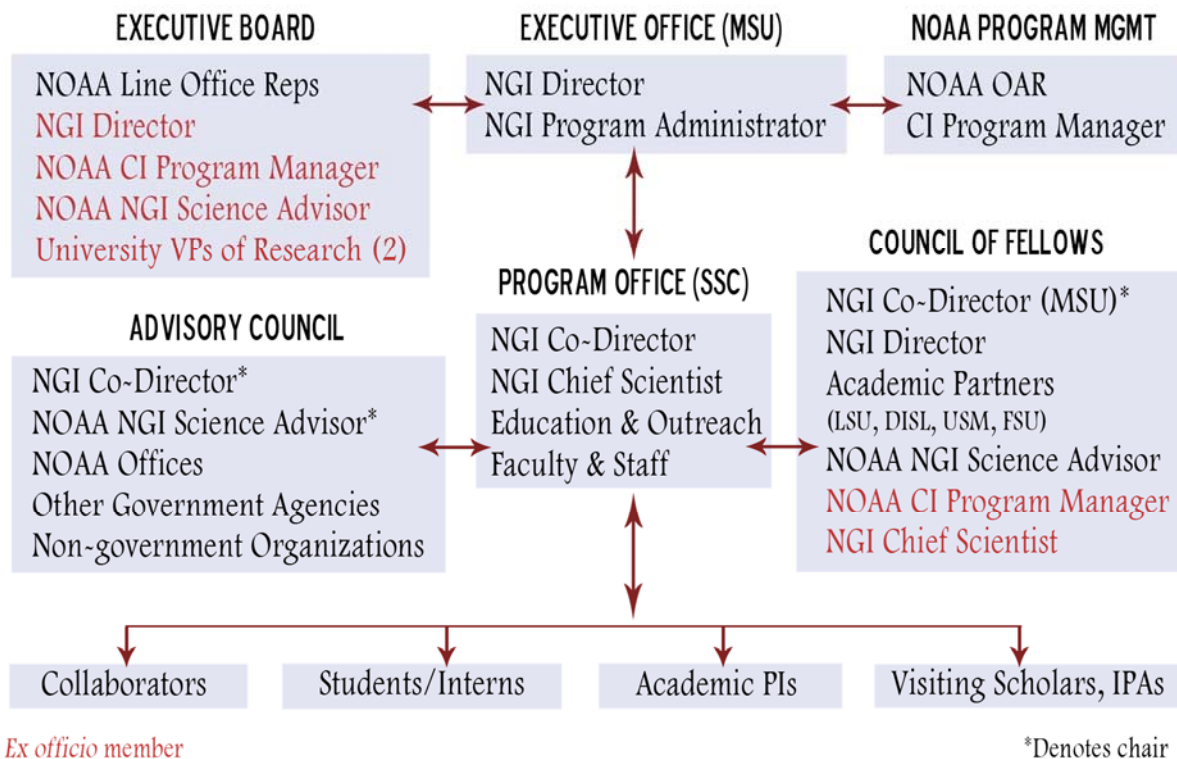


Figure 1. NGI organization diagram

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, 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 Science Officer, 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, 2013 through June 30, 2014, the NGI Council of Fellows consisted of:

- Steve Ashby, 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

The Fellows participate in regular teleconferences to remain up to date between face-to-face 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. 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)
- Margaret Davidson, Acting Director, Office of Ocean and Coastal Resource Management
- 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 (Special Advisor, *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 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
- 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
- Jamie Miller, Mississippi Department of Marine Resources
- Jeff Waters, US Army Corps of Engineers
- Chuck Wilson, Ph.D., GOMRI Chief Scientist

Executive Summary of Important Research Activities

Preliminary research inquiries are yielding promise. Given a short reporting period, findings and accomplishments are surprisingly substantial. Major emphasis is currently on data collection and synthesis and product development for ocean and atmospheric assessments. Examples include:

- Use of autonomous vehicles (ocean wave gliders and unmanned aerial systems) to augment data collection for ocean acidification and river hydrograph forecasting
- Assessment of ocean surface current predictions associated with climate change predictions and applied to fish (larval and adult) movement
- Expanding strategic initiatives relating to marine observing systems in the Gulf of Mexico (e.g., GCOOS). The GCOOS build out plan includes a section on ecological monitoring that is extremely useful for fisheries management and restoration activities.
- The Surface Meteorology Data Assembly Center (SAMOS DAC) continues to provide a high-quality, well-documented, surface underway dataset for use by a diverse community. In the past year, SAMOS data have been used to validate ocean model estimates of the freshwater inflow to the Gulf of Mexico under flood conditions (Androulidakis and Kourafalou 2013) and to examine the influence of the Mississippi River freshwater plume on a surface oil patch in the Gulf of Mexico.

Several projects have been able to develop products for use in continued research by the originating researchers and others in the scientific community. These include:

- ATMS De-Striping Optimal Filter to remove Television Frequency Interference signals that contaminate satellite microwave imager measurements which can result in erroneous retrievals of oceanic environmental parameters
- Operational production of the quick-look 2° tropical Pacific (<http://coaps.fsu.edu/RVSMDC/html/pacmonyqrq.shtml>) and 1° tropical Indian (<http://coaps.fsu.edu/woce/html/ndnquick.htm>) ocean pseudo-wind stress products. Protocols 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.
- Evaluations of Impacts of Assimilation of ATMS Data in HWRF on Track and Intensity Forecasts of 2012 Four Landfall Hurricanes to demonstrate the added benefits of assimilating the Advanced Technology Microwave Sounder (ATMS) radiances in the Hurricane Weather Research and Forecasting (HWRF) system.
- SST algorithms for the VIIRS sensor were tested and evaluated and the OSI SAF Algorithm was selected as the NOAA operational algorithms. The VIIRS ocean color products was shown to produce high quality bio-optical products which can be compared with MODIS satellite.

- A local, regime-dependent cloud mask (CM) algorithm was developed for isolating cloud-free pixels from cloudy pixels for Geostationary Operational Environmental Satellite (GOES) imager radiance assimilation using mesoscale forecast models. Based on MODIS CM results, the average Probability of Correct Typing (PCT) reaches 92.94% and 91.50% over land and ocean, respectively
- Improved Tropical Storm Forecasts with GOES-13/15 Imager Radiance Assimilation and Asymmetric Vortex Initialization in HWRF
- Delivery of and public access to a QA/QC dataset of 10,000 miles of road centerlines for 14 counties in southeastern Mississippi.

Several workshops and outreach activities have been conducted under the funding and goals of NGI.

- Hypoxia Research Coordination Workshop was conducted to advance fisheries ecosystem management in the northern Gulf to inform efforts to assess and predict the potential ecological and socioeconomic effects of diversions and hypoxia. Emphasis was on assessing ecological impacts of diversions on aquatic habitats and potential impacts on the development of hypoxic zones. This is in support NOAA's Ecological Roadmap Initiatives:
 - Action HY2: "Initiate more robust user needs assessment of living resource/habitat impacts" [of Gulf hypoxia] and
 - Action HY8: "Integrate nutrient-based models (water quality management) with living resource models (fisheries management)."
- The NOAA-NGI Diversity Internship Program supported 8 interns at 8 academic and federal locations across the Gulf coast. Interns were from 3 demographic groups underrepresented in NOAA's workforce (African-American, Asian and Hispanic/Latino) and included undergraduate students and Master's candidates. Six of the eight interns were females. Internship activities and focus areas were very diverse. Project areas included water quality – monitoring and stormwater management, fisheries research – groundfish surveys, gut analyses, ichthyoplankton distributions, GIS analyses of landform changes, diatom distribution and abundance in the Gulf of Mexico after the DWH, the use of stable oxygen isotopes as tracers and social science research on the effects of oyster attributes on people's willingness to pay.
- 19 workshops were delivered to 189 participants representing municipalities, counties and state agencies across Mississippi

Distribution of NOAA Funding

NOAA's investment into NGI spans all three NOAA CI tasks as well as each one of NGI's themes, with several projects having multiple themes (Figures 2 and 3).

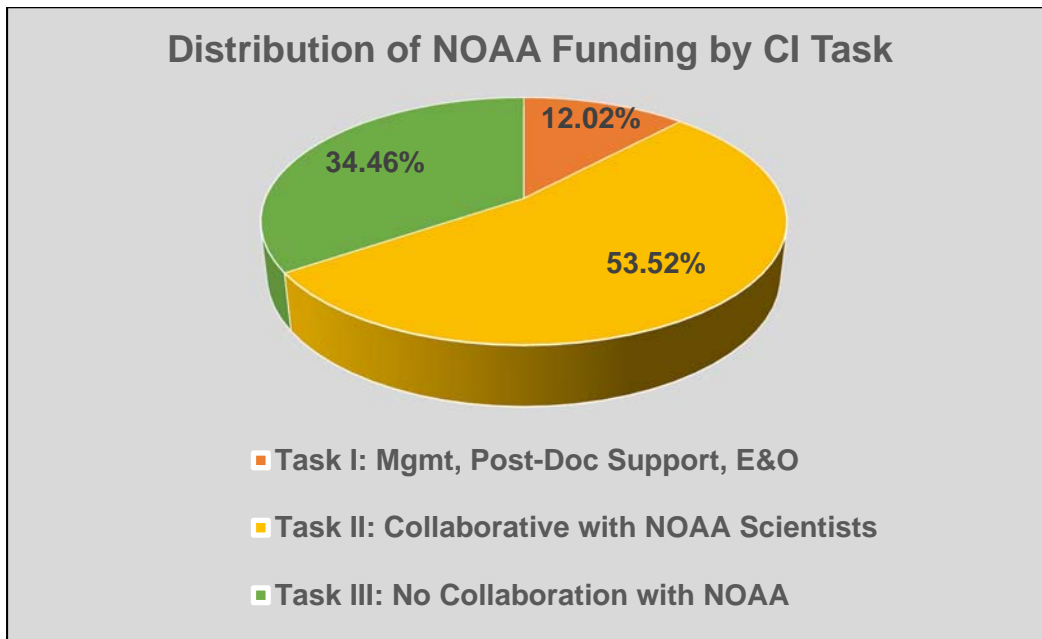


Figure 2. Distribution of NOAA funding by the three cooperative institute task categories.

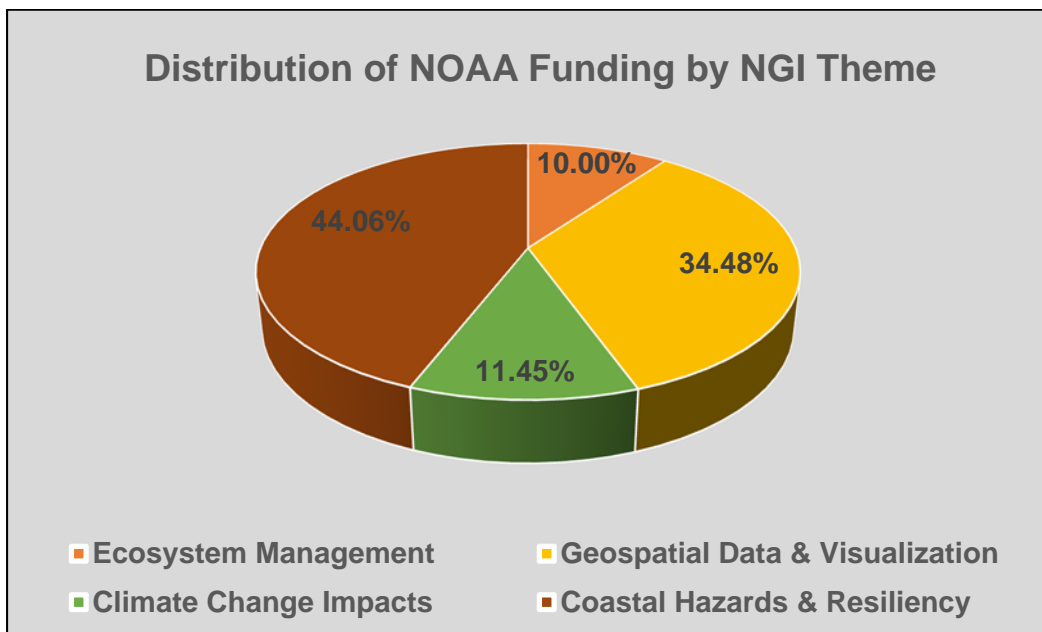


Figure 3. Distribution of NOAA funding by the four NGI themes.

Task I Activities

Task I funding supports the central management and coordination of the five complementary academic partners working together with NOAA. Task I funding during the reporting period was provided by NOAA for the administration of NGI. Funding was used to support the administration of NGI, students, education and outreach, and other research activities (Figure 4). Administration included leading the efforts of the CI as well as program and project management on each of the traditional CI projects that were active during the funding period.

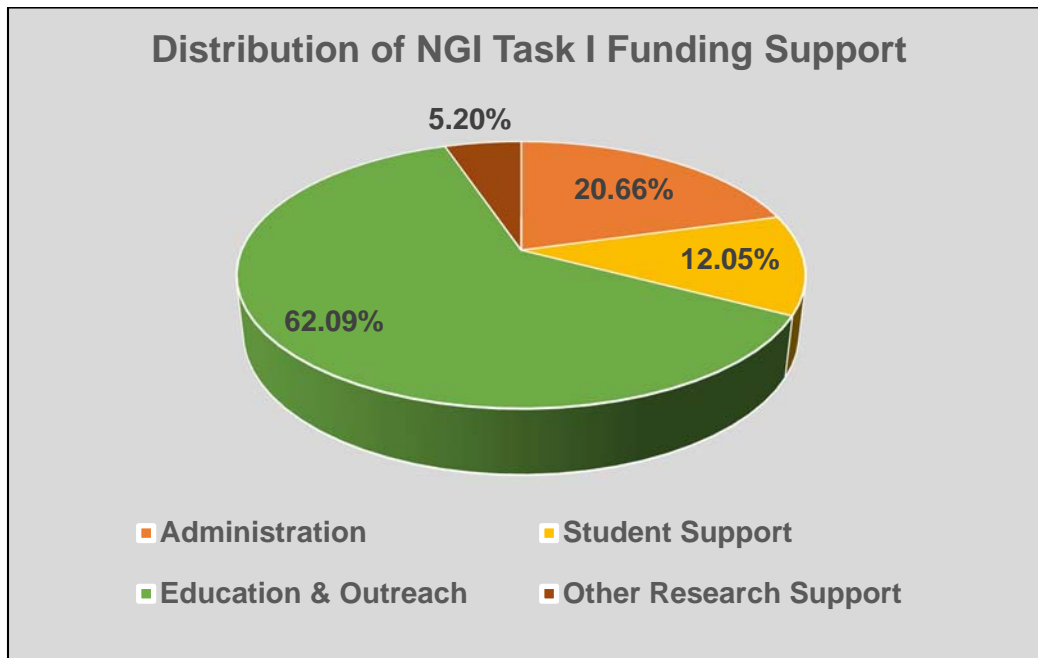


Figure 4. Distribution of NGI Task I funding.

Project List

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

Table 1. Projects for the July 1, 2013 – June 30, 2014 reporting period.

NGI File #	Principal Investigator	Project Title	Page #
11-NGI2-02	Just Cebrian	Monitoring in Small Embayments as Early Warning System for Ecosystem Change on Larger Spatial Scales	17
12-NGI2-16	Steve Ashby	Summer Internship for the NGI Ecosystem Data Assembly Center	21
12-NGI2-17	Vernon Asper	Developing an Enhanced Stereo Camera System for Environmental Monitoring	22
12-NGI2-19	Stephan Howden	Waveglider Pilot Project in Support of the NOAA Ocean and Great Lakes Acidification Research Implementation Plan	25
12-NGI2-22	Steve Ashby	Student Assistance with Statistical Analysis of Meterological and Oceanographic Data	27
12-NGI2-23	Jane Moorhead	Analysis of Engineering Test Data	28
12-NGI2-25	Pat Fitzpatrick	Evaluating Baseline Operational Ocean Surface Current Predictions and Low-member Multi-Model Ensembles in the Gulf of Mexico	32
12-NGI2-28	Shiao Wang	Persistence of Microbial Indicators, Source Tracking Markers, Pathogens, and Their Molecular Signatures in Gulf Beach Waters	36
12-NGI2-33	Eric Chassignet	Increasing our Understanding of the Interaction Between Physical and Ecological Processes in the Gulf of Mexico and Carribbean	39
12-NGI2-35	Scott Milroy	Geospatial Date Visualization and Access for NOAA's Exploration Data Collection	41
12-NGI2-38	Monty Graham	Assessing and Coordinating NDBC's Strategic Initiatives Relating to Marine Observing Systems	43
13-NGI2-39	Xiaolei Zou	Bias characterization and hurricane initialization using ATMS, SSMIS, and AMSR-2	46
13-NGI2-42	Xiaolei Zou	Applications of Advanced Satellite Microwave Radiances and Retrieval Products to NWP and Climate Studies	48
13-NGI2-43	Steve Ashby	Ecosystem Approach to Management for the Northern Gulf	51
13-NGI2-45	Stephan Howden	Time-Series and Underway Assessments of Ocean Acidification and Carbon System Properties in Coastal Waters	57
13-NGI2-46	William Patterson	Data Management in Support of NOAA's Integrated Ecosystem Assessment for the Gulf of Mexico through the NGI	59
13-NGI2-48	Scott Milroy	Development of Geospatial Data Products for NOAA's Exploration Data Collection	61
13-NGI2-49	Mark Bourassa	Climate Variability in Ocean Surface Turbulent Fluxes	63
13-NGI2-50	Bob Arnone	Calibration and Validation of NPP VIIRS - Color and SST Ocean Products for Monitoring Oceans	68
13-NGI2-52	Shawn Smith	U.S. Research Vessel Surface Meteorology Data Assembly Center	76

13-NGI2-53	Shiao Wang	Pilot Genomic Observatories to Characterize Gulf of Mexico Microbial Populations	84
13-NGI2-54	Pat Fitzpatrick	An Examination of Ocean-Forcing Issues in HWRF-POM and HWRF-HYCOM	86
13-NGI2-55	Scott Samson	Enhancing the Mississippi Digital Earth Model (MDEM)	88
13-NGI2-57	Steve Ashby	Lagrangian Based Habitat Assessment for Bluefin Tuna (Thunnus Thynnus) Spawning in the Gulf of Mexico	91
13-NGI2-58	Robert Moorhead	Engineering Studies for NOAA UAS Program	93
13-NGI2-59	Xiaolei Zou	Toward Operational Uses of Geostationary Imagery & FY-3 Polar-Orbiting Microwave Radiance Data in the GSI Analysis System	95
13-NGI2-60	Ken Barbor	Development of Detailed Habitat Maps along the Continental Shelf of the Gulf of Mexico using Previously Collected Multibeam Sonar Data	98
13-NGI2-61	Steve Ashby	Hypoxia Research Coordination Workshop	100
13-NGI2-62	Dean Grubbs	Determination of Habitat use and Movement Patterns for Adult Smalltooth Sawfish	102
13-NGI2-63	Rulth Carmichael	Support of NOAA's Marine Mammal Health and Stranding Response Program (MMSHRP) in the Northern Gulf of Mexico through the NGI: Alabama Marine Mammal Stranding Response	108
13-NGI2-64	Monty Graham	Establishing Secure Long-Term Archival for NOAA/NMFS Preserved Specimens at USM's Plankton Archival Facilities	110
14-NGI2-67	Tina Miller-Way	Northern Gulf Institute Diversity Internship Program	111
14-NGI2-68	Trey Breckenridge	Telepresence and Information Management for Stennis Exploration Command Center	115

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/University of South Alabama, jcebrian@disl.org

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

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

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.

In addition, we used a separate methodology to calculate the contribution of the benthos to total ecosystem metabolism in each of the lagoons. For these metabolism measurements, we placed 20 pairs of clear and dark chambers, and 10 pairs of clear and dark BOD bottles in each of the lagoons. We measured oxygen concentrations at the start and the end of three-hour incubations, including solar noon. We calculated benthic and water column metabolism based on the change in oxygen concentrations over time, expressed all measurements on a square meter basis, and expressed the contribution of the benthos to total ecosystem metabolism on a percent basis.

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 five additional sample rounds from July 1st 2012 to September 30th 2013. During two of these sample rounds (summer and fall

2012), we collected 72 water samples inside and outside the lagoons (for a total of 252 during the entire project). During all 5 sample rounds (summer 2012, fall 2012, winter 2013, spring 2013 and summer 2013) we used benthic chambers and bottle incubations to estimate the contribution of the benthos to total ecosystem metabolism.

- 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 in 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 lagoons.

Our data show significant differences in the contribution of the benthos to total gross primary production between the sites. The relative contribution of the benthos changes over time, but the sites remain consistently different from each other. The relative contribution of the benthos differs between areas covered by seagrass and areas dominated by benthic microalgae, regardless of the degree of disturbance in the sites. The values are highest in the seagrass

beds of State Park and Kees Bayou, and lowest in the bare sediment of Gongora. Despite their shallow depth (0.5-0.8 m), two of our sites were dominated by pelagic production. Only in State Park, the least disturbed site, did the water column contribute to less than 50% of total gross primary production. Benthic respiration follows the same pattern as gross primary production. The contribution of benthic respiration to total ecosystem respiration is highest in the seagrass beds of State Park and Kee's Bayou, and lowest in the sediments of Gongora. However, the contribution of the benthos to total ecosystem respiration is higher than the contribution to total gross primary production. In State Park and in the seagrass bed of Kees Bayou, there is more respiration in the benthos, compared to the overlying water column.

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: None reported

Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology

NGI FILE #12-NGI2-16

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

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

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

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

Completed assisting 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:

- a. Name of collaborating organization: Charles Carlton, NOAA NCDDC
- b. Date collaborating established: July 2011
- c. Does partner provide monetary support to project? Amount of support? Yes, \$20,022
- d. Does partner provide non-monetary (in-kind) support? Yes
- e. Short description of collaboration/partnership relationship: Collaborated on data management activities.

Information on any outreach activities: Products are available to the public.

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, University of Southern Mississippi, vernon.asper@usm.edu

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

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

Project objectives and goals

The goal of this project is to develop an autonomous undersea stereo camera system primarily for the assessment fish populations. The equipment is to be mounted to a mooring and deployed in an area of interest with up to three additional 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 a greater separation – 61cm between lens centers. 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 three glass ports for the stereo cameras and video camera. A mounting system was 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

During the previously documented reporting period, much of the mechanical design and software development were completed. Efforts within this reporting period have been centered on manufacturing the mechanical and electrical systems, completing the acquisition program, and modifying the hardware and software as necessary to fit within the protocols used during typical NMFS surveys.

Machining of the in-house components was conducted at the Mississippi Mineral Resources Institute shop at University of Mississippi as well as the shop of the University's Mechanical Engineering department. Aluminum was machined into the main housing and its end caps, the specialized end caps for the off-the-shelf dome port housings, and the overall mounting frame that keeps the stereo pair indexed. These parts are being anodized by an external company prior to final assembly and delivery.

A notable feature of these custom components are the ability to precisely index the stereo pair of industrial cameras. Internally, the cameras are indexed to their respective end caps. Externally, the end caps themselves are positioned onto the one-piece mounting frame by way of tight-tolerance indexing pins. The housing bodies can be pulled from the end caps that anchor them to the mounting structure when needed for adjusting focus and aperture settings. The third camera in the assembly is the video camera, which occupies the central housing along with the logging computer and support electronics. The cap on the camera-end of the central housing has a recess for a glass port machined into it along with o-ring grooves and a plastic external retainer.

In addition to the manufacturing that was progressing over this period, a pre-delivery meeting was arranged between a representative of the NIUST design team and NMFS personnel from both the engineering and operations groups. A demonstration of the in-progress system was conducted after a two-day training session for 3D fisheries software. Participation in the training session was helpful in that operational considerations of the overall system could be addressed in addition to the predefined engineering requirements. The system demonstration introduced the acquisition software and core hardware to the engineering and operations teams. Reception was favorable, and various system modifications within the scope of the original specifications were discussed.

Within the main housing is the logging computer with its hard drive, the gigabit Ethernet switch that connects and powers the stereo cameras, the video camera, and a custom board consisting of power supplies and control electronics. The design of this board became significantly more complex when an additional design consideration was introduced. The previous stereo camera system used by NMFS entered a low-power state at the conclusion of the acquisition period, offering a significant energy savings. Logic was added to the control board to receive a signal from the computer at the conclusion of imaging. The computer's operating system is then shutdown, and afterwards, the control board switches off the power supplies.

The control board also interfaces with the operator control unit for the system – the “octopus”. This unit consists of a pair of switches and an LED for each camera system, and it is a component used with the existing NMFS stereo camera systems. One switch turns on power to the camera systems. The other switch selects between configuration mode (in which the computer boots and waits for operator commands) and record mode (in which the acquisition program runs to completion and then powers down the system). The LED provides feedback, indicating the state of the system during normal operation. A set of easily distinguishable light patterns are produced to indicate normal behavior and exceptions. These patterns were derived from previously used protocols and modified to incorporate expanded capabilities of this new camera system.

Description of significant results, protocols developed, and research transitions

As a prototyping project, this research contains no significant results beyond the milestones

described above. Upon delivery of the prototype, the acquisition system will transition directly into field trials and data collection.

Information on collaborators / partners:

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

Information on any outreach activities: None reported

Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology

NGI File # 12-NGI2-19

Project Title: Waveglider 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, University of Southern Mississippi, Stephan.howden@usm.edu

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

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

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 CO₂ 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 CO₂ fluxes, and variations in ocean pH, in the very dynamic and heterogeneous northern Gulf of Mexico.

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

During the reporting period analysis of the data from the project were further analyzed and presentations and abstracts were being prepared for the following upcoming meetings:

- NOAA Ocean Acidification Program Inaugural PI Meeting, 16-17 September, Silver Spring, MD.
- U.S. Ocean Acidification Principal Investigator's Meeting, 18-19 September, Washington, DC
- 2014 Ocean Sciences Meeting, 23-28 February, Honolulu, HI

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 pCO₂ and ocean acidification data in the northern Gulf of Mexico.

Information on collaborators/partners:

- a. Name of collaborating organization: Liquid Robotics, Inc: Jamie Griffith; NOAA/AOML: Dr. Rik Wanninkhof; MBARI: Gernot Frederich; Gulf of Mexico Coastal Ocean Observing System (GCOOS)
- b. Date collaborating established: These collaborations were established at the beginning of this project.
- c. Does partner provide monetary support to project? Amount of support? GCOOS provided a small grant (\$25k) to LRI.
- d. Does partner provide non-monetary (in-kind) support? NOAA/PMEL is providing scientific expertise in the collaborative data analysis.
- e. Short description of collaboration/partnership relationship: NOAA/AOML provided scientific expertise in the collaborative data analysis. GCOOS provided a small grant (\$25k) 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.

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-NGI2-22

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

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

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

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.

Project was completed (expired 9/30/13). Statistical comparisons for air temperature, relative humidity, anemometer, and wave sensors test data to standard sensor data sets were conducted. Implemented all the algorithms on matlab and tested individually on 8 datasets that spans 2 years.

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

Statistical comparisons of meteorological and oceanographic test data to standard data sets were conducted.

The sonic anemometer on average is slightly faster than the propeller anemometer (possibly due to threshold speeds).

The difference in direction between anemometers increases dramatically when the measured propeller wind speed is less than 1 m/s. 99% chance that if the difference in wind direction between anemometers is greater than the standard deviation of the delta, then the measured propeller speed is less than 1 m/s.

Information on collaborators/partners:

- a. Name of collaborating organization: Karen Grissom, NOAA/NWS/NDBC
- b. Date collaborating established: July 2012
- c. Does partner provide monetary support to project? Amount of support? Yes, \$30,000
- d. Does partner provide non-monetary (in-kind) support? Yes
- e. Short description of collaboration/partnership relationship: Collaborated on developing data analysis.

Information on outreach activities: None reported

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, Mississippi State University, janem@ece.msstate.edu

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

Project objectives and goals

The project involved the analysis of test data acquired from NDBC's modems, transmitters, antennae and anemometers to make certain new equipment would perform at comparable or higher rates than older equipment needing to be replaced. The following task descriptions provide more detail.

During the past year, NDBC collected data for the evaluations and provided the data for evaluation by NGI. The data was evaluated and the results presented to NDBC personnel to determine if modifications allowed data quality to maintain quality standards.

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

Over the period of 7/1/13 through 9/1/13, evaluations were performed on data from the following equipment:

- 1) High Data Rate GOES Transmitter
- 2) GOES antenna modifications
- 3) Ultrasonic Anemometer

Progress on these deliverables specifically targeted 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 [completed]

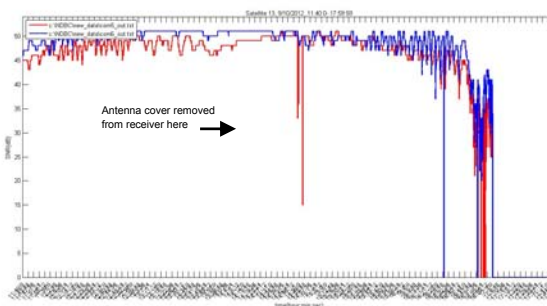
During the time period, the antenna and transmitter modifications data analyses was completed and presented to NDBC engineers. Prior to the analysis, NDBC engineers had concerns due to a number of recent issues with high data rate transmitters failing to perform frequency discipline. The decision was 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/N₀ from all GPS satellites passing overhead. The C/N₀ measurements from each antenna were compared for possible attenuation from the PVC cover.

The results of the data analysis, (a small subset of the results are shown below) did not show any signal attenuation from the PVC cover. 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 affects on the data received. There was no significant difference in the C/N₀ whether the antenna cover was installed or removed, or even when it was reinstalled. The results showed a recorded C/N₀ 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.



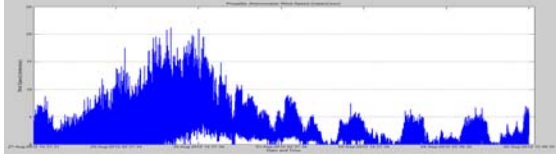
Analysis showed that very minimal dB differences existed between the two antenna-received data. The differences were less than 2 dB even with the sandwich radome. This difference should not present any problems in the analysis of data.

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.

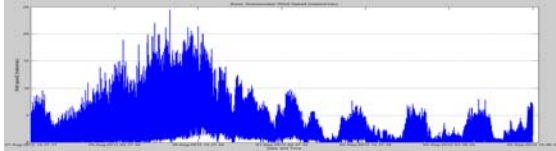
Ultrasonic Anemometer [completed]

NDBC asked for evaluation of wind speed data collected from a sonic anemometer and a propeller anemometer during hurricane Isaac. The data collected was the continuous wind measurements – 10-minute, round the clock averages of wind speed collected at OSTF1. The sonic anemometer was within a few yards of the test station. Data collected from each device was averaged over the same time periods for an exact temporal comparison with the OSTF1 data.

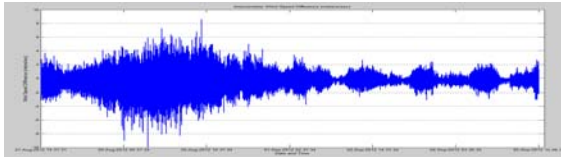
The following are time series plots of wind speed data.



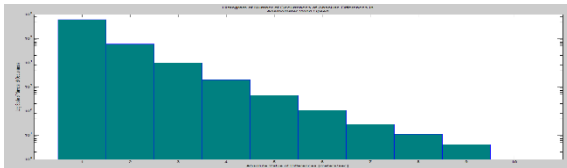
Plot 1) Propeller Anemometer Wind Speed



Plot 2) Sonic Anemometer Wind Speed

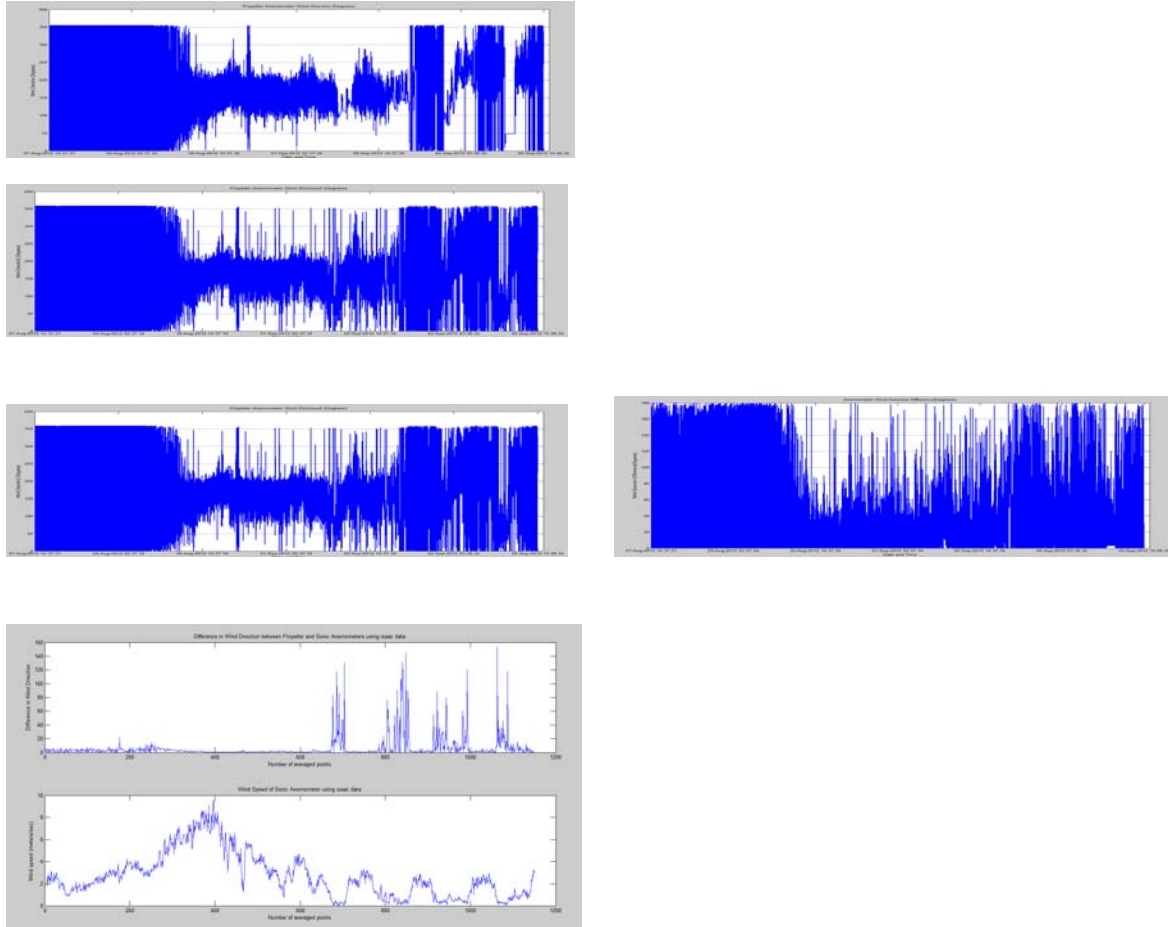


Plot 3) Absolute value propeller minus sonic differences.



Histogram of absolute value of #differences To analyze the differences between the two data samples, histograms of the Number of Differences using 10 bins (Values range from -10 through +9) (log scale). The histogram illustrates that the two anemometers are very comparable for strong winds. Even though the wind speed measurements were over 20 meters/sec, the number of occurrences where the differences between the two anemometers remained low. No tendencies toward over-speeding seemed to occur even with gusty winds.

Comparisons were also made between the two anemometers regarding wind direction. Data was collected individually from the two anemometers during hurricane Isaac and the continuous wind direction data was averaged to compare to the OSTF1 data. Below are the graphs of the wind direction for the sonic and the propeller anemometers. Also shown on the right are the difference graphs, including the absolute value of the difference. Absolute values greater than 180° were recalculated.



Although the differences for wind direction were greater for the wind direction than for the wind speed, the sonic anemometer provided comparable results. As equipment is updated to the sonic anemometer, users can expect the same high quality that was being achieved with the propeller anemometer. The results were presented to NDBC.

Information on collaborators / partners: None reported

Information on any outreach activities: None reported

Related NOAA Strategic Goals: Climate Adaptation and Mitigation, Healthy Oceans

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, Mississippi State University, fitz@gri.msstate.edu

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

Project objectives and goals

In Year 1, we compared 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. We downloaded the model data and observations 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. Graphics were generated and statistical methodologies were developed, and are discussed in the Year 1 report. Partial downloads of datasets were performed, but due to their volume, was not completed.

In year 2, we completed the data downloads, and performed multiple types of validation metrics. As the project continued and comparisons of multiple models were performed, it became apparent that any singular type of metric would yield generally inconclusive results (with some exceptions), and we developed the concept of super-ranking to clarify model comparison. This methodology will be discussed in this report.

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

Ocean model datasets

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 model datasets is a slow process.

This problem was particularly acute for NCOM AMSEAS, which were 484 mb. In Year 2, NCDDC assisted with this issue under ERDDAP on their ecowatch website, and subsetting of time and variables for NCOM AMSEAS became straightforward with simple shell scripts. With these changes, dataset downloads were reduced to 1.2 mb each. An additional problem was then discovered. Many NCOM AMSEAS datasets were missing. We contacted NCDDC, and the problem was resolved.

Winter periods have been added since the Year 1 report, and include December 2010, January 2011, December 2011, January 2012, December 2012, and January 2013. The following model datasets were downloaded (see Year 1 report for more details on the technical issues and websites used):

1. NCOM Global Region 1, 1/8 deg (3-hourly data), subsetted to the Gulf of Mexico (GOM) region.
2. NCOM AMSEAS, 1/30 deg (3-hourly data)
3. HYCOM Global, 1/12 deg (daily data at 0Z), subsetted to GOM region.
4. HYCOM Gulf of Mexico (GOM), 1/25 deg (3-hourly data)

Observations datasets

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>.

Moored buoys were added for the winter periods December 2010, January 2011, December 2011, January 2012, December 2012, and January 2013. Drifting buoys were only available for December 2010 and January 2011.

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:

- HYCOM Global is a 0Z daily dataset. In contrast, HYCOM GOM, NCOM AMSEAS, and NCOM Global are 3-h datasets.
- 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, comparisons to drifters are done at 15 m. The methodology is discussed below.

Model comparisons to moored buoys were performed at 2-m and 15-m levels. Either linear interpolation was performed, or in single-level cases, near-neighbor with a 0.4-m tolerance was used. An Akima spline was tested but produced non-physical results near the surface. These moored stations encompass the northwestern GOM near Texas, the northeast GOM near Florida, and in the central GOM.

Daily comparisons were done in two ways. Daily averages were performed to reduce the influence of tide harmonics and inertial oscillations for NCOM AMSEAS, NCOM Global, and HYCOM GOM. Daily averages could also be done with both type of platforms (moored and drifter), since the drifter-derived methodology is a daily average (discussed next). However, this was not possible with HYCOM Global, since the data is an instantaneous observation at 00Z.

Therefore, 0Z comparisons were also included against moored buoys so that all four models could be compared.

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. Blockley et al. (2012) showed that the level best represented by the drogue location is the 15-m level.

Validation period

Validation is performed for summer and winter periods. Specifically, in the summer, 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). In the winter, the models are evaluated against moored data for 6 months (December 2010, January 2011, December 2011, January 2012, December 2012, and January 2013) and against drifting data for 2 months (December 2010 and January 2011).

Validation methodology

In Year 1, we documented beta testing with classic statistical metrics and a variety of statistical, time series, and daily vector plots for case studies. As Year 2 progressed with the assembly of additional model datasets, it became clear using individual metrics would yield generally inconclusive comparison results. As discussed in Year 1, we then postulated a weighted tally system for first place, second place, third place, etc. for absolute error and bias. This approach is a tally system by platform and month to partially capture seasonal and geographical differences. Each platform is ranked first, second, third, or fourth by absolute error, and a matrix is generated. 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.

We have since added more validation metrics as follows individually for speed and direction in four categories, which are then super-ranked:

Acceptable absolute error percentage

These are simply occurrences where speed errors are within 10 cm/s, and acceptable direction errors are within 20 deg.

Positive and negative error outlier metrics:

- Positive outlier percentage
- Negative outlier percentage
- Number of occurrences with consecutive positive outliers
- Number of occurrences with consecutive negative outliers
- Maximum duration of consecutive positive outliers
- Maximum duration of consecutive negative outliers
- Same as above, but for direction.

Validation metrics:

- Model efficiency factor
- Pearson correlation coefficient
- Spearman correlation coefficient
- Kendall's Tau

- Reliability index
- Multiplicative bias
- Normalized dispersion
- Normalized bias
- Root mean squared difference
- Root centered mean square difference

Vector correlation:

A methodology developed by Hanson et al. (1992) that describes the goodness-of-fit of a relationship between two sets of vectors that includes translation, scaling, and either rotational or reflectional dependency.

Each individual metric provides benefits as well as deficiencies compared to others. Furthermore, individual tallies still provide unclear comparisons for determining the optimal modeling system. Therefore, the concept of super-ranking was developed. This will be discussed in the next section.

The definitions for these metrics will be provided in the final report.

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

- Spreadsheets have been generated for each metric at each station stratified by model, appropriate level, daily average (excluding global HYCOM), and at 0Z (except for drifting buoys).
- All graphics discussed in Year 1 have been updated and extended for the new datasets
- Spreadsheets have been generated synthesizing these results using super-ranking.

Super-ranking is achieved in the following steps. First, each station’s metric is ranked by model accuracy for speed and direction using the weighted tally system. Next, each metric is weighted a multiple of three first place, two for second place, one for third place, and zero for fourth, and they are summed. They are ranked again by first place, second place, etc. This provides the final “super-rank.” Super-ranks have been done by station, season, 2 m, 15 m, daily averages, and 0Z for all four categories.

We are in the process of final evaluation, and will be reporting model comparisons by season and geography in the final report later this summer.

Information on collaborators / partners: None reported

Information on any outreach activities: Presentations of these results were done with scientists at NOAA/AOML and NOAA/NCEP for information dissemination and research feedback. Specifically, these results were presented to Hyun-Sook Kim, Avichal Mehra, and Sundararaman Gopalakrishnan.

Related NOAA Strategic Goals: Weather-Ready Nation

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 (PI) name, affiliation, email address: Shiao Y. Wang, University of Southern Mississippi, Shiao.Wang@usm.edu

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

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 on the persistence of molecular signatures for fecal indicators.

Description of research conducted during the reporting period and milestones accomplished and/or completed. (7/1/13 through 10/31/13)

In earlier experiments, our results showed that the microcosms are highly reliable for determining the survival rate or persistence of enterococci. Using the microcosms as *in situ* test chambers in the field under natural conditions, we found that sewage enterococci do not in general persist in the water column as their concentration quickly declined over time. This was reported in an earlier report. 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.

One interesting and surprising result was that on one occasion, sewage enterococci grow in microcosms placed near the bottom at beach sites. Figure 1 shows the dramatic contrast in enterococci density between microcosms at the surface versus those at the bottom. Enterococci density decreased by approximately 1.5 logs at the surface but increased by 1.5 logs at the bottom, just above the sediment at the beach site.

We followed up by examining organic nutrients, to see whether there is a difference in the between surface and bottom water off the beach over a four day period in July 2013 at two sites, one in Long Beach and the other at Pass Christian. Analysis of dissolved organic carbon was not informative. There was considerable variation (data not shown), we think due to contamination during collection as there was a small amount of sand/sediment in some of the sampling bottles. Analysis of total dissolved nitrogen (TDN) however was useful. Measurements were almost always higher at the bottom compared to water at the surface (Figure 2). The TDN findings are consistent with our hypothesis that more nutrient-rich water just off the bottom at beaches on days with low wave energy may support enterococci growth.

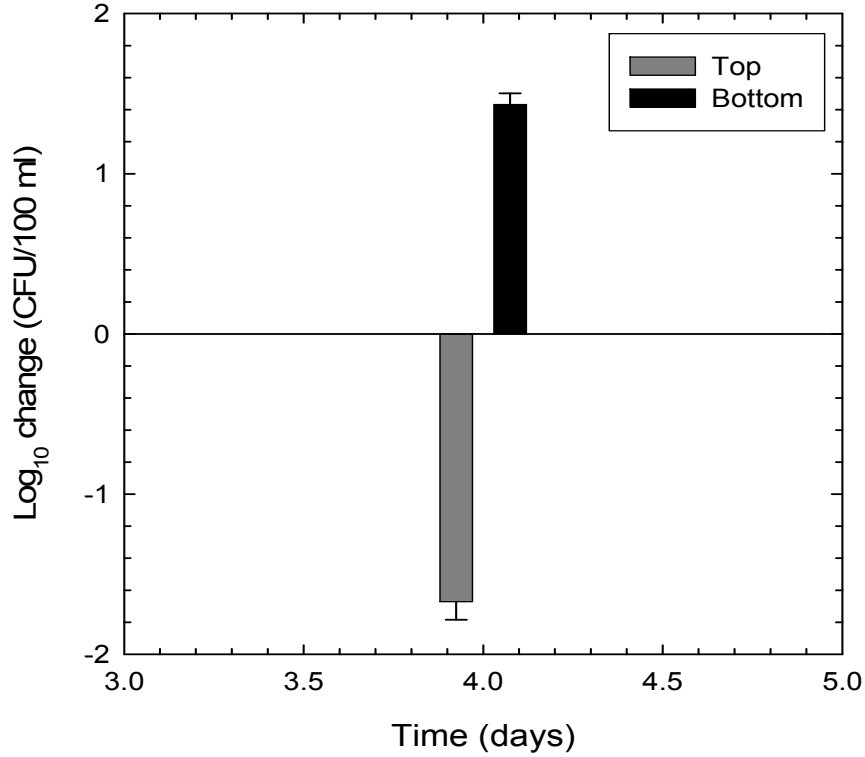
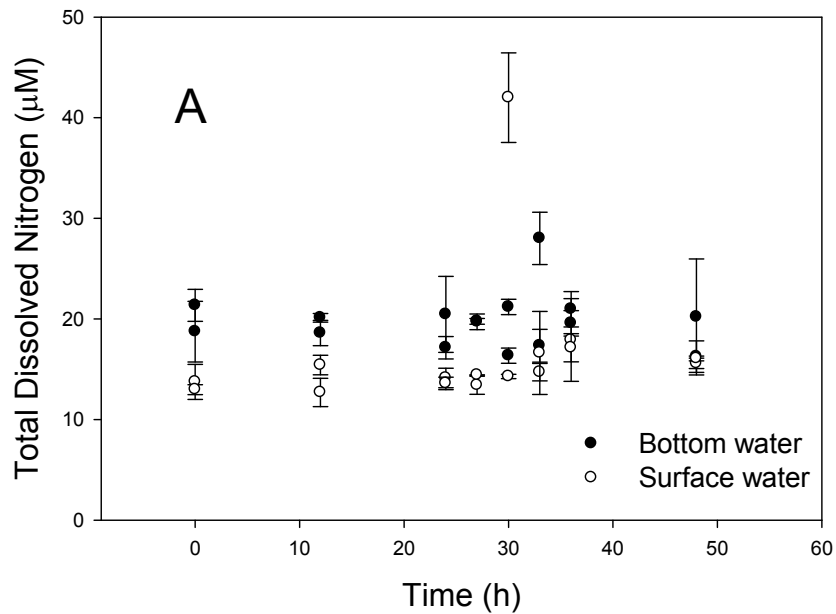


Figure 1. Effect of water column location on enterococci survival in beach water after four days. Gray and black bars represent changes in the density of viable enterococci in microcosms at the surface and bottom, respectively. Each bar is the averaged Log₁₀ change of ten microcosm replicates. Error bars represent standard error among ten replicates at each location.



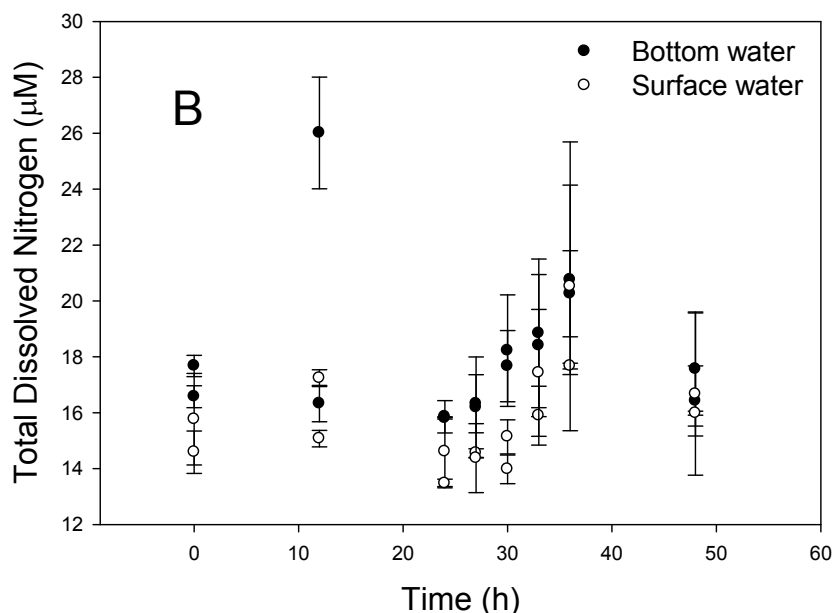


Figure 2. Total dissolved nitrogen at the surface and bottom at two beach sites. A. Long Beach B. Pass Christian. Mean \pm SD. Duplicate samples per site. n = 1 - 4.

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

This contrast in enterococci survival between the surface and bottom at beaches was not consistently observed, in fact it was rare. The significance of this finding is that it might explain the occasional high enterococci counts at beaches without known causes such as sewage leaks or sewer line breaks. This has been a perplexing problem for beach regulators, especially in the Northern Gulf. Our hypothesis is that on occasion, when weather is calm, a layer of nutrient-rich water builds just off the bottom, especially in depressions in shallow water along the beach. This layer of nutrient-rich water allows bacteria such as enterococci to proliferate. When stirred, for example with passage of a weather front and increased wave activity, resuspension of such bacteria would cause occasional spikes in enterococci counts at beaches.

Information on collaborators/partners:

- a. Name of collaborating organization: Chris Sinigalliano, NOAA/AOML
- b. Date collaborating established: None reported
- c. Does partner provide monetary support to project? Amount of support? None reported
- d. Does partner provide non-monetary (in-kind) support? None reported
- e. Short description of collaboration/partnership relationship: Collaborators with similar research interests in marine microbes.

Information on any outreach activities: None reported

Related NOAA Strategic Goals: Healthy Oceans

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 Caribbean

Project Lead (PI) name, affiliation, email address: Eric Chassignet, Florida State University, echassignet@fsu.edu

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

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° (*Weatherly and Thistle*, 1997). 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 (*Coleman et al.*, 2004), 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 (*Rothschild*, 1986; *Chambers and Trippel*, 1997). Thus, understanding recruitment processes of fish species is crucial for their effective management (*Fitzhugh et al.*, 2005). 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 (*Norcross and Shaw*, 1984). 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 (*Norcross and Shaw*, 1984). 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 (*Gentner*, 2009). Adult gag spawn on offshore reefs along the continental shelf break each spring (February - April) (*Coleman et al.*, 1996). Pelagic gag larvae are transported across the shelf until eventually settling as juveniles in seagrass habitats along the coast 30-60 days later (*Koenig and Coleman*, 1998). The physical mechanisms responsible for this onshore larval transport remain unknown (*Fitzhugh et al.*, 2005). 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.

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

This research conducted during the reporting period used observations and a 54-year Gulf of Mexico numerical simulation to quantify and understand the transport of particles associated with upwelling and downwelling in the Big bend region.

Milestone: None at present, but M.S. student Tam Nguyen will defend her thesis “Physical Upwelling in the De Soto Region” in late August or early September 2014.

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

The two main mechanisms for upwelling/downwelling in the Big Bend region are wind variability and remote and direct influence of the Loop Current. We look at the interface displacement along three sections as depicted in Figure 1.

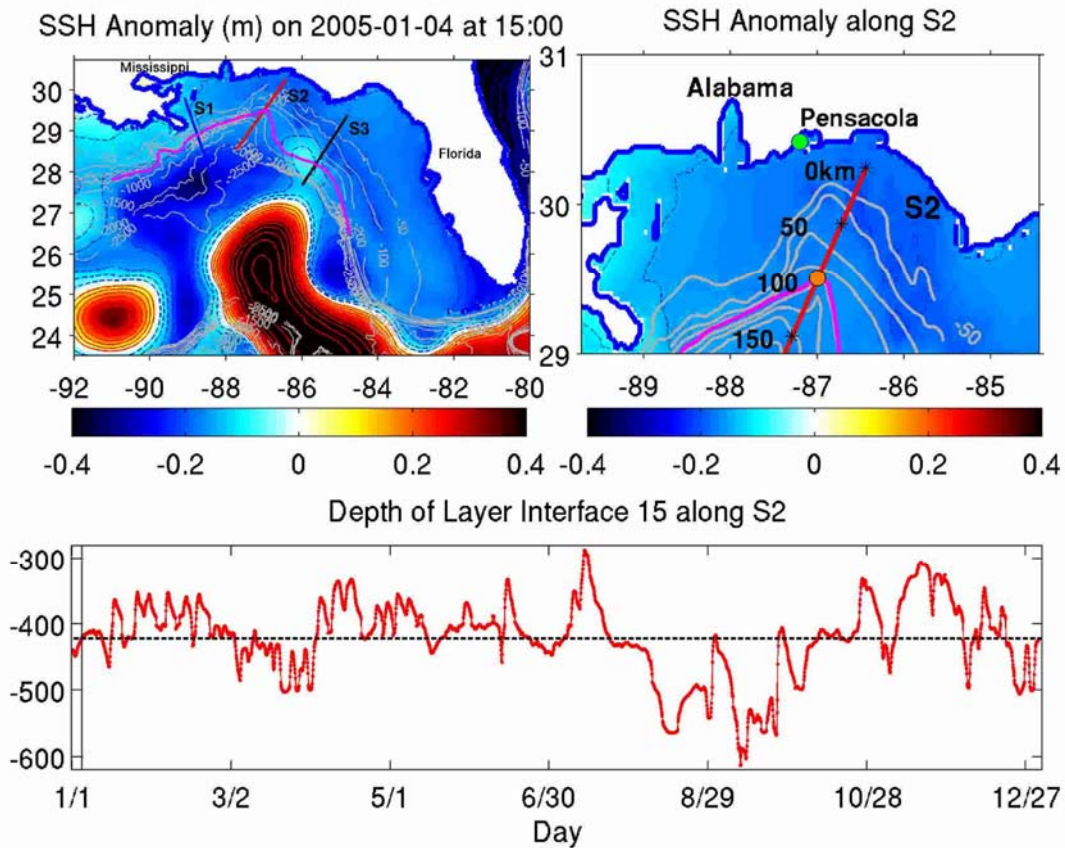


Figure 1. Example of the variability of a HYCOM layer interface depth along section S2.

Wind-related upwelling/downwelling depends a lot on the orientation of the isobaths with respect to the wind direction. It is more favorable in the eastern part of the Big Bend region and over the DeSoto canyon's head. The impact of the Loop Current is investigated by band-passing the time series between 20 and 80 days. The Loop Current can indeed generate large-scale downwelling in the Big Bend region directly and remotely and that several events occur in one year. In the mature phase when the LC retracts southward, presence of cyclonic eddies off the West Florida shelf can make a Loop Current induced high pressure travel along the shallow isobaths of 200 m to 700 m into the Big Bend region. In the young phase, the Loop Current can touch the West Florida shelf and intrude into the Big Bend region at the same time therefore generating large-scale upwelling. The vertical excursion of large-scale downwelling can range from -100 m to +100 m and vary over the domain.

Information on collaborators / partners: None reported

Information on any outreach activities: None reported

Related NOAA Strategic Goals: Healthy Oceans

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, University of Southern Mississippi, scott.milroy@usm.edu

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

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 in previous reporting year (details included in 2013 NGI/NOAA Annual Report).

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

Progress: COMPLETED in previous reporting year (details included in 2013 NGI/NOAA Annual Report).

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: Goals 1-2 accomplished in the previous reporting year. For the current reporting year (01 Jul 2013 – 30 Jun 2014), 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 reported

Information on any outreach activities: None reported

Related NOAA Strategic Goals: Healthy Oceans, Resilient Coastal Communities and Economies

Related NOAA Enterprise Objectives: Science and Technology, Engagement

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: Dr. Monty Graham, University of Southern Mississippi, Stennis Space Center, MS, monty.graham@usm.edu

Co-PI(s) name(s), affiliation, email address: Landry Bernard, University of Southern Mississippi, Stennis Space Center, MS, landry.bernard@usm.edu

NOAA sponsor and NOAA office of primary technical contact: Kathleen O'Neil, NWS

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 of 1 July through 30 September 2013, primary effort was to continue with defining "The Way Forward for the Next Ten Years" as described in the paper titled "The NOAA National Data Buoy Center" by; Helmut H. Portmann¹, Landry J. Bernard², Joseph Swaykos¹, and Richard L. Crout¹ (*National Oceanic and Atmospheric Administration, National Data Buoy Center¹, University of Southern Mississippi²*) 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. 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. 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. Now that the data infrastructure was available, what will the next generation observing system look like?

Building on the way forward, the primary objective for this period was to start defining what the next generation Observing System would be. The initial region was selected to be the Gulf of Mexico and to work closely with the NOAA Regional Association for that area, the Gulf of Mexico Coastal Ocean Observing System (GCOOS). GCOOS for many years has worked with agencies that form the Federal backbone of the Integrated Ocean Observing System. GCOOS has worked with NDBC to collect observing requirements from stakeholders from Florida to Texas. Some of the stakeholders are from the following industries: oil & gas, tourism, commercial and recreational fishing, seafood, renewable energy, shipping, and the Blue

Technology sector. In the process of defining the needed observing system a number of significant issues were raised 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 platform 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 observing requirements?

All of these questions apply equally to other IOOS Regional Association observing systems that are being developed in other areas.

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:

“The Tropical Atmosphere Ocean Array (TAO) Refresh – New Capabilities and Value Added” by; Richard Bouchard¹, Landry Bernard², Raymond Beets¹ and Karen Grissom¹.

(1) *National Oceanic and Atmospheric Administration, National Data Buoy Center*¹

(2) *University of Southern Mississippi*²

was published for the 94th Annual AMS Meeting. 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.

Information on collaborators / partners:

In order to assess and coordinate NDBC's strategic initiative, several documents and numerous meetings 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. During this period, many meetings were attended and papers reviewed with organizations associated with the RESTORE-Act (i.e. National Fish and Wildlife Foundation (NFWF), National Academy of Science (NAS) Gulf Program, and Ecosystem Restoration Council).

Information on any outreach activities:

This paper was presented at the 46th Annual AGU Fall Meeting.

1. "A User's Guide to the Tsunami Datasets of NOAA's National Data Buoy Center" by; Richard Bouchard¹, Kathleen O'Neil¹, Kevin Kern¹, Karen Grissom¹, Michael Garcia¹, and Landry Bernard².
(1) *National Oceanic and Atmospheric Administration, National Data Buoy Center*¹
(2) *University of Southern Mississippi*²

This paper was presented at the 94th Annual AMS Meeting.

2. "The Tropical Atmosphere Ocean Array (TAO) Refresh – New Capabilities and Value Added" by; Richard Bouchard¹, Landry Bernard², Raymond Beets¹ and Karen Grissom¹.
(1) *National Oceanic and Atmospheric Administration, National Data Buoy Center*¹
(2) *University of Southern Mississippi*²

This paper was presented at the GoMRI Gulf Oil Spill and Ecosystem Conference, January 2014.

3. "Current and Future Ecosystem-Monitoring Strategies in the Gulf of Mexico: Spanning Disciplines, Platforms, and Affiliations" by; Stephanie Watson¹, Chris Simoniello¹, Ann Jochens¹, Matt Howard¹, Ruth Mullins-Perry¹, and Landry Bernard²
(1) *Gulf of Mexico Coastal Ocean Observing System-Regional Association*¹
(2) *University of Southern Mississippi*²

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

Related NOAA Enterprise Objectives: Science and Technology

NGI FILE #13-NGI2-39

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

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

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

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

- Developed a new observation-based RFI detection method for satellite imager data (AMSR-E, AMSR2 etc.) over ocean using a principal component analysis (PCA) method
- Developed an optimal filter for striping mitigation in ATMS brightness temperature observations
- Estimate the ability of ATMS observations in capturing detailed warm core thermal structures for the improved monitoring and forecasting of tropical cyclones
- Assessed 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
- Developed an asymmetric hurricane initialization algorithm and implemented it into The Hurricane Weather Research Forecast (HWRF) system

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

- Detection of Television Frequency Interference with Satellite Microwave Imager Observations over Oceans

The geostationary satellite television (TV) signals that are broadcasted over various continents can be reflected back to space when they reach ocean surfaces. If the reflected signals are intercepted by the antenna of microwave imager on board polar-orbiting satellites, they are mixed with the thermal emission from the Earth and result in direct contamination on the satellite microwave imager measurements. This contamination is referred as Television Frequency Interference (TFI) and can result in erroneous retrievals of oceanic environmental parameters (e.g., sea surface temperature and sea surface wind speed) from microwave imager measurements. In this study, a principal component analysis (PCA)-based method is applied for detecting the TFI signals over oceans from the Advanced Microwave Scanning Radiometer (AMSR-E) on board the Earth Observing System (EOS) Aqua satellite. It is found that the third principal component of the data matrix of the AMSR-E spectral difference indices from each AMSR-E swath captures the TFI contamination. The TFI-contaminated data on AMSR-E descending node at both 10.65 and 18.7 GHz frequencies can be separated from un-contaminated data over oceanic areas near the coasts of Europe and United States continents based on the intensity of the data projection onto the third PC. Compared to the earlier methods, the proposed PCA-based algorithm works well on the

observations without *a priori* information and is thus applicable for broader user applications.

- **ATMS De-Striping Optimal Filter**

The striping noise is visually discernable in the global O-B differences of brightness temperature fields for the ATMS temperature sounding channels. It is also hidden in the ATMS water vapor sounding channels (Qin et al., 2013). In order to further investigate the root causes of striping noise, the characteristics of noise in ATMS warm counts, cold counts, warm load temperatures and scene counts are also analyzed. It is found the noise characteristics in the scene counts are similar to those in the warm counts and cold counts, mimic a combination of Gaussian and flicker noise. The noise in the warm load temperatures is of Gaussian type. This suggests that removing the noise in the warm and cold calibration counts is not sufficient for the ATMS de-striping purpose. In this study, 22 de-striping optimal filters for each of the 22 ATMS channels are developed. One month of winter and summer ATMS data with de-striping algorithms are being produced for NWP impact studies.

- **Impacts of Assimilation of ATMS Data in HWRF on Track and Intensity Forecasts of 2012 Four Landfall Hurricanes**

This study demonstrates the added benefits of assimilating the Advanced Technology Microwave Sounder (ATMS) radiances in the Hurricane Weather Research and Forecasting (HWRF) system to forecasts of four Atlantic hurricane cases that made landfall in 2012. In the National Centers for Environmental Prediction (NCEP) Gridpoint Statistical Interpolation (GSI) data assimilation system, the HWRF model top is raised to ~0.5 hPa and the cold start embedded in the HWRF system is changed to a warm start. The ATMS data quality control procedure is examined and illustrated for its effectiveness in removing cloudy radiances of all the 22 ATMS channels using primarily the information from ATMS channels 1 and 2. For each hurricane case, two pairs of data assimilation and forecasting experiments are carried out and compared with and without including ATMS data. The only difference between the two pairs of experiments is that the second pair also includes data from several other polar-orbiting satellite instruments. It is shown that ATMS data assimilation in HWRF results in a consistent positive impact on the track and intensity forecasts of the four landfall hurricanes.

Information on collaborators/partners:

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

Information on any outreach activities: None reported

Related NOAA Strategic Goals: Weather-Ready Nation, Resilient Coastal Communities and Economies

Related NOAA Enterprise Objectives: Science and Technology

NGI FILE #13-NGI2-42

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, Florida State University, xzou@fsu.edu

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

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

- Analyzed ATMS striping noise from its earth scene observations and found that striping noise similar to ATMS also existed in MHS data
- Developed and tested two post-launch calibration algorithms of AMSU-A upper-air sounding channels using GPS RO data
- Developed an optimal ATMS remapping algorithm for climate research
- Completed a cross-calibration between ATMS and AMSU-A using the simultaneous nadir overlap (SNO) algorithm for linking the microwave sounding observations from AMSU to ATMS for long-term monitoring of climate change
- Diagnosis of polarization signatures from two window channels of MicroWave Humidity Sounder (MWS) onboard Chinese FengYun-3
- Assessed Uncertainty of AMSU-A derived temperature trends in relationship with clouds and precipitation
- 30-year atmospheric temperature trend derived by one-dimensional variational data assimilation of MSU/AMSU-A observations

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

- Analysis of ATMS Striping Noise from its Earth Scene Observations
The striping noise is visually discernable for the temperature sounding channels as random along-track strip differences between brightness temperature observations and simulated observations based on numerical weather predictions simulation (i.e., O-B). However, the O-B differences for water vapor sounding channels do not visually show a clear striping pattern due to a larger dynamic range of the images associated to cloud and water vapor variability in the atmosphere. This study applies the principal component analysis (PCA) with an Ensemble Empirical Mode Decomposition (EEMD) for extracting the striping noise in brightness temperature observations from satellite microwave sounding instruments ATMS, AMSU-A, AMSU-B and MHS. It is shown that the PC coefficient of the first PCA mode, which mainly describes a scan-dependent feature of cross-track radiometer measurements, captures the striping noise. The EEMD is then applied to the PC coefficient of the first PCA mode to extract the first three high-frequency oscillatory components, which are defined as the intrinsic mode functions

(IMFs) and denoted as the PC1/IMF3 noise. When the PC1/IMF3 noise is removed from the data, the striping noise disappears in the global distribution of O-B for ATMS temperature sounding channels 1-16. Using the same method, it is demonstrated that the striping noise is also present in ATMS water vapor sounding channels 17-22 and can be removed by a combined use of PCA and EEMD methods. From sample data used here, the magnitude of the ATMS striping noise is about ± 0.3 K for the temperature sounding channels and ± 1.0 K for the moisture sounding channels, which are the same as those in the pitch-over maneuver data. It was also determined that striping noise of the same size is present in AMSU-B and MHS observations on board NOAA-16 and NOAA-18 satellites, respectively. The striping noise is very small in magnitude (~ 0.1 K) for AMSU-A observations.

- Optimal ATMS Remapping Algorithm for Climate Research

ATMS combines all the channels of its predecessors AMSU (e.g., AMSU-A1, AMSU-A2, and AMSU-B) sensors into a single package with considerable savings in mass, power, and volume. It has 22 channels in bands from 23 GHz through 183 GHz. The unique design of ATMS allows a consistent sampling rate for both temperature and water vapor sounding channels. The noise in the lower frequency channels 1 to 16 (i.e., K and V bands) is higher than those of AMSU-A1 and AMSU-A2 due to a shorter integration time. The oversampling characteristics of ATMS K and V bands observations make it possible to make benefit from The redundant information in oversampled ATMS channels 1-16 make it possible to remap the AMTS observations into a higher spatial resolution or a lower spatial resolution to improve channel sensitivity. The remapping of ATMS observations at K and V bands to the same resolution as the AMSU-A are also highly expected by user communities who wish to continue their AMSU-A like applications with ATMS [1][2][3][4]. The remapping of ATMS observations to the same resolution as the AMSU-A involves a resolution enhancement in ATMS channels 1 and 2 (K/Ka bands) and a resolution reduction of ATMS channels 3-16. In this paper, the Backus-Gilbert method was used for the conversion from ATMS FOVs to AMSU-A FOVs. This method provides not only an optimal combination of measurements within a specified region, but also a quantitative measure of the tradeoff between resolution and noise. Based on a sub-pixel microwave antenna temperature simulation technique, ATMS observations at specified FOV size with 1.1° sampling interval are simulated. Remapping results were quantified by using simulated datasets and real AMSU observations. It is shown that the brightness temperature bias is significantly reduced by using the B-G remapping coefficients generated in this study. For K/Ka bands, a resolution enhancement by the remap of ATMS observations introduces about 0.6 K increase in noise. For other bands, improved channel sensitivity was found for the remapped data.

- Connecting the Time Series of Microwave Sounding Observations from AMSU to ATMS for Long-Term Monitoring of Climate

The measurements from Microwave Sounding Unit (MSU) and Advanced Microwave Sounding Unit-A (AMSU-A) on board NOAA polar-orbiting satellites have been extensively utilized for detecting atmospheric temperature trend during the last several decades. After the launch of Suomi National Polar-orbiting Partnership (SNPP) satellite on October 28, 2011, MSU and AMSU-A time series will be overlapping with the Advanced Technology Microwave Sounder (ATMS) measurements. While ATMS inherited the central frequency and bandpass from most of AMSU-A sounding channels, its spatial resolution and noise features are however distinctly different from those of AMSU. In this study, the Backus-Gilbert method is used to optimally resample the ATMS

data to AMSU-A field of views (FOVs). The differences between the original and resampled ATMS data are demonstrated. By using the simultaneous nadir overpass (SNO) method, ATMS-resampled observations are collocated in space and time with AMSU-A data. The inter-sensor biases are finally derived for each pair of ATMS/AMSU-A channels. It is shown that the brightness temperatures from ATMS now fall well within the AMSU data family after resampling and SNO cross-calibration. Thus, the MSU/AMSU time series can be extended into future decades for more climate applications.

Information on collaborators/partners:

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

Information on any outreach activities:

General Description: During the reporting period, we attended 2014 AMS annual meeting to present our recent research results.

Type (speaker, workshop, training): Speaker

Name of event: 2014 American Meteorological Society (AMS) annual conference

Date: February 2-6, 2014

Location: Atlanta, GA

Description: One oral and two poster presentations

Approximate Number of Participants: Annual meeting included 2,000 meteorologist

Type (speaker, workshop, training): Speaker

Name of event: 2014 19th International TOVS Study (ITS) conference

Date 26 March – 1 April 2014

Location: Jeju Island, South Korea

Description: Three oral presentations

Approximate Number of Participants: 100 participants

Related NOAA Strategic Goals: Climate Adaptation and Mitigation, Weather-Ready Nations

Related NOAA Enterprise Objectives: Science and Technology

NGI FILE #13-NGI2-43

Project Title: Ecosystem Approach to Management in the Northern Gulf

Project Lead (PI) name, affiliation, email address: Steve Ashby, Mississippi State University, sashby@ngi.msstate.edu and William H. McAnally, Mississippi State University, 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, EPA, Richard.Fulford@ep.gov

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

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

A workshop was conducted in April of 2014 with 21 participants. There were three main purposes for the workshop:

1. Elicit environmental managers' advice on the capabilities they need for successful EAM.
2. Complete biological interaction definitions within the ecosystem model TroSim.
3. Identify connections of social and economic processes to physical and biological outcomes.

Two breakout sessions were conducted.

Breakout A: Completing the Ecosystem Model

Our goal is to address these questions:

1. How can we improve the model from a technical standpoint? (i.e. data gaps, spatial and temporal resolution, application to various ecosystem processes, trade-off between spatial scale and application versatility)
2. How can it be best applied to specific management needs and how can it become a true effective and usable tool for managers? (i.e., utilizing the model for ecosystem service valuation and assessing human well-being, incorporation of societal dimensions, interfacing with other IEA models)

Breakout B: Connecting the Social and Economic Sciences

Our goal is to address these questions:

1. How are coastal communities affected by changes in inundation (including storm surge), water quality, fishery production, etc.?
2. What is the link between these changes and human well-being?
3. How do these changes affect the provision of ecosystem services?
4. How do we measure/monitor changes?

Key findings of the workshop are given in four sections – management needs, ecosystem modeling, human well-being, and path forward. The conceptual model used to define roles in the workshop is shown in Figure 1.

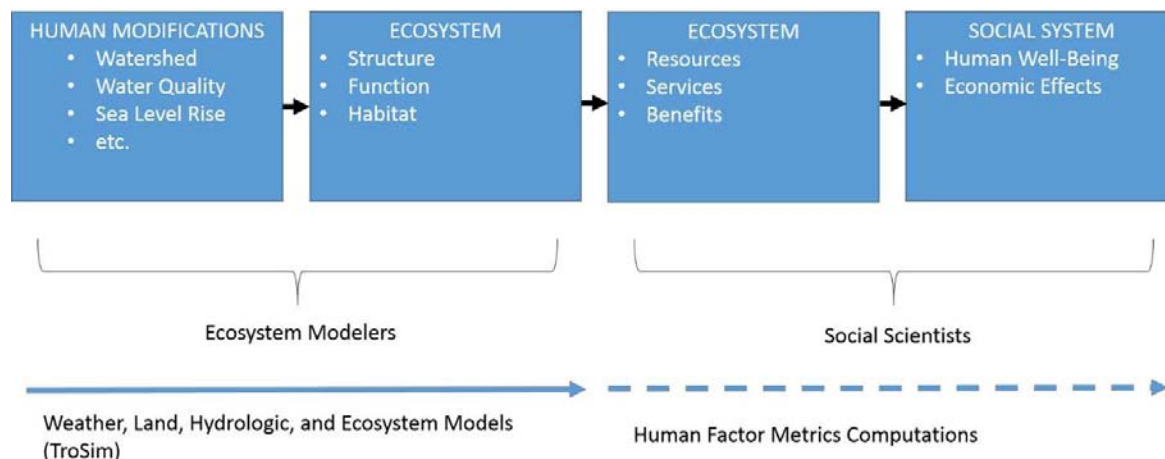


Figure 1. Conceptual Model for expanding EBM

Management Needs¹

Management needs for Gulf region resource management were documented in an earlier NOAA funded project report² in which local, state and federal resource managers were engaged to describe what they needed to better accomplish their missions in the Mobile Basin and associated offshore region. The Sulis Informatics System design is based on the management needs defined in that document and multiple subsequent interactions with resource managers.

¹ Note that the stakeholder assessments were all performed prior to the NGI projects and results were adapted to the IEA process.

² Tagert, Mary Love, Kimberly Ann Collins, William H. McAnally, Jairo N. Diaz-Ramirez, 2008, Mobile Basin Stakeholder Needs and Assessment, Northern Gulf Institute, Mississippi State University.

Tools and methods for management use of EAM should:

- Help stakeholders understand how ecosystem quality supports them
- Help stakeholders understand how they affect ecosystem
- Identify users/stakeholders and interests from the beginning of development
- Ensure a transparent process
- Provide Base Versus Plan benefits in ecosystem quality
 - With vs without project
 - With vs without management action
 - With vs without regulatory mandate
 - Incremental benefits vs costs
 - Changes over time – how long to reach a goal, etc.
- Be scalable
- Place-based
- Synergistic across purposes and locations
- Be transparent to stakeholders so they understand and accept the results
- Estimate cumulative impacts
- Warn of unintended consequences
- Include the physical, biological, and human (social) components of the ecosystem

- Allow comparison of the burdens and benefits of regulations
- Allow multiple metrics to be evaluated and compared
 - Different management needs
 - Different stakeholders
- Consider RESTORE Act Council and NOAA science program priorities, NRDA
- Enable stakeholders to define “do no harm” and goals
- Communicate complex results in clear fashion (red, yellow, green)
- Dashboard controlled outputs and stakeholder requested scenarios
- Co-evolve with managers’ needs

Ecosystem modeling

The ecosystem models presently in use for the NGI project consist of:

- FVCOM hydrodynamic model and TroSim ecosystem model for Mississippi Sound.
- EFDC hydrodynamic and water quality model for Perdido Bay

A number of other models for the sites and other Gulf locations are documented on the Sulis Community Models webpage:

(<http://www.ngi.msstate.edu/sulis/apps/CommunityModels/index.html>)

Ecosystem model needs defined during the workshop were (see Attachment B):

1. Validate the TroSim model for oyster production on existing Gulf reefs.
2. Validate the TroSim Model for the next target species – possibly seagrass, marsh grass, or gag grouper.
3. Continue coordination with ATLANTIS and EWE modeling efforts with the goal of connecting them for Gulf-wide modeling.

Human Well-Being

Human connections to the ecosystem can be categorized as direct economic (e.g., fisheries production), indirect economic (e.g. flood attenuation), ecosystem services (e.g., aesthetics, and human well-being (e.g., cultural cohesion).

The Human well-being breakout focused on well-being. Key points were:

A. Data

1. Census data at 10 or 5 year intervals provide well-documented and reliable snapshots of:
 - a. Demographic distributions
 - b. Economic well-being statistics
2. Bureau of Labor Statistics provide employment and income data
3. Tax rolls and revenues
4. Electrical connections
5. Public Health data are available but dispersed across multiple sources
6. More general well-being data are collected sporadically, often after catastrophic events such as hurricanes and oil spills. They are collected by surveys, interviews, and focus groups.
7. Ecosystem services data³

B. Predictive Relationships

1. Demographic trends are identified and used to predict future populations
2. Work is underway to relate population shifts to sea level rise-related displacement
3. Other relationships are generally descriptive, ad hoc, and location-specific
4. Some studies of effects of energy-related impacts, such as oil shale boom in North Dakota

C. Needed information

1. Where do displaced populations go and how does that affect the communities they move to?
2. How do shifts in prime fishing grounds affect the communities?
3. What resources are available to stressed communities?
4. How do communities relate to the eco-environment, symbiotic or separate?
5. Do ecosystem changes:
 - a. Displace people, commerce, infrastructure
 - b. Alter culture
 - c. Affect recreational uses
 - d. Change well-being

Path Forward

Workshop participants responded to the question, "What should be the next steps in NGI's EAM effort?" Asked to summarize the varied responses, the assembled group suggested a pilot application:

1. Select one of the existing EAM sites to push forward
2. Make TroSim fully operational (validated) for that site
3. Identify a management action or natural change to test as the Altered Condition
4. Project Existing Condition and Altered Condition oyster harvest and seagrass/marsh grass states
5. Estimate impacts to ecosystem services
6. Use focus groups to identify reactions to projected changes and impacts
7. Relate changes between Existing Conditions and Altered Conditions to impacts to reveal needed management and communication issues.

Continued studies in Perdido Bay

During the course of the report period, we have expanded the data set in order to better understand more intimate ecological relationships found in shallow embayments with varying degrees of anthropogenic disturbance.

We calculated the contribution of the benthos to total ecosystem metabolism in each of the lagoons. For these metabolism measurements, we placed 20 pairs of clear and dark chambers, and 10 pairs of clear and dark BOD bottles in each of the lagoons. We measured oxygen concentrations at the start and the end of three-hour incubations, including solar noon. We calculated benthic and water column metabolism based on the change in oxygen concentrations over time, expressed all measurements on a square meter basis, and expressed the contribution of the benthos to total ecosystem metabolism on a percent basis.

To compliment calculations of primary production, seagrass cover as well as distribution and abundance of fishes, nekton, and benthic infauna were also assessed. For each embayment, three 20 m seine pulls were executed on each collection date with benthic core samples taken to assess seagrass coverage and infaunal community structure. Measures of environmental parameters were also noted. All fish and nekton were counted and identified. Benthic infauna was separated into major taxonomic groups.

Additionally, during the report period, an experiment was initiated to assess carbon uptake by seagrasses after large-scale disturbances or losses. After initial sampling of sediments to assess standing organic carbon stocks, treatment plots were stressed via shading over the course of 9 months before removal at which a T_0 sampling was taken. After 1 year, sampling will occur every few years to establish a long term monitoring regime.

During the course of the reporting period, the following milestones have been reached:

- The field sampling as described in the project narrative was completed during the reporting period (July 1st 2013 to June 30th 2014). We added five additional sample rounds; one took place in Summer 2013, two in Fall 2013, one in Winter 2013, and one in Spring 2014. During all sample rounds, we used benthic chambers and bottle incubations to estimate the contribution of the benthos to total ecosystem metabolism.
- Nutrients from collected water samples are currently being analyzed
- All data collected over the course of the two year fisheries study is has been analyzed and is currently being incorporated into the overall dataset.
- Baseline and T₀ samples are being processed and analyzed for carbon content as well as assessment of bacterial community structure.

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

A PhD dissertation was completed (Zeigler, 2013) 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.

Perdido Bay research- 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.

Current results show the lagoons following similar seasonal patterns as previously stated in past reports. Our data show significant differences in the contribution of the benthos to total gross primary production between the sites. The relative contribution of the benthos changes over time, but the sites remain consistently different from each other. The relative contribution of the benthos differs between areas covered by seagrass and areas dominated by benthic microalgae, regardless of the degree of disturbance in the sites. The values are highest in the seagrass beds of State Park and Kees Bayou, and lowest in the bare sediment of Gongora. Despite their shallow depth (0.5-0.8 m), two of our sites were dominated by pelagic production. Only in State Park, the least disturbed site, did the water column contribute to less than 50% of total gross primary production. Benthic respiration follows the same pattern as gross primary production. The contribution of benthic respiration to total ecosystem respiration is highest in the seagrass beds of State Park and Kees Bayou, and lowest in the sediments of Gongora. However, the contribution of the benthos to total ecosystem respiration is higher than the contribution to total gross primary production. In State Park and in the seagrass bed of Kees Bayou, there is more respiration in the benthos, compared to the overlying water column.

Results of the fisheries investigation yielded unexpected results. We do not see any significant differences in the abundance of species across the gradient of anthropogenic disturbance. Furthermore, seagrass-associated species did not show higher abundances in high seagrass cover areas, but rather in areas of low cover that had adjacent fringing marshland. Ongoing analysis of the data set will hopefully elucidate the mechanisms behind these controls.

Information on collaborators/partners:

- a. Name of collaborating organization: Gulf of Mexico Alliance (GOMA)
- b. Date collaborating established: May 2014

- c. Does partner provide monetary support to project? Amount of support? No
- d. Does partner provide non-monetary (in-kind) support? Yes, technical input/review
- e. Short description of collaboration/partnership relationship: GOMA has Priority Issue Teams that focus on Ecosystem Integration and Assessment, Habitat Conservation and Restoration, and Environmental Education. There are many areas in common with the IEA project that allow technical exchanges.

Information on any outreach activities:

General Description (see above for workshop summary)

Type (speaker, workshop, training): Workshop - Dr. Matt Lauer, invited social scientist

Name of event: Ecosystem Approach to Management

Date: April 2014

Location: Baton Rouge, LA

Description: (see above summary)

Approximate Number of Participants: 21

Related NOAA Strategic Goals: Healthy Oceans, Resilient Coastal Communities and Economies

Related NOAA Enterprise Objectives: Science and Technology

NGI FILE #13-NGI2-45

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 Howden, University of Southern Mississippi, stephan.howden@usm.edu

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

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) are being conducted by partnerships between NOAA and the University of Southern Mississippi (USM).

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

7/10/2013 Buoy deployed from the USM R/V Tommy Munro. Water profile and discrete water samples were taken at the buoy. Samples for DIC and Talk sent to U. Delaware for analysis.

10/22/13 Notified by PMEL that MAPCO2 gas cylinder empty and they scheduled a shipment to us of a new cylinder.

12/17/13 Cruise to buoy. Discovered that the cylinder was empty because the hose between the MAPCO2 electronics and the cylinder had been vandalized. The tubing into the electronics case was damaged, so we could not make a repair at sea and PEML scheduled a shipment to us of a new hose and electronics package. Water profile and discrete water samples were taken at the buoy. Samples for DIC and Talk sent to U. Delaware for analysis.

2/10/14. Charted the R/V Wilson from Dauphin Island Sea Lab to go to the buoy and replace the MAPCO2 electronics, gas cylinder. The scientific dive team from DISL was hired to install a SAMI pH instrument under the buoy and clean the hull and instruments of biofouling. The installations were a complete success. Water profile and discrete water samples were taken at the buoy. Samples for DIC and Talk sent to U. Delaware for analysis.

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

The time series of $x\text{CO}_{2\text{air}}$, $x\text{CO}_{2\text{sw}}$, pH, wind speed, C,T and S has continued to be collected. This time series will help determine the seasonal and long-term trends of ocean acidification, and air-sea exchanges of CO_2 in the northern Gulf of Mexico.

Information on collaborators/partners:

- a. Name of collaborating organization: NOAA/PMEL, NOAA/AOML & NOAA OAP Dr. Rik Wanninkhof (NOAA/AOML), Dr. Anne Michelle Wood (NOAA/AOML), Dr. Jeremy Mathis (NOAA/PMEL), Dr. Christopher Sabine (NOAA/PMEL), Dr. Richard Freely (NOAA/PMEL) and Dr. Jon Hare (NOAA/NMFS/NEFSC).
- b. Date collaborating established: 2011
- c. Does partner provide monetary support to project? Amount of support? n/a
- d. Does partner provide non-monetary (in-kind) support? n/a
- e. Short description of collaboration/partnership relationship: The CenGOOS buoys serve as a platform for the PMEL MAPCO2 system (including attached CTDs, dO and pH sensors). NOAA collaborators participate in data analysis and writing of presentations and publications.

Information on Outreach Activities: None reported

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

Related NOAA Enterprise Objectives: Science and Technology

NGI FILE #13-NGI2-46

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

Project Lead (PI) name, affiliation, email address: William F. Patterson III, Dauphin Island Sea Lab wpatterson@disl.org

Co-PI(s) name(s), affiliation, email address: Russ Beard, NCDDC, russ.beard@noaa.gov; Rost Parsons, NCDDC, rost.parsons@noaa.gov

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

Project objectives and goals

This project continued a NOAA affiliation with the Dauphin Island Sea Laboratory (DISL) on ecosystem data management systems. The goal was 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 were 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 facilitates scientific studies, public education, and outreach. The resulting data management systems 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

- 16 metadata records published
- Numerous metadata records in progress; DISL metadata records in progress are now available for viewing at the link:
<https://docs.google.com/a/disl.org/spreadsheet/ccc?key=0AqO4asIV-9OadFFGNU1RdmpnQ3pWVms3b2VfbnRiX0E&usp=sharing#gid=0>.
- Submission of 25 DISL datasets to the NOAA NODC Oceanographic Data Archive. DISL datasets are available for download by the scientific public at the link:
<http://www.nodc.noaa.gov/cgi-bin/OAS/prd/accession/query/response/8db777f99b0d954a414daaf632b2ff26>
- Revision of previously published records to meet updated NOAA NCDDC standards
- Hosted metadata training workshop for DISL research community (March 13).
- Published four issues of a quarterly Data Management Newsletter to keep the DISL research community up to date on activities and innovations in DISL data management.
- Data Management Specialist, Ms. Mimi Tzeng, served as a member of the advisory committee for the NSF project "Software Stewardship for the Geosciences" led by Dr. Yolanda Gil at the Information Sciences Institute and Department of Computer Science, University of Southern California.
- 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 (Ms. Lei Hu), Data Management Specialist (Ms. Mimi Tzeng), 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 2014, the Data Management Specialist reviewed and updated DISL's metadata records. In addition, the Data Management Specialist converted 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 include: 1) updating, creating, and publishing metadata records; 2) submission of DISL datasets to the NOAA NODC Oceanographic Data Archive; 3) continued participation in NSF EarthCube events and online; 4) publishing Data Management newsletter quarterly throughout the year; and 5) hosting an updated metadata training workshop.

Information on collaborators / partners: None reported

Information on any outreach activities:

- Mimi Tzeng and Lei Hu remotely participated in the NSF EarthCube "Articulating Cyberinfrastructure Needs of the Ocean Ecosystem Dynamics Community" workshop on 7-8 October 2013.
- Lei Hu attended the Gulf of Mexico Coastal Ocean Observing System's Education and Outreach Council Meeting in Pensacola, FL on 12-13 November 2013.
- Mimi Tzeng attended the Gulf of Mexico Research Initiative meeting in Mobile, AL on 26-29 January 2014. During that meeting, she participated in scientific session 002 (Data Management) and session 010 (Longterm Monitoring of the Gulf of Mexico). She also attended "An Information Exchange and Collaboration on Data Management for Environmental Disasters" on 29 January 2014, which was a NOAA-led meeting in which organizations involved in collecting or organizing DWH-related data discussed ways to improve the coordination of data archival. Lastly, she attended a Gulf of Mexico Research Initiative Information and Data Cooperative (GRIICD) business meeting on 29 January 2014 to learn GOMRI data submission policies and requirements.
- Metadata Training Workshop by Kathy Martinolich and Mimi Tzeng at DISL on 13 Mar 2014 (9 attendees included faculty, research staff and administrators, and students).
- DISL Data Management Newsletter distributed quarterly by email.
- Participation in EarthCube Connections - an online tool to link interdisciplinary collaborators. Since joining, Mimi Tzeng reviewed an NSF EarthCube proposal and now serves on the Advisory Committee on the EarthCube proposal cited above.

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 #13-NGI2-48

Project Title: Development of Geospatial Data Products for NOAA's Exploration Data Collection

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

NOAA sponsor and NOAA office of primary technical contact: Sharon Mesick, NESDIS

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. The current project seeks to leverage standard capabilities in order to develop next-generation data products, designed specifically for EAM decision support.

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

Goal 1: Assess the collection of exploration geospatial data visualization products in the context of OER's need for specific ecosystem-based assessment tools.

Progress: PENDING (completion of Goal 1 is anticipated by 31 Aug 2015, in accordance with project milestones).

Goal 2: Plan and implement improvements to the standard GIS tools currently in place, or develop new GIS tools, designed specifically for EAM decision support.

Progress: PENDING (completion of Goal 2 is anticipated by 31 Aug 2016, in accordance with project milestones).

Milestones: Goal 1 is to be completed by 31 Aug 2015. Goal 2 is to be completed by 31 Aug 2016.

Progress: ALL MILESTONES PENDING; have yet to reach the date(s) for milestone completion.

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

Research results are pending; have yet to reach the date(s) for milestone completion.

Information on collaborators/partners: None reported

Information on any outreach activities: None reported

Related NOAA Strategic Goals: Healthy Oceans, Resilient Coastal Communities and Economies

Related NOAA Enterprise Objectives: Science and Technology

NGI FILE #13-NGI2-49

Project Title: Climate Variability in Ocean Surface Turbulent Fluxes

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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. The SHF directly changes the temperature of the air whereas the LHF released energy only after the water vapor condenses. 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 CO₂), 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 considering the ocean and the atmosphere as coupled for climate applications. The same physics was applied on smaller scale to examine how an oil slick modifies air/sea interaction and thereby modifies its motion.

The FSU activity is motivated by a need to better understand interactions between the ocean and atmosphere on daily 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 the 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. We have traditionally examined the distributions of weather, with more emphasis on typical weather conditions. However, recent work on extremes strongly suggests that climate cycles also influence the likelihood and magnitude of extreme events.

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 assimilation efforts combine ocean surface data from multiple Ocean Observing System networks (e.g., VOS, 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., LDEO 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 has 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. Continue operation production of the 2° Tropical Pacific and 1° Legler Tropical Indian Ocean FSU wind products.
2. Develop a multi-satellite wind product
3. Design a satellite-based flux product, based on (2)
4. Engage new users of (2) and (3)
5. Continue interaction with national and international satellite and in situ wind groups
6. Continue interaction with national and international flux groups

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.

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/pacmonyqrq.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 NOAA goals of Prepare for drought and water resource challenges and Sustainably manage marine ecosystems 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.

Reduced funding could seriously jeopardize the production of these wind products. Reduced support for the VOS program and reduced maintenance of tropical buoy arrays reduces the quality of this product.

2.2. Develop a multi-satellite wind product

We have made great improvements to our gridded satellite product. We now assimilate wind data (speeds and vector components) from many instruments. We also utilize sea surface temperature data (Reynolds OI Satellite data set) and a model (the University of Washington Planetary Boundary-Layer Model) of wind responses to SST patterns to add realistic small scale variability to areas where satellite winds are not available. This is a major improvement, as it

allows us to have a much more consistent time series of wind derivations (e.g., curl for ocean forcing, and convergence for links to the atmosphere) than we had in prior years. This adjustment has been tested for impacts on surface fluxes of momentum, heat, and fresh water, and found to have a very large influence in the area of western boundary currents (winter average 30W/m^2 regional changes), and smaller adjustments over the mid-latitude oceans. These changes appear to be larger than the long-term heat imbalance needed to account for observed changes in Ocean Heat Content.

The model of wind responses has been shown to be flawed in the tropics. We are working on removing to simplifications of physics that result in this problem.

Interestingly, the processes modeled for this objective are very similar to the processes that couple oil slicks to small scale atmospheric and oceanographic circulations. The slick causes local changes in surface roughness (wave characteristics) and sea surface temperature, which causes changes in surface wind and momentum resulting in atmospheric and oceanographic processes that cause the slick to contract and rotate (Zheng et al. 2013).

2.3. Design a satellite-based flux product, based on (2)

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 slowed our efforts to assimilate the air temperatures and humidities needed to calculate fluxes because we saw small scale patterns consistent with the wind and momentum variability mentioned in section 2.2). We have verified that these small scale features are important to estimates of Air-Sea Exchanges of Heat, Momentum, and Fresh Water. It is worth noting that wind-related changes are underestimated in numerical weather models. We anticipate that better understanding of this process will eventually contribute to improvements in weather models and ocean models. The changes in wind direction have a substantial impact on the curl of surface stress, which is very important for ocean forcing. These changes will impact the ocean's mixed layer and the deep ocean transport, hence they are important for the transport of Ocean Heat Content.

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. Lack of funding could seriously slow this work.

Engage new users of (2) and (3)

We have found several users of wind and flux products to engage in testing of our improved wind product. The comments from this group will also improve the satellite-based flux product as that is based on the same core code as the wind and momentum product. This information is also contributing to a proposed satellite-based program to better observe and understand these processes, as well as similar processes closer to coastlines than has been previously examined.

Continue interaction with national and international satellite and in situ wind groups

We continue to engage and lead the national and international communities in the areas of satellite and in situ wind and flux products. Through leadership of the NASA Ocean Vector Winds Science Team and chairmanship of the International Ocean Vector Winds Science Team we work with national and international partners to improve gridded wind and flux products. We are also co-Is in the ICOADS Value ADded (IVAD) project, which is greatly improving the very long ICOADS record for use in climate applications. In this project, we aid in the removal of

biases in winds, which will lead to reduced biases in derived quantities: Air-Sea Exchanges of Heat, Momentum, and Fresh Water. The satellite winds continue to be very useful in the forecast of storm surge and wave damage - managing risks to coastlines and coastal infrastructure.

Continue interaction with national and international flux groups

See 2.5

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. Four undergraduates were employed via this funding over the past year. Two are undergraduate honors students, and one now has a full time job in part because of the training received with us. We also have one graduate student, who has worked on estimating white capping from satellite data (papers soon to be submitted). White capping is of interest because of its strong connection to wind and to CO₂ fluxes.

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.

Results of our research are routinely published in peer reviewed journals and presented at professional meetings. We try to send our students (graduate and undergraduate) to meeting to further their professional growth.

In this year we completed the development and implementation of a NASA funded professional development (PD) for middle school science teachers. The topic of this PD (called ASK-Florida) was Climate and Climate Change. A portion of the development benefitted from our research related to climate variability, ENSO variability and impacts in particular. It also leveraged the PIs participation in the global observing system, informing teachers of carefully observed and verified changes in the Earth system. The program also emphasized that local and regional changes are different than globally averaged changes. This approach could be used to highlight local changes, which were of more interest to the teachers and students, and link them to larger scale climate patterns. Local changes included sea level rise, temperature and precipitation patterns, and mitigation of ENSO changes on agricultural productivity. This activity contributed to improved education and outreach in three Florida counties, and portions of the work are now being used by 4H. Reviews by the county education supervisors were extremely positive, regrettably funding for the NASA program was not usefully continued. Our work has also been used to inform university juniors, seniors and graduate students about the coupled ocean/atmosphere system and the observing system used to study it.

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 #13-NGI2-50

Project Title: Calibration and Validation of NPP VIIRS – Color and SST Ocean Products for Monitoring Oceans

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Project objectives and goals

This proposed activity is to establish the on-orbit calibration and validation of satellite ocean products for the VIIRS (Visible Infrared Imaging Radiometer Suite) on NOAA's Suomi National Polar– Orbiting Preparatory Project (S-NPP) satellite. The project addresses two ocean products: A) Sea Surface Temperature and B) Ocean Color. The VIIRS sensor design will be used aboard follow-on satellite missions, therefore it is critical to characterize the sensor and optimal processing techniques for future missions (J1 is to be launched in 2018). The project is coordinating with NOAA, NASA, University, and Navy scientists and has demonstrated the capability for VIIRS ocean products to reach Beta maturity in the JPSS program. The project has two specific Satellite products.

The project goal is to improve and evaluate ocean products by performing calibration and validation of the ocean products for ecological and physical properties and to provide ocean monitoring and forecasting capability. Improving ocean products will significantly enhance the capability to monitor coastal and open waters for both near real-time operational and scientific products and will also establish a long term climate trend of the ocean properties. NOAA's environmental satellites fulfill a critical national requirement for monitoring and forecasting the ocean properties and processes.

The work plan will evaluate the Ocean EDR (Environment Data Records) from VIIRS and validate the ocean products through monitoring the trends of VIIRS spectral channels including the SDR (Scientific Data Records) and the EDR (Environmental Data Records). We will work with the JPSS ocean cal val team to test and improve present processing satellite algorithms using *in situ* data collection to monitor the trends of satellite products.

The project goal is to support the NOAA– Center for Satellite Applications and Research (STAR) and JPSS programs in identifying issues regarding the stability of the satellite products and provide guidance to the JPSS program. The VIIRS cal val team will thoroughly investigate the sensor characterization as well as the software processing used to derive ocean products.

The project will also evaluate the modifications that the JPSS program is making to the sensor (SDR and EDR), in addition to monitoring the trends of the VIIRS sensor degradation to the spectral channels, to determine the final impact on the ocean products.

Our goal this year was to develop high spatial resolution ocean products by using additional satellite channels to increase the spatial resolution for coastal near shore applications. The VIIRS ocean products will be integrated and evaluated with ecological and physical models to help provide new forecasting and monitoring applications.

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

A. VIIRS- Sea Surface Temperature (SST) Research

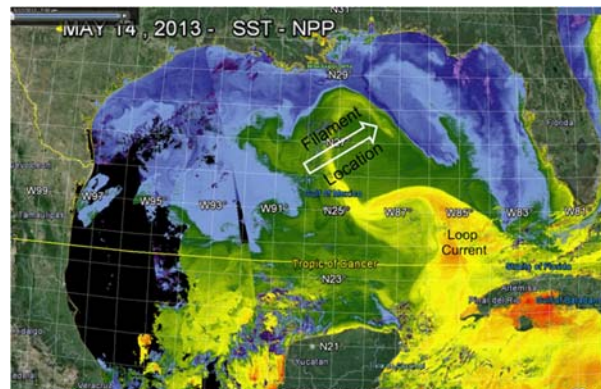
The SST products were evaluated for the VIIRS sensor on a global basis by comparison of the SST products with drifting Buoys. The SST evaluation includes examining three algorithms used to derive the SST from the thermal IR channels are 1) operational Integrated Data Processing Segment (IDPS) algorithms 2) OSI- SAF, considered for update to the IDPS, and 3) SeaTemp (NAVY).

The SST evaluation also includes an assessment of the VIIRS Cloud mask (VCM) products, which is a method to screen the SST product to improve performance. The VCM is a JPSS product whose software is updated periodically, and has a direct impact on the quality of the SST products. The SST team provided direct input to the VCM team to improve the VCM products as it applies to SST products.

This year, the STAR cal val team decided that the IDPS SST EDR products were to be replaced by the NOAA STAR – product using the OSI-SAF algorithms. These algorithms are being tested in a number of locations and compared with the Navy SST Algorithms. The results show the OSI SAF algorithms offer an improvement to the present SST since it can provide reliable data out to 63 degrees from NADIR as opposed to the original algorithms which is 53 degrees. The added swath coverage provides a considerably larger amount of global SST coverage. The quality of the SST product is highly dependent on the cloud removal quality flags and the impact on the equations used to derive the coefficients used in the SST algorithms based on the brightness temperatures. The research that we conducted this year addressed both subjects and focused on the Cloud mask used with SST algorithms exclusively on Suomi NPP VIIRS derived SST products.

We examined the 3 SST algorithms for the effect on SST fields from daytime SST equations that are or were used by the Naval Oceanographic Office (NAVOCEANO), NOAA/STAR, Météo France, the (IDPS), and the University of Miami. For the Météo France equation, coefficient values from NAVOCEANO, NOAA and Météo France were tested. To match a scene provided by the University of Miami, the region in this study covered the Northern Gulf of Mexico and part of the Western North Atlantic for a daytime scene which was captured on May 14, 2013 (Figure 1). We attempted to validate the SST fields by comparing the satellite-derived values with those of drifting or moored buoys. We also examined the end of scan region, as it is the area where results of the SST equations differ most. Analyzing the difference in temperature at the overlap between swaths provided insight on how well the various combinations of equations and coefficients perform at higher satellite zenith angles. The NLC (OSI-SAF daytime) equation was shown to perform well, although the choice of coefficients significantly affected results.

Figure 1. SST from VIIRS May 14, 2013.



As expected, NL53deg (NAVOCEANO daytime) and IDPS (standard NLSST) performed poorly at high satellite zenith angles as they were not designed to process such data. Beside Météo France; NOAA/STAR, IDPS and NAVOCEANO are now using or plan to use the NLC equation.

Milestone completed: Results were presented at the SPIE.DSS14 conference and “Comparison of VIIRS SST fields obtained from differing SST equations applied to a region covering the Northern Gulf of Mexico and Western North Atlantic” published in the proceedings.

In the cloud detection study, we examined the VIIRS Cloud Mask (VCM) which, as a JPSS official product, that provides information about cloud coverage to all NPP VIIRS IDPS products. This analysis of VCM, focusing exclusively on its applicability to SST, was conducted by comparing VCM to the NAVOCEANO Cloud Mask which is included in the program to make SST retrievals at NAVOCEANO. Unlike the standard evaluation of VCM, which is based on counting the number of correctly or incorrectly classified clear and cloudy pixels in a finite number of scenes, the evaluation in this study was based on the impact of the cloud or clear determination on the accuracy of the SST retrievals. The NAVOCEANO SST processing was modified to read the Cloud Mask Intermediate Product (CMIP) and output full resolution (M-band) SST fields. VCM was shown to perform well during the daytime when adding a test to address the presence of other contaminants such as aerosols and cloud leakage adjacent to VCM detected clouds. Specifically, the RMS error for daytime cleared SST retrievals is the same for both NCM and VCM, but with VCM allowing a greater number of retrievals. However, none of VCM daytime cloud tests were found to bring additional cloud detection capabilities to NCM. At night, VCM with added tests also performs well, with similar RMS errors for both NCM and VCM, but with a larger number of retrievals for VCM. A few VCM nighttime tests may also be helpful to NCM but would have to be used with caution. NCM is being modified to keep results of individual tests for further analysis and optimization.

Milestones Completed: Results were presented at the SPIE.DSS14 conference and “Analysis of the VIIRS Cloud Mask, Comparison with the NAVOCEANO Cloud Mask, and How They Complement Each Other” published in the proceedings. The SST team provided direct input to the VCM team to improve the VCM products as it applies to SST.

B: VIIRS- Ocean Color Research

The ocean color cal val team at Stennis participated in bi-monthly- NOAA- JPSS- cal val team telecons. Every 2 weeks, we collaboratively reviewed and discussed collective results of work with other team members. The EDR calibration and validation color team collaborators of approximate 25 scientists represent the following organizations:

NOAA STAR/NESDIS, NASA-Goddard-OCPG , Northrup Grumman, University of Miami, University of Southern Mississippi, Naval Research Laboratory, QNA, University of South Florida, City College of New York, University of Massachusetts Boston, Oregon State University, and University of Southern California. In addition to these EDR members, the JPSS SDR teams (12members) also participated in the telecom to discuss the impact if the SDR on the EDR.

Every 2 months, USM presented our accomplishments and specific status and results to the cal val team. In total, we presented on 6 occasions this year, consisting of a 30 – 40 minute presentation to the entire team followed by a write up summary to the JPSS program office of the ocean color cal val status. An examples of 2 of our reports are included in the appendix.

The major milestones completed in this year in Ocean color are: “details are in publications”

1. Satellite ocean color comparisons with in-situ data: We evaluated the ocean color products by comparison with *in situ* measurements. The matchup between in-situ and satellite required defining the spatial and temporal uncertainty to perform the analyses. We performed matchup analyses of the Satellite derived color products with in-situ ship and Aerosol Robotic Network (AERONET) platform color products of 1) spectral nLw Normalized water leaving radiance, 2) chlorophyll, and 3) Inherent optical properties. The WavCis Platform in the Gulf of Mexico on the oil platform off of La was used for tracking the VIIRS sensor performance. Several others Aeronet platforms were also used for the analyses including the AAOT- off of Adriatic, The Eureka Site off of Los Angeles and LISCO- Long Island Sound. These Aeronet Sites use the SeaPrism sensor, which is calibrated by the NASA and NIST for cross calibration. Results have shown them to be fairly stable and with the tolerances for coastal cal val. The matchup required that the uncertainty of the in-situ data be defined and methods to constrain the quality of the “valid” data. And the uncertainty of the satellite be determine. We defined these uncertainty at 11% and 9 % which were presented at several presentation and publications (Arnone et al 2014 a, b, Ladner et al., 2014a).

2. Monitoring the VIIRS cal val stability and trends: A major concern in satellite calibration for ocean color products is to determine the stability of the sensor so as to minimize the sensor uncertainty. The long term trends of the ocean color properties are required to provide a continuity between different satellite such as MODIS and VIIRS to determine climate changes. There are several changes in the VIIRS sensor stability that impact the ocean color products including the degradation of the sensor, calibration tables from the solar diffuser and software changes to the SDR processing and others. The trends of the VIIRS ocean color products are very sensitive to small changes and the color products have been used to define these impacts.

The assembled a time series of the satellite nLw and the AERONET SeaPRISM at WavCIS (Northern Gulf of Mexico) and other sites to track the performance VIIRS color channels (M1-M7) to determine the stability of the satellite. The VIIRS sensor was shown to have decreasing global chlorophyll values beginning in June 2013 and continuing to January 2014. We explored the reasons for this occurrence by analyzing the long-term time series data set at the Marine Optical Buoy (MOBY; Hawaii) and Coastal AERONET sites.

The anomaly appears to be a result of the SDR (Scientific Data record), although the entire SDR team was working on the issue, and the ultimate origin of the issue was not clear at the time of the presentation. The coastal area did not appear to observe the decrease, which was mainly observed in the open ocean waters. The issue was partially resolved when we observed that the changes in the SDR calibration were occurring based on the solar diffuser issues and how they were calculating the Look Up Tables (LUT) for the sensor gains.

The long term trends of the VIIRS sensor was discussed at the JPSS Science meeting in April 2014. We presented 6 posters at the sciences meeting which was held at the STAR building in College park, MD.

3. Regional Gains: The calibration of the VIIRS for ocean color uses a methods of vicarious calibration to adjust the top of the atmospheric radiance (Lt) to match the in-situ measurements. For each channel a gain is computed using the vicarious calibration (Arnone et al, 2014 Bowers et al .2014) to provide the optimum calibration. Using the time series at the NOAA MOBY blue water site, a vicarious “gain” of the visible channels for satellite calibration was determined. We evaluated the trend of the satellite calibration and product performance over time. The MOBY site is run by NOAA to provide an optimum open ocean calibration site based on NIST standards. NASA also uses this site for MODIS and other sensors. The MOBY in-situ data was collected daily and matchup with VIIRS ocean color to perform the vicarious calibration. This

data set was used assembled for a 2 year period in which detailed analyses was performed to remove outliers which should not be used in the calibration. The details of the data constrains that are required for optimum vicarious calibration was defined (Bowers et al. 2014). The MOBY site represents an open ocean site where we defined the changes in the gains that occurred throughout the year. The trends in the gains provide a method to assess the changes in response of the satellite characteristics. Using the analyses of the changing updates to the computed gains we compared with NASA and STAR team members to track uncertainties in the ocean color products. To evaluate how VIIRS gain computed using Moby Blue water sites with gains computed in coastal sites we used the WavCis site to compute the Vicarious gain adjustments as a Green gain. The comparisons of the blue and green gain were determined to impact of the ocean color products. The Green water gain is a regional gains derived from the Gulf of Mexico. We determined the blue and greens gain were comparable in open ocean waters but saw differences in the ocean color products in coastal waters. This can be a result of the way that the 670 nm channel is calibrated and used for vicarious calibration. The results of this research are impacting the VIIRS products in coastal waters where we can show an improved products. This is a study that is continuing to next year.

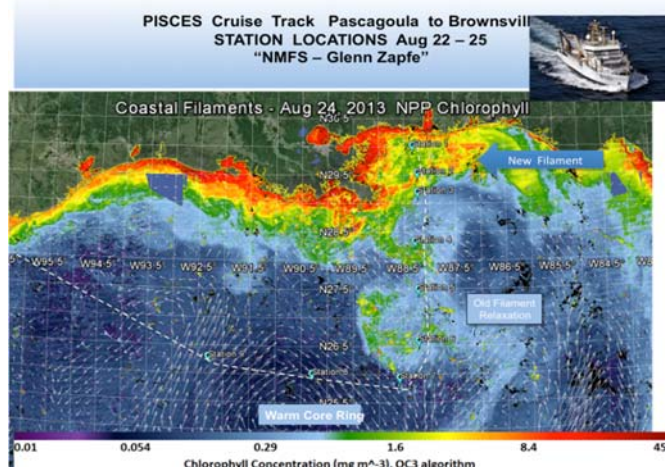
4. NOAA- Operational Software IDPS support: We evaluated and reported to the JPSS office improvements to the operational software (IDPS). We have our research software (L2gen) which we use for testing and evaluation of the JPSS operational software. The research software is producing improved matchups compared to the IDPS software and we provided updates to what additional software modifications should be considered for the operational version. We are working with the team members to define these DR.

5. Improved algorithms in coastal waters: The IDPS software was clearly showing problems in coastal waters. The algorithms were retrieving negative radiances in coastal waters which clearly suggests atmospheric correction issues. We evaluated the NIR atmospheric correction in coastal waters as an addition to operational software packages that will help improve products in the coast waters. We evaluated this and presented several oral and poster presentations to illustrate that the NIR correction will significantly improve the VIIRS ocean color products in coastal waters. The results of the research demonstrate that the VIIRS sensor is very capable of providing a continuity of the ocean color products in the coastal waters and is comparable with MODIS. This clearly demonstrates the VIIRS products can provide NOAA an operational capability for Harmful Algal Blooms which is important application for the VIIRS ocean color products. Changes to the NOAA- IDPS operational code have been demonstrated and plans for the implementation are being determined.

6. Cruises participation: This year we participated in five at sea cruises for calibration and validation. The cruises are:

- a) Central Gulf of Mexico with NMFS and the PICES where stations were collected and compared with VIIRS
- b) Chesapeake Bay cruise with NOAA, were used to demonstrate the use of the NIR atmospheric correction is required.

Figure 2. Chlorophyll Ocean color Products and location of Cruise track in the Northern Gulf of Mexico.



Additionally the matchup with VIIRS products demonstrated the capability for VIIRS products in coastal areas.

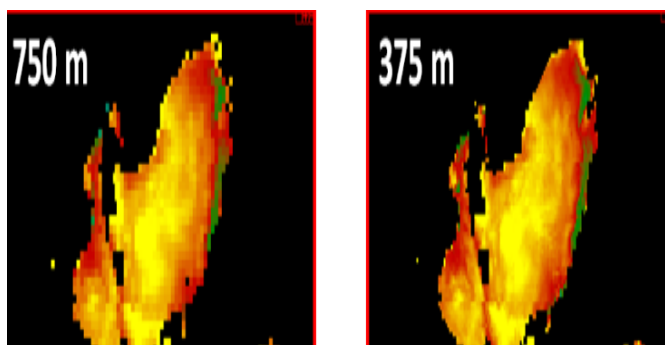
c) Northern Gulf of Mexico GEOCAPE- We participated in the NASA cruise for a new geostationary satellite called GEOCAPE in the Northern Gulf of Mexico. The GeoCAPE (Geostationary Coastal and Air Pollution Events) NASA cruise off of Louisiana and Texas was a comprehensive cruise in which daily VIIRS products were used for directing the ship operations for data collection. Approximately 40 stations were collected for VIIRS cal val which included nLw and IOP measurements. Several papers and presentations on these results were presented (Arnone et al. 2013, 2014).

d) Mississippi Sound on the RV. Ocean Color (NAVY)- A small vessel operation out of Gulfport to offshore Cat Island was conducted using a flow through system and water leaving radiances. The flow through data was used to define the spatial variability along the transect and how this compared with the VIIRS spatial variability. Results clearly demonstrate the utility on VIIRS for defining coastal variability. (Arnone et al. Vandermeulen et al 2014).

e) Gliders in NOAA NDBC. A Seaglider operated by NOAA NDBC and Shell Oil was deployed for four months in the northern Gulf of Mexico. Data from the glider was compared to VIIRS-derived estimates of salinity (calculated from spectral absorption channels; Vandermeulen et al. 2014), in addition to characterizing the subsurface profiles of satellite concurrent areas of interest, including river plumes.

7. Enhanced resolution of VIIRS products: The 2 visible/NIR Imaging (I) channels of VIIRS have a 375 m spatial resolution compared to the 7 Moderate resolution (M) bands which have a 750 m spatial resolution. We explored a method to exploit the I bands to spectrally sharpen the M bands to produce 375 m ocean color products. This new approach utilizes the spatial covariance of the spectral channels to sharpen the ocean color M bands (412, 443, 486, 551, 671 nm; 750-m spatial resolution) with the I1 channel (645 nm; 375-m spatial resolution). The resulting higher spatial resolution radiance products are then placed back into satellite processing software and used as input to bio-optical algorithms to obtain higher resolution ocean color products. Traditional band sharpening artifacts are reduced/eliminated by the use of an adaptive, wavelength-specific spatial resolution ratio that is weighted as a function of the relationship between proximate I1 and M(λ) band variance at each pixel.

Figure 3. Ocean Color: bb_551_qaa product at 750-m resolution and 375-m resolution with using the dynamic ratio sharpening technique. The qualitative improvement of frontal features demonstrates the advantages to band-sharpening in coastal and inland waters.



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

SST Significant Results: SST algorithms for the VIIRS sensor were tested and evaluated and the OSI SAF Algorithm was selected as the NOAA operational algorithms. The STAR-NOAA is presently providing the Global SST products to JPL for operational applications using the OSI-SAF algorithm. The OSI SAF Algorithm was evaluated against several operational algorithms (i.e. IDPS and NAVY) and we found to have advantages of increased coverage as a result of increase swath coverage and still retained the RMS error required for operation. Additionally,

the VIIRS Cloud Mast (VCM) was tested and evaluated for SST retrievals. The SST was shown to be useful for the VCM algorithm. Methods to integrate the VCM with improved SST products were demonstrated and will be tested. These results are in reports (Cayula et al., 2014).

Ocean Color significant results: The VIIRS ocean color products was shown to produce high quality bio-optical products which can be compared with MODIS satellite. Significant results include : a. Gains computed (green and blue water) b) Impact of the NIR on coastal products c) Trends of the VIIRS at WavCis and MOBY d) Demonstrated that VIIRS ocean color products are comparable to MODIS products e) The use of the I bands can be used for sharpening the M bands for increased resolution in coastal areas. f) Evaluated uncertainty of in situ optical measurements with concurrent “round-robin” testing g) Evaluated uncertainty of satellite products through orbital overlap scenes

The long term stability of VIIRS indicated an issue with the SDR product which resulted in a decrease in open ocean chlorophyll. We monitored the VIIRS for product stability in coastal waters and determined the impact of vicarious gains in blue and green water. We discovered a possible issue in the vicarious calibration performed on the 670 channel and impact on the coastal products. The operational IDPS algorithms were shown limited capability in coastal water with high particle scattering. The NIR correction methods was demonstrated to be required for the VIIRS sensor in coastal waters and can be implemented into the operational JPSS IDPS algorithm for coastal bio-geo chemical products. We identified issues with the VIIRS sensor that can improve the color products which include 1) VIIRS stripping, 2) defining the spatial and temporal in-situ and satellite uncertainty. We are working with NOAA and NASA to define improvements to protocols for: 1) in-situ optical measurements used for satellite validation 2) defining the quality of the data set used for performing a vicarious calibration at MOBY and the AERONET sites 3) determining the uncertainty of satellite and insitu data using in “matchup data sets”. The protocols for standardizing instruments, procedures for data collection and in-situ data processing is being established with both NOAA and NASA for bio-optical instrumentation for satellite cal val methods.

Information on collaborators/partners:

- a. Name of collaborating organization: NOAA JPPS program office, STAR/NESDIS, NASA-Goddard-OCPG , Northrup Grumman, University of Miami, University of Southern Mississippi, Naval Research Laboratory, QNA, University of South Florida, City College of New York, University of Massachusetts Boston, Oregon State University, and University of Southern California. Additional collaborations includes NOAA agencies with National Marine Fisheries Service, National Data Buoy Service, NOAA- Comprehensive Large Array-Data Stewardship System (CLASS).
- b. Date collaborating established: 2010 and earlier. The support for the VIIRS Ocean
- c. Does partner provide monetary support to project? Amount of support? None reported
- d. Does partner provide non-monetary (in-kind) support? None reported
- e. Short description of collaboration/partnership relationship: The support for the VIRRS Ocean products comes from the NOAA- STAR and JPSS office which provides support prior to launch in 2011. Our cal val team which we lead with STAR for Ocean products was created in 2007 as a partnership of these agencies and universities. We has a strong working collaboration in the development and current and planned NOAA and NASA satellite sensors.

Information on any outreach activities:

The VIIRS Ocean Product team has extensive outreach at a number of conferences and invited presentations. These are listed in the publications:

- a. R. Arnone is the conference chair at the SPIE Defense Security and Sensing Conference for Ocean sensing and monitoring organized a session on the VIIRS Ocean products with an invitation to speakers from around the world. (<http://spie.org/STA/conferencedetails/oceans>). The SPIE Conference has been ongoing for 5 years and meeting was April 29-30, 2014 with an attendance of over 2500 and this program presented 6 invited presentations
- b. The JPSS Science meeting was held at STAR- May 8-10 with an attendance of 250 and we presented 5 invited presentations.
- c. The NASA Ocean Color team meeting was held in College Park with an attendance of 100 personnel and we presented.
- d. The AGU-Ocean Science Meeting in Hawaii in Feb 2014 was attended by 5000 and we presented 4 presentations.
- e. Cal val Team telecon with over 30 personnel held every 2 weeks with presentation every 2 months.
- f. Presentation at Oil Spill conference Mobile Jan 2014 with over 500 personnel.
- g. Invited presentation at the Gulf Coastal Research Laboratory on USM's Ocean Weather Laboratory Nov 2013 with 100 personnel.
- h. Web page outreach of VIIRS ocean products on line and distributed online. USM Ocean Weather: <http://www.usm.edu/marine/research-owx>
- i. VIIRS products outreach on GCOOS - <http://gcoos.tamu.edu/?p=6630>

Related NOAA Strategic Goals: Weather-Ready Nation, Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology

NGI FILE #13-NGI2-52

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

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

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

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

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 the implementation of 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 FY2013, 1 New Zealand-, 2 Australia-, and 28 United States-operated research vessels routinely transmitted 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 use, 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 evaluating data quality (from collection to archival) for previously recruited vessels, distributing data to a widening user community, and working more closely with OMAO and the NOAA research vessel fleet. We also continued active participation in the international marine climate community.

Deliverables for the reporting period included the following:

1. Continue daily monitoring and automated quality control of data received from all vessels contributing to the SAMOS DAC.
2. Continue routine research-quality evaluation of meteorological data for all NOAA vessels contributing to the SAMOS DAC.
3. Distribute all quality-controlled SAMOS observations via web, ftp, and THREDDS services and ensure routine archival at NODC.
4. Develop and test new automated quality-control methods.
5. Engage OMAO to augment instrumental metadata for all recruited NOAA vessels.
6. Engage new user communities.
7. Continue liaison activities with U.S. and international (limited) government agencies, archives, climate programs, and the marine community

By making progress on these deliverables, described in the following sections, the SAMOS DAC continues to provide a high-quality, well-documented, surface underway dataset for use by a diverse community. In the past year, SAMOS data have been used to validate ocean model estimates of the freshwater inflow to the Gulf of Mexico under flood conditions (Androulidakis and Kourafalou 2013) and to examine the influence of the Mississippi River freshwater plume on a surface oil patch in the Gulf of Mexico. Both works address NOAA's goal for sustainable management of marine ecosystems and the former also addresses the goal for risks to coastlines and coastal infrastructure. Li et al. (2013) used SAMOS data to validate numerical weather prediction model and satellite estimates of winds in the Southern Ocean, improving the community understanding of the wind-driven Antarctic Circumpolar Current, key to upwelling and the general ocean circulation in the region. These are a few tangible examples of the

impact that the SAMOS initiative has on addressing NOAA’s societal challenges. Since SAMOS data are frequently used to validate satellite or model products and to develop new satellite retrieval algorithms, and these products are subsequently used for a range of research applications, it is difficult to directly track all the specific challenges that are addressed by FSU’s COD-funded efforts to provide a high-quality research vessel data product. Overall, our efforts target the program deliverables related to sea surface temperature, surface currents (via wind observations), and the air-sea exchanges of heat, momentum, and freshwater.

2.4. Data quality control (Deliverables 1 and 2)

A comparison of ship days of data received by the SAMOS DAC in FY2012 and FY2013 is presented in Table 1. The total number of vessels routinely transmitting meteorology and surface oceanographic data to the SAMOS DAC has remained stable in the past year; however, four vessels ceased data submission (*Ka’imimoana*, *McAurthur II*, *Oceanus*, *T.G. Thompson*) and five (*Endeavor*, *Fairweather*, *Falkor*, *Rainier*, *Thomas Jefferson*) were either recruited or had their data transmissions restored. Close collaboration between the SAMOS DAC and NOAA OMAO (see below) resulted in the receipt of additional data from NOAA vessels in FY13

Automated quality processing is completed on every dataset received from recruited vessels (Table 1). The automated processing continues to be a smooth operation; each dataset is versioned and tracked via an SQL database. In FY2013, we evaluated 4890 days of underway meteorological and near-surface ocean (SST and salinity) data (a 3.5% decrease from FY2012). The reduction of 180 ship days of data received and processed by the SAMOS DAC in FY2013 versus FY2012 is likely the result of overall reductions in ship operating days across the research vessel community. These data span the global ocean, extending into poorly sampled regions of the Indian, South Atlantic, and Southern oceans (Fig. 1). 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.

Table 1: Ships transmitting observations to SAMOS DAC during FY 2012 and FY 2013. Eight vessels recruited with funds from NSF’s Ocean Instrumentation and Technical Services program and one recruited via a contract with the Schmidt Ocean Institute are shown for completeness. Operators include NOAA, the Bermuda Institution of Ocean Sciences (BIOS), the Woods Hole Oceanographic Institution (WHOI), Australia and New Zealand via the Integrated Marine Observing System (IMOS), the U.S. Coast Guard (USCG), the U. S. Antarctic Program (USAP), the Scripps Institution of Oceanography (SIO), the Schmidt Ocean Institute (SOI), the University of Hawaii (UH), the University of Rhode Island (URI), the University of Washington (UW), and Oregon State University (OSU).

Vessel	Operator	Number of ship days with data	
		1/10/2011–30/9/2012	1/10/2012–30/9/2013
<i>Atlantic Explorer</i> ^{1,3}	BIOS	200	156
<i>Atlantis</i> ²	WHOI	332	169
<i>Aurora Australis</i> ¹	IMOS/Australia	213	157
<i>Bell M. Shimada</i>	NOAA	148	177
<i>Endeavor</i> ^{1,3}	URI	--	9
<i>Fairweather</i>	NOAA	--	11
<i>Falkor</i> ⁴	SOI	--	20
<i>Gordon Gunter</i>	NOAA	196	157
<i>Healy</i> ²	USCG	188	83
<i>Henry B. Bigelow</i>	NOAA	175	155
<i>Hi’ialakai</i>	NOAA	153	77
<i>Ka’imimoana</i>	NOAA	166	--
<i>Kilo Moana</i> ^{1,3}	UH	214	78
<i>Knorr</i> ²	WHOI	339	247

<i>Lawrence M. Gould</i> ²	NSF/USAP	256	259
<i>McArthur II</i>	NOAA	5	--
<i>Melville</i> ^{1,3}	SIO	234	275
<i>Nancy Foster</i>	NOAA	135	143
<i>Nathaniel Palmer</i> ²	NSF/USAP	315	345
<i>New Horizon</i> ^{1,3}	SIO	10	318
<i>Oceanus</i> ⁵	WHOI/OSU	48	--
<i>Okeanos Explorer</i>	NOAA	115	126
<i>Oregon II</i>	NOAA	151	185
<i>Oscar Dyson</i>	NOAA	200	224
<i>Oscar Elton Sette</i>	NOAA	183	127
<i>Pisces</i>	NOAA	160	207
<i>Rainier</i>	NOAA	--	117
<i>Roger Revelle</i> ^{1,3}	SIO	357	308
<i>Ronald Brown</i>	NOAA	126	134
<i>R. G. Sproul</i> ^{1,3}	SIO	16	108
<i>Southern Surveyor</i> ¹	IMOS/Australia	170	157
<i>Tangaroa</i> ¹	IMOS/New Zealand	232	195
<i>Thomas Jefferson</i>	NOAA	--	166
<i>T. G. Thompson</i> ^{1,3}	UW	33	--
		5070	4890

¹No research-quality visual QC completed.

²Visual QC discontinued at the end of 2012 as a result of NOAA budget reductions.

³NSF funding supported recruitment (part of UNOLS Rolling Deck to Repository program).

⁴*Falkor* recruited to SAMOS via contract with the Schmidt Ocean Institute. Leveraging COD-funded SAMOS infrastructure at FSU.

⁵*Oceanus* moved from WHOI to OSU at the start of 2012. This interrupted the data flow to SAMOS.

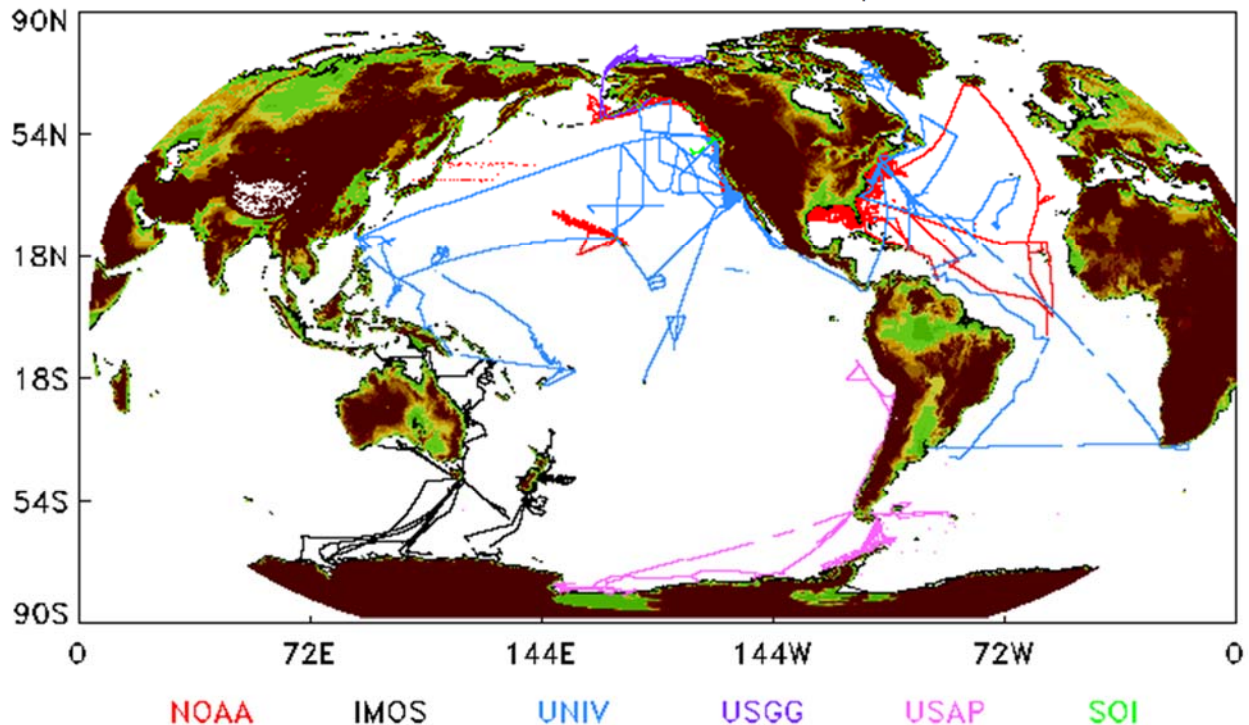


Figure 1. Cruise tracks showing data provided to the SAMOS DAC for FY2013. Data are color coded by the primary data providers. All university-operated vessels are shown in blue.

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, but ensures 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 completed visual 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 continued funding reductions from NOAA resulted in the loss of this capability for all non-NOAA vessels at the end of CY2012. The loss of visual QC for 5 vessels (Table 1) affected 1103 ship days of data, including data from the *L. M. Gould*, the *Nathaniel Palmer*, and the *Healy*, which primarily are located in the Southern and Arctic oceans. The reduction in the quality assessment of these high-value observations may adversely affect research applications in these extreme environments. We note that the Australians conduct visual QC for IMOS vessels. We are unable to leverage our NSF funding to provide additional visual QC for the non-NOAA vessels.

We again produced an annual report (Briggs et al. 2013) that summarizes the data quality for all vessels contributing data for the calendar year 2012. The report has been distributed to all operators of SAMOS vessels and posted to the SAMOS web site.

2.5. Data distribution and archival (Deliverable 3)

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](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. Available data 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 documented data management plan, 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, a subscription service for operators to access monthly data reports, desired SAMOS parameters and accuracy requirements, relevant literature and publications, best practice guides, and training materials.

SAMOS data are not presently provided to the Global Telecommunication System. As part of our work with JCOMM (see below) we are collaborating with the managers of the U.S. Voluntary Observing Ship scheme at the National Data Buoy Center (NDBC) to assess the quality of data records transmitted via the GTS from the same vessels that contribute to SAMOS. The majority of the U.S. research vessels contributing to SAMOS provide irregular 1-, 3-, or 6-hourly reports to the GTS via other National Weather Service- (NWS) supported programs (e.g., AMVER SEAS). Preliminary results reveal that the SAMOS data can be used to trouble-shoot the GTS data feeds from the NWS programs. The collaboration with NDBC personnel has also allowed SAMOS to receive updated instrumental metadata for several NOAA-operated RVs. The PI notes that our major user community continues not to require SAMOS data to be delivered via GTS. 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 either 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 10 October 2013 located 1220 monthly SAMOS ship archive sets at NODC. Periodically, the PI downloads SAMOS data from NODC to ensure system integrity.

2.6. *Developing new automated quality control (Deliverable 4)*

Progress on this deliverable was limited in FY2013. We completed a prototype code to update our land-sea test for platform position to use the one-minute (vs. two-minute) gridded topography dataset available from the National Geophysical Data Center. Implementation of this code should occur in late CY2013 and will reduce the number of ship positions that are incorrectly flagged as being over land by our present land-sea code. Other developments were delayed by the loss of a primary programmer at the start of 2013 and the 4-month search for a suitable replacement. Continued funding reductions and shifting priorities will likely result in limited, if any, new quality-control procedural developments in the coming years.

2.7. *Interaction with OMAO (Deliverable 5)*

Over the past year, the DAC has continued to communicate with the Office of Marine and Aviation Operations (OMAO) at NOAA. We now provide daily data delivery and data quality status reports to OMAO headquarters in Silver Spring via a real-time JSON web service. OMAO harvests the information from the web service and displays it at OMAO for their management team. Two face-to-face meetings, one at the annual UNOLS RV technicians meeting in Palisades, NY (Feb 2013) and the other at the NOAA Rolling Deck to Repository meeting in Silver Spring, MD (June 2013), provided an opportunity to improve the lines of communication with OMAO. These meetings allowed the PI and the DAC technical staff to begin working with OMAO’s programming team to develop new methods to extract instrumental metadata from the data acquisition system used by the NOAA fleet. We have obtained a copy of this software and are working to install it in our instruments lab at FSU. This will allow our data quality analysts to have a better understanding of the tools being used by the marine technicians on NOAA vessels and should improve fleetwide communication on SAMOS problems. In June, we also encouraged OMAO to approach COD to discuss the science user requirements of the NOAA RVs for climate applications. There is a growing interest in OMAO to ensure that their vessels are routinely providing all possibly underway observations on all cruises, regardless of the core science mission of the cruise. Through our ongoing dialog and data exchange, the DAC is providing a service to OMAO that improves the quality of the data collected by NOAA vessels. Our communications, in part, resulted in an increase of 93 ship days of data from the NOAA fleet reaching the national archives in FY2013 (Table 1). In a time of generally reduced sea days for the U.S. research fleet, increasing the quantity of high-quality marine observations reaching the national archives adds value to the public investment in NOAA’s research fleet. Ongoing interactions between the DAC and OMAO also address Technology and Mission Support goals in NOAA’s strategic plan.

2.8. Engage new user communities (Deliverable 6)

DAC personnel and colleagues in the marine climate community continue to spread the message about the SAMOS initiative and the value of high-quality underway observations from RVs. In the past year this engagement was primarily through presentations at national and international meetings. The PI presented on SAMOS at the Fall AGU meeting in San Francisco, CA (Dec. 2012), the NSF Rolling Deck to Repository Advisory meeting in Palisades, NY (Dec. 2012), the UNOLS Research Vessel Technical Enhancement Committee meeting in Palisades, NY (Feb. 2013), and the 7th Session of the JCOMM Ship Observation Team in Victoria, Canada (Apr. 2013; funded by COD). Colleagues at the NSF Rolling Deck to Repository program presented SAMOS activities to the international community at the European Geophysical Union meeting in Vienna, Austria (Apr. 2013) and at the International Conference on Marine Data and Information Systems in Lucca, Italy (Sep. 2013). The continued engagement with the research and operational community through meetings has increased the visibility of the SAMOS initiative and we are receiving more requests for our observations. In addition to the three known publications using SAMOS data by authors outside of FSU, we also know the data are being used to validate shortwave and longwave radiation fluxes in NRL models (J. May, personal communication, 2013), to estimate CO₂ fluxes in the western Arctic (C. Hauri, personal communication, 2013), and to determine ambient conditions during aerosol measurements on CLIVAR cruises (W. Landing, personal communication, 2013).

2.9. Liaison activities (Deliverable 7)

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) program, and the NOAA R2R initiative. The PI routinely receives requests from other marine data programs to share the lessons learned from SAMOS. Just over a decade past the first Workshop on High-Resolution Marine Meteorology held in Tallahassee, FL, on 3-5 March 2003 (funded by NOAA COD), the SAMOS project has become a model for the management of underway surface atmospheric and oceanographic 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 (Marine Climate Data System, Instrument Systems). In April 2013, the PI was invited to and participated as a U.S. representative at the 7th Session of the JCOMM Ship Observation Team in Victoria, Canada. This meeting provided an opportunity to connect with the U.S. VOS program and resulted in a follow-up, face-to-face meeting in May 2013 between the PI and NDBC personnel responsible for coordinating the VOS program for the NWS.

3. Outreach and Education

Through COD funding, we continue to train the next generation of marine and data scientists. Aaron Paget completed his Ph.D in 2013 for which he investigated how white capping can be estimated from satellite data. This project ties into better estimates of mid- to high-latitude winds and fluxes. Although we are not examining the following, the white capping work is also very important for ocean color observations (it is the limiting factor at high wind speeds) and estimating surface fluxes of CO₂, so the work supports the larger NOAA climate goals related to sustainable management of marine ecosystems.

The PI also mentored a high school student as part of the summer 2013 Young Scholars Program at FSU. Although not working directly with the SAMOS observations, our student examined biases in forecasts of tropical storm and hurricane strength at landfall along the U.S. coastline in 2004 and 2005. This preliminary investigation provided insight into sources of errors in the forecasts and directly addresses NOAA's climate challenge for risks to coastlines and coastal infrastructure. COD funding to the PI allows him the flexibility to participate as a mentor in this summer research experience for high school students.

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

Information on collaborators/partners:

- a. Name of collaborating organization: NOAA OMAO – John Katebini and Mark VanWaes
- b. Date collaborating established: 2013
- c. Does partner provide monetary support to project? Amount of support? None reported
- d. Does partner provide non-monetary (in-kind) support? Yes
- e. Short description of collaboration/partnership relationship: As noted in section 2.4, FSU collaborates with NOAA partners at OMAO to improve communication of best practices for meteorological and flow water system observations on the NOAA fleet. We also collaborate to provide feedback to operators and OMAO headquarters to support decision making for the fleet.

Information on outreach activities: None reported

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 #13-NGI2-53

Project Title: Pilot Genomic Observatories to Characterize Gulf of Mexico Microbial Populations

Project Lead (PI) name, affiliation, email address: Shiao Wang, University of Southern Mississippi, shiao.wang@usm.edu

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

Project objectives and goals

The objective of the project is to establish pilot-scale microbial genomic observatories from representative Gulf of Mexico habitats on behalf of NOAA and the Gulf of Mexico Alliance. There is a profound lack of baseline information in the Gulf about interactions between microbial features such as community structure, diversity, relative abundance, ecosystem functions, and the influence of environmental factors such as ocean acidification, land-based pollution, global climate change, and sea level rise. The goal is to improve our knowledge of microbial diversities and community structures critical to our understanding of ecosystem health, function, and resiliency at these habitats. Eventually, the information will be integrated with NOAA's Gulf Coast Ocean Observing System. The project also provides an opportunity to collaborate internationally with the Ocean Sampling Day efforts and Earth Biome Project.

The value of the work is highly leveraged by the acquisition of microbial metagenomic information provided to us for free as participants of international Ocean Sampling Day efforts. The information obtained is in the form of next-generation sequencing data that will form an extremely large microbial DNA sequence baseline data set that normally would be very expensive to obtain. It is anticipated that the genomic observatories established by this project will serve as a proof of concept for other sentinel sites in the Gulf of Mexico, and that the acquisition of other future funding will permit the long-term continuation of these observatories once they are established with this project. This project will serve to address a variety of NOAA mission goals including healthy oceans and resilient coastal communities and economies, and to conserve and manage coastal and marine ecosystems and resources.

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

Seawater samples were obtained during summer and winter solstices of 2013 and 2014 and processed according to Ocean Sampling Day guidelines. Samples were obtained from three sites in Florida (Site 37 - Port Everglades, Site 38 - Long Key, and Site 45 – Tampa Bay) and one site in the Northern Gulf (Site 46 – Horn Island). Samples obtained during the 2013 summer solstice were shipped on dry ice for processing and analysis to Argonne National Laboratory, Chicago, IL. Due to the large number of samples collected around the world, samples obtained during the 2013 winter solstice were shipped to the Max Planck Institute for Marine Microbiology in Germany for processing. DNA extraction was to be performed at the Biological Institute Helgoland of the Alfred Wegener Institute on the island Helgoland, Germany. DNA sequencing is still to be performed at the Argonne National Laboratory. Samples obtained during the 2014 summer solstice (June 21) have been processed and frozen at -80°C and await shipment to Germany.

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

We are currently waiting for DNA sequence results. Protocols for the international effort continue to be refined. There is now an OSD Handbook that serves as a best practice guide

describing procedures and policies on the marine sample collection, logistics and bioinformatics by the Micro B3 (Biodiversity, Bioinformatics, Biotechnology) Consortium. The Handbook is not yet available online at this moment (6/26/2014).

Information on collaborators/partners:

- a. Name of collaborating organization: NOAA OAR
- b. Date collaborating established: September 1, 2013
- c. Does partner provide monetary support to project? Amount of support? No
- d. Does partner provide non-monetary (in-kind) support? Yes, NOAA lab in Miami ships samples to Germany.
- e. Short description of collaboration/partnership relationship: NOAA collaborator collects and processes marine water samples from Florida sampling sites.

Information on outreach activities: None reported

Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology

NGI FILE #13-NGI2-54

Project Title: An Examination of Ocean-forcing Issues in HWRF-POM and HWRF-HYCOM

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

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

Project objectives and goals

The objective is to perform case study evaluations of tropical cyclones in which in-depth surface and sub-surface ocean sampling was implemented. Specifically, we will evaluate the 2014 versions of HWRF-HYCOM and GFDL-POM to assess model accuracy and identify any biases using XBTs, drifting buoys, moored buoys, and gliders. Satellite ocean algorithms will also supplement these evaluations.

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

We began this project through discussions with the Hurricane Research Division to determine appropriate hurricane case studies with water temperature observations. Frank Marks informed us Hurricane Isaac (2012) contained the best sample of AXBTs as well as a glider. Then, we examined several data archives, including AOML and the National Data Buoy Center (NDBC), but the best consolidation, quality control, and technical documentation of ocean observations were at the Coriolis website (<http://www.coriolis.eu.org/>).

Hyun-Sook Kim, a contractor for NOAA's Modeling and Observing Integration Branch, contacted us and offered collaboration on this project. She provided trial HWRF datasets so we could interact on data formats, map projection issues, and required variables. She then provided a series of operational Hurricane Isaac HWRF. After further discussion, it was decided the runs should be redone based on the 2014 version of HWRF, and using hindcast observed initial positions instead of operational positions.

Based on these datasets, we have constructed time series plots of water temperature of interpolated HYCOM data versus moored buoys, drifting AXBT buoys, and glider data for all model runs in the Gulf of Mexico initiated at 00Z, 06Z, 12Z, and 18Z. We have also overlaid time series of HWRF wind forecasts versus HWINDS datasets to assess if inaccurate wind structure forecasts may present a problem in the analysis. The evaluations end when any simulation track departs from the observed track.

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

A major problem has been the lack of documentation on HYCOM data processing in the literature and at hycom.org. For example, the methodology for determining vertical levels is not in the literature. NOAA/NCEP provided the MATLAB template, from which we wrote our own code. It also wasn't initially apparent that the temperature data was actually potential temperature θ . Comparing water temperature data at vertical levels requires iterations from θ .

Moreover, there was confusion on the reference pressure p_{ref} . HYCOM uses a $p_{ref}=200$ Pa, which is not the $p_{ref}=0$ Pa standard in the oceanography literature but preferred in ocean models and not documented at hycom.org. Upon further examination, on June 17, NOAA/NCEP then discovered θ is *output* with $p_{ref}=0$ Pa and with a newer empirical equation for θ from Jackett et al. (2006). The older version was run with the algorithm of McDougall et al. (2003). The code will be rerun with these changes in July.

Future work will include repeating this process for HWRF-POM, COAMPS, and the GFDL models.

Information on collaborators/partners:

- a. Name of collaborating organization: Hyun-Sook Kim, NOAA contractor
- b. Date collaborating established: Not reported
- c. Does partner provide monetary support to project? Amount of support? None reported
- d. Does partner provide non-monetary (in-kind) support? Yes
- e. Short description of collaboration/partnership relationship: We have interacted weekly and often daily with Hyun-Sook Kim, a contractor for NOAA's Modeling and Observing Integration Branch. She has been very helpful, providing model data, feedback, and MATLAB scripts. We usually use our own code as these Matlab scripts are quite advanced and perform many tasks, and it's easier for us to code for singular tasks. But, the code provided templates and equations we could follow.

Information on any outreach activities:

The Hurricane Isaac case studies will be presented at the International Conference on Mesoscale Meteorology and Tropical Cyclones in Boulder, CO, in September, 2014. We will evaluate and compare the ocean forcing from HWRF-HYCOM, HWRF-POM, and COAMPS. Our collaborators will be Hyun-Sook Kim, Sue Chen from the U.S. Naval Research Laboratory, and Richard Yablonsky from the University of Rhode Island.

Related NOAA Strategic Goals: Climate Adaptation and Mitigation, Weather-Ready Nation

Related NOAA Enterprise Objectives: Science and Technology

NGI FILE # 13-NGI2-55

Project Title: Enhancing the Mississippi Digital Earth Model (MDEM)

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

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

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

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 of 2013, 19 workshops were delivered to 189 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. Three new courses are in the process of development and will be available to the public in the fall of 2014. The courses are designed around the needs identified by workshop participants over the past several years. The 2-day workshops focus on both commercial and open source GIS applications.
- c. 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.
- d. The Mississippi Department of Environmental Quality has been acquiring, processing and assessing the QA/QC of over 10,000 miles of high-resolution road centerline geospatial data from 14 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 transitions

This project is focused on outreach, education and data acquisition. There is not a 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:

- a. Name of collaborating organization: Mississippi Department of Environmental Quality
- b. Date collaborating established: July 1, 2009
- c. Does partner provide monetary support to project? Amount of support? No
- d. Does partner provide non-monetary (in-kind) support? Yes
- e. 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 outreach activities:

Workshops and training: The GEO Project curriculum consists of 8 courses in GIS applications and geospatial database management. Nineteen 2 and 3 day workshops with 189 participants were held at 13 locations across the state. Detailed listing of the workshops:

Course Name	Date	Location	Number of Participants
ArcGIS II: Essential Workflows	June 17, 2014	Holmes Community College	8
ArcGIS I: Introduction to GIS	June 11, 2014	Grand Bay NERR - Coastal Resources Center	11
ArcGIS I: Introduction to GIS	June 3, 2014	Holmes Community College	10
ArcGIS I: Introduction to GIS	May 27, 2014	Grand Bay NERR - Coastal Resources Center	10
ArcGIS I: Introduction to GIS	May 22, 2014	Mississippi State University	12
ArcGIS I: Introduction to GIS	May 20, 2014	Mississippi State University	10
ArcGIS I: Introduction to GIS	April 22, 2014	Holmes Community College	12
ArcGIS II: Essential Workflows	April 1, 2014	Grand Bay NERR - Coastal Resources Center	9
ArcGIS I: Introduction to GIS	March 18, 2014	Grand Bay NERR - Coastal Resources Center	13
ArcGIS II: Essential Workflows	March 18, 2014	Holmes Community College	10
ArcGIS I: Introduction to GIS	February 18, 2014	Holmes Community College	11
ArcGIS II: Essential Workflows	September 24, 2013	Holmes Community College	7
ArcGIS I: Introduction to GIS	September 10, 2013	NASA Stennis Space Center	12
ArcGIS I: Introduction to GIS	August 20, 2013	Mississippi Emergency Management Agency	6
ArcGIS II: Essential Workflows	August 13, 2013	Mississippi State University	10
ArcGIS I: Introduction to GIS	August 6, 2013	Mississippi State University	10
ArcGIS II: Essential Workflows	July 30, 2013	Holmes Community College	6
ArcGIS I: Introduction to GIS	July 17, 2013	Holmes Community College	13
ArcGIS I: Introduction to GIS	July 9, 2013	Gulf Coast Community College	9

Related NOAA Strategic Goals: Weather-Ready Nation, Resilient Coastal Communities and Economies

Related NOAA Enterprise Objectives: Engagement

NGI FILE #13-NGI2-57

Project Title: Lagrangian Based Habitat Assessment for Bluefin Tuna (*Thunnus Thynnus*) Spawning in the Gulf of Mexico

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

Co-PIs names, affiliation, email address: Jerry Wiggert, University of Southern Mississippi, jerry.wiggert@usm.edu

NOAA sponsor and NOAA office of primary technical contact: Woody Nero, NMFS

Project Objectives and Goals

Reduce the uncertainty of the environmental conditions for spawning of Atlantic bluefin tuna (ABFT) by re-examining SEAMAP net collection data of larval size and estimates of age to inform a Lagrangian backtrack analysis that applies ocean model data to identify spawning source water. The end product will be the derivation of a more precise predictive model for ABFT adult spawning preferences, improved spawning habitat maps, and refinement of the ABFT larval assessment of spawning stock biomass.

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

The FATE project is applying existing and forthcoming data to examine five years of Bluefin Tuna larvae samples obtained during SEAMAP surveys (2009 - 2013) that have co-occurring AMSEAS and HYCOM ocean model data.

The research has incorporated three coordinated approaches:

- 1) Backtrack modeling has been employed to derive larval drift paths from likely spawning source to net capture, through transport pathways identified through the use of current velocity fields from oceanographic model outputs (HYCOM and AMSEAS). The backtrack method has been validated through comparison with available drifter data.
- 2) Environmental indices associated with Bluefin tuna spawning are being identified through the backtrack effort. This information is being used to refine spawning habitat models currently in use.
- 3) Emerging knowledge on the ecology of Bluefin tuna is being revealed by the drift paths and apparent along path conditions revealed by the backtrack model effort. These insights are being used to test emerging hypothesis of vertical migration, predation and natural mortality on the larvae.

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

Backtrack model results: The comparison between the drifters and the model highlight that the longer the backtracking is the biggest the error. After 10 days of backtracking the error is expected to be bigger than 50% of the displacement. This indicates that for optimal results the backtracking should be used for less than 10 days.

Environmental indices results:

This phase of the project is in progress. Source code to reveal information on the preferred environmental conditions for spawning has been developed. These routines are used to report

the ocean conditions (temperature, salinity, currents, curl, mixed layer depth) at each potential spawning location. These environmental indices are extracted after backtracking from sample locations where larvae are captured, based on their location and (size-based) age. To develop a comprehensive view of the preferred conditions for spawning, the software is designed to accumulate indices at sampling locations where larvae are observed as well as where no larvae are obtained. Backtrack from these sampling locations is then employed to reveal tendencies of where environmental conditions are conducive to spawning and where they tend to inhibit spawning.

Information on collaborators/partners:

This project is being carried out as a close collaboration between the NOAA/NMFS project scientist (Dr. Woody Nero) and the USM-DMS project team (Drs. Jerry Wiggert and Cléa Denamiel). Drs. Nero and Denamiel carryout the day-to-day project tasks, which is facilitated by the close proximity of the NMFS and DMS sites at Stennis. Dr. Wiggert meets regularly (bi-monthly) with the USM-DMS postdoctoral scholar (Dr. Denamiel) to oversee the project's progress, provide guidance on research tasks, and facilitate access to any resource needs.

Information on outreach activities: None reported

Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology

NGI FILE #13-NGI2-58

Project Title: Engineering Studies for NOAA UAS Program

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

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

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 was 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

- Visited 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.
- Completed analysis of payloads and sensors appropriate for RFC requirements.
- Provided sensors and payload report to the NOAA UAS Program Office in September 2013.
- 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 AeroVironment Inc.
- Prepared required documents to fly Puma with NOAA OAMO AOC between New Orleans, LA and Waveland, MS in September. Mission was delayed until November.
- Flew Altavian Nova (MSU owned) and AV Puma (NOAA owned) over section of lower Pearl River near Slidell, MS November 5-7, 2013.
- Mosaicked the collected data and provided to the LMRFC, along with videos of launches and landings.
- Prepared a presentation on preliminary results and provided to the NOAA UAS Program Office and the LMRFC.
- Made plans for another mission to the lower Pearl River area in February 2014; mission was cancelled.

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

- The AV Puma UAS is a rugged platform. However, it lacks the ability to do an adequate job of mapping.

- The Altavian Nova is a less rugged platform. However, it has the ability to capture 1 inch pixels from 800' AGL with adequate pointing accuracy from a non-metric payload.
- The Altavian Nova can capture visible image data well enough to meet many of the mapping requirements of the RFCs.

Information on collaborators/partners

- a. Name of collaborating organization: NWS LMRFC
- b. Date collaborating established: May 2008
- c. Does partner provide monetary support to project? No Amount of support? N/A
- d. Does partner provide non-monetary (in-kind) support? Yes, their time and advice. They assist in providing requirements, collecting data, and evaluating the applicability of the results
- e. Short description of collaboration/partnership relationship: See previous answer. They are helping us understand the needs of the RFCs with regards to collecting data, predicting incidents, and evaluating incidents and models. We are providing them with time-varying data so that can determine hydrologic processes. We are providing them with much higher resolution data than they previously had.

Information on any outreach activities:

Started working on a 2nd workshop for the River Forecasting Centers to present recent results, to update them on UAS technology, and to update their requirements. This workshop is planned for the day before the annual Alaska UAS Interest Group meeting in September in Anchorage, AK.

Related NOAA Strategic Goals: Climate Adaptation and Mitigation, Weather-Ready Nation, Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology

NGI FILE #13-NGI2-59

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: Dr. Xiaolei Zou, Florida State University, xzou@fsu.edu

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

Project objectives and goals

This project will refine the assimilation process of GOES-11/12/13/15 imager radiance assimilation along with 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

- Assessed the added values of GOES-13/15 imager radiance data to other satellite data for improved hurricane forecasts using the Hurricane Weather Research Forecast (HWRF) system with a symmetric and asymmetric vortex initialization schemes
- Developed a new cloud detection algorithm to MHS quality control, whose original cloud detection algorithm in NCEP GSI system had detrimental impact on GOES data assimilation
- Developed and tested 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
- Investigated the impacts of three orbits satellite radiance assimilation on coastal QPFs near Gulf of Mexico

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

1) An Objective Regional Cloud Mask Algorithm for GOES Infrared Imager Radiance Assimilation

A local, regime-dependent cloud mask (CM) algorithm is developed for isolating cloud-free pixels from cloudy pixels for Geostationary Operational Environmental Satellite (GOES) imager radiance assimilation using mesoscale forecast models. In this CM algorithm, thresholds for six different CM tests are determined by a one-dimensional optimization approach based on probability distribution functions of the nearby cloudy and clear-sky pixels within a $10^\circ \times 10^\circ$ box centered at a target pixel. It is shown that the optimal thresholds over land are in general larger and display more spatial variations than over ocean. The performance of the proposed CM algorithm is compared with Moderate Resolution Imaging Spectroradiometer (MODIS) CM for a one-week period from 19 to 23 May 2008. Based on MODIS CM results, the average Probability of Correct Typing (PCT) reaches 92.94% and 91.50% over land and ocean, respectively.

2) Improved Tropical Storm Forecasts with GOES-13/15 Imager Radiance Assimilation and Asymmetric Vortex Initialization in HWRF

The Geostationary Operational Environmental Satellite (GOES) imagers provide visible and infrared channel data that are of high temporal and high spatial resolutions for many applications such as monitoring severe weather events. In this study, GOES-13 and GOES-15

imager radiances are directly assimilated through the National Centers for Environmental Prediction (NCEP) Gridpoint Statistical Interpolation (GSI) system to produce the analysis fields as the initial conditions of Hurricane Weather Research and Forecasting (HWRF) model. Impacts of GOES imager data assimilation on track and intensity forecasts are demonstrated for a landfall tropical storm that moved across the Gulf Mexico --- the 2012 Debby. With a higher model top and a warm start added to HWRF, an asymmetric component is also added to the original HWRF symmetric vortex initialization. Two pairs of data assimilation and forecasting experiments are carried out for assessing the impacts of the GOES imager data assimilation on tropical storm forecasts. The first pair employs a symmetric vortex initialization and the second pair includes an asymmetric vortex initialization. Numerical forecast results from the two pairs of experiments are compared among each other. It is shown that a direct assimilation of GOES-13 and GOES-15 radiance observations, which are available at all analysis times, in HWRF results in a consistently positive impact on the track and intensity forecasts of the tropical storm Debby in Gulf Mexico. The largest positive impact on the intensity forecasts comes from a combined effect of GOES imager radiance assimilation and an asymmetric vortex initialization.

3) Impact of NOAA-15 AMSU-A Data on Quantitative Precipitation Forecasts and Its Implications for Three-Orbit Constellation

This study demonstrates the added benefits of assimilating the Advanced Microwave Sounding Unit-A (AMSU-A) radiances on short-range coastal precipitation forecasts (QPFs) near Gulf of Mexico from an early morning orbit satellite (e.g. NOAA-15), in addition to those data from a mid-morning (MetOp-A) and an afternoon (NOAA-18) orbits. The National Centers for Environmental Prediction (NCEP) Gridpoint Statistical Interpolation (GSI) is used for assimilating the AMSU-A data. For the case selected in this study, two pairs of data assimilation and forecasting experiments are carried out to compare the differences in QPFs with and without AMSU-A data from NOAA-15. It is shown that the two orbits provided by NOAA-18 and MetOp-A make the Gulf of Mexico and the western United States continent a data-void area for satellite data assimilation at 0000 UTC and 1200 UTC. Adding data from an early morning-orbit fills such a data gap. Assimilation of NOAA-15 AMSU-A data thus results in a consistent positive impact on the QPFs near the Gulf coast. Results from these experiments suggest a need for a continuing availability of an early morning orbit satellite with AMSU-A or AMSU-A like instrument onboard. A partial solution is a sustained effort to maintain the NOAA-15 AMSU-A for a longer-lived operation.

Information on collaborators/partners:

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

Information on any outreach activities:

General Description: During the reporting period, we attended the 2014 AMS annual meeting to present our recent research results

Type (speaker, workshop, training): Speaker

Name of event: 2014 American Meteorological Society (AMS) annual conference

Date: February 2-6, 2014

Location: Atlanta, GA

Description: One oral and two poster presentations

Approximate Number of Participants: Annual meeting included 2,000 meteorologist

Type (speaker, workshop, training): Speaker
Name of event: 2014 19th International TOVS Study (ITS) conference
Date 26 March – 1 April 2014
Location: Jeju Island, South Korea
Description: Three oral presentations
Approximate Number of Participants: 100 participants

Related NOAA Strategic Goals: Weather-Ready Nation

Related NOAA Enterprise Objectives: Science and Technology

NGI FILE #13-NGI2-60

Project Title: Development of Detailed Habitat Maps along the Continental Shelf of the Gulf of Mexico Using Previously Collected Multibeam Sonar Data

Project Lead (PI) name, affiliation, email address: Kenneth Barbor, University of Southern Mississippi, ken.barbor@usm.edu

Co-PI(s) name(s), affiliation, email address: Ian Chruch, University of Southern Mississippi, lan.church@usm.edu

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

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 HSRC is to data mine multibeam and side scan sonar data collected from various trusted sources in the coastal northern Gulf of Mexico, U.S. Caribbean, and the southeast coast of the U.S. SEFSCL will also provide multibeam data collected using their Simrad ME70. From these mined and provided data, snippets of data spanning habitats of interest will be extracted for further analysis. This analysis includes the construction of various layers, ultimately ported to an ArcGIS data base. Directly retrieved layers include bathymetry and backscatter, with a derived layer of rugosity, and an analyzed layer of substrate classification. Substrate classification will be further informed through the analysis of existing substrate records and video, where available.

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

The efforts of the HSRC were delayed, as was noted in the initial proposal, while a faculty search was completed to fill the recent vacancy in the Hydrographic Science Program. The search was successful with the new faculty member arriving mid-January 2014. However, a full teaching load during the Spring Semester prevented him from significantly advancing the project.

To date, Multibeam and side scan sonar data in the Gulf of Mexico and Caribbean for NOAA *Ship Nancy Foster* have been downloaded from the National Geophysical Data Center (NGDC) and appropriate snippets from these data extracted. Scripts have been written in MB-system, an open source program for manipulating multibeam data, to process the backscatter information contained in the snippets.

SEFSCL video observations and usSEABED sampling data are being compiled as reference seabed habitat data into ArcGIS layers.

SEFSCL has provided existing ME70 data for the areas of interest. Following updates to the MatLab® code developed by Dr. Tom Weber, these data will be converted to Generic Sensor Format (.GSF) for further processing with the resulting bathymetry compiled into ArcGIS layers. Various software routines will be evaluated for the extraction of backscatter data contained in the ME70 raw data as well as techniques for removing artifacts from the backscatter data. Clean backscatter data from the ME70 and NGDC data will be normalized to produce a backscatter ArcGIS layer. Areas of similar backscatter values will be compared to video records and other observational data to evaluate habitat type. These habitat types, derived from backscatter will form additional ArcGIS layers.

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

To date, the efforts have been largely mechanical; although, the development of scripts within MB-System has provided a degree of automation to these mechanical processes. The determination of the best method for extracting backscatter data and removing artifacts will provide valuable transition to operations. Similarly, the methodology for normalizing ME70 backscatter for comparison to other more ubiquitous multibeam will be an important transition.

Information on collaborators/partners: None reported

Information on outreach activities: None reported

Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Goals: Science and Technology

NGI FILE #13-NGI2-61

Project Title: Hypoxia Research Coordination Workshop

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

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

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

Project objectives and goals

- Advance the science underpinning management of the large annual hypoxic zone (“dead zone”) in the northern Gulf of Mexico.
- Provide a forum for strengthening communication between physical, biological, and socioeconomic modelers of the Gulf of Mexico hypoxia and the Mississippi River diversions, and the users and stakeholders.
- Validate and refine key fisheries management and habitat conservation needs associated with ecosystem effects of hypoxia and large-scale river diversions in the Gulf of Mexico;
- Assess adaptive management needs for advancing ecosystem modeling of hypoxia and diversion effects on habitats and living resources in the northern Gulf of Mexico.

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

Conducted the 5th Annual Hypoxia Research Coordination Workshop to update scientific understanding of hypoxic zone causes and impacts, coordinate Gulf hypoxic zone research, monitoring and modeling activities, and facilitate information exchange between the research and management communities. The workshop will focus the models used to assess and predict the impacts of diversions and hypoxia on Gulf fisheries and their habitats in an ecosystem context, including humans – an issue critical to assessing the ecological and socioeconomic value of ecosystem restoration efforts, and to informing adaptive management of these efforts moving forward.

a. Output: *Ecological Modeling Matrix*

b. Output: *Defined management needs related to living resource and habitat effects of Gulf hypoxia and diversions*

c. Output: *Ecological Modeling Adaptive Management Framework* for advancing ecosystem modeling of hypoxia and diversion effects on fisheries in the northern Gulf of Mexico.

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

The workshop was designed to advance fisheries ecosystem management in the northern Gulf to inform efforts to assess and predict the potential ecological and socioeconomic effects of diversions and hypoxia. Emphasis was on assessing ecological impacts of diversions on aquatic habitats and potential impacts on the development of hypoxic zones. This is in support NOAA’s Ecological Roadmap Initiatives:

Action HY2: “Initiate more robust user needs assessment of living resource/habitat impacts” [of Gulf hypoxia] and

Action HY8: “Integrate nutrient-based models (water quality management) with living resource models (fisheries management).”

A White Paper entitled “*Ecosystem Modeling Adaptive Management Framework* for advancing ecosystem modeling of hypoxia and diversion effects on fisheries in the northern Gulf of Mexico” will be produced.

A White Paper on the “Direct and Indirect Effects on Gulf of Mexico Fisheries and Future Information Needs will be produced.

A workshop report for the Hypoxia Task Force will be prepared.

Dr. Ashby participated as members of the Steering Committee for the workshop, helping to set the agenda and chose participants for writing teams, and participated on the writing team.

Information on collaborators / partners

- a. Name of collaborating organization: The Steering Committee members for the workshop were all collaborators on this project. The membership of the committee is: Steve Ashby (Northern Gulf Institute), Alan Lewitus (NOAA NCCOS), Dave Kidwell, NOAA NCCOS), Dave Scheurer (NOAA NCCOS), Chris Kelble (NOAA OAR), Howard Townsend (NOAA OHC), LaToya Miles (NOAA ARL), Marie Bundy (NOAA NOS), Steve Giordano (NOAA OHC), Rich Fulford (EPA Gulf Breeze Laboratory), Lael Butler (EPA Gulf of Mexico Program), Julie Marcy (USACE Engineer Research and Development Center), and Alisha Renfroe (National Wildlife Federation)
- b. Date collaborating established: July 2009
- c. Does partner provide monetary support to project? Amount of support? None Reported
- d. Does partner provide non-monetary (in-kind) support? Yes
- e. 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

Type (speaker, workshop, training): Workshop

Name of Event: Advancing Ecological Modeling for Diversions and Hypoxia in the Northern Gulf of Mexico

Date: July 14-16, 2014

Location: Stennis Space Center, MS

Description: Workshop was designed to advance fisheries ecosystem management in the northern Gulf to inform efforts to assess and predict the potential ecological and socioeconomic effects of diversions and hypoxia.

Approximate Number of Participants: 95

Related NOAA Strategic Goals: Climate Adaptation and Mitigation, Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology

NGI FILE #13-NGI2-62

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

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

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

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 24-36 days of fishery-independent sampling to capture and tag adult smalltooth sawfish. However, actual days at sea may be limited by permitted captures of endangered sawfish and availability of satellite transmitters.

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 trawl 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.

Methods: Bottom longlines consisting of nylon or 3.5 mm monofilament mainline and 50-100 gangions are deployed to capture sawfish. Gangions are terminated with non-offset, baited circle hooks ($\geq 16/0$) and longlines are anchored and marked with a buoy and/or highflieer 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 either 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 (Sibert et al. 2003) incorporating sea-surface temperature (Nielson et al. 2006) 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, two research trips (12 total days, 8 days at sea) were completed and 30 total fishery independent longline sets were made, all aboard an FSU research vessel (a 26' Calcutta). Twelve adult or large juvenile sawfish were captured and tagged (Figure 1). The first trip was completed in August 2013, with a goal of tagging 4 sawfish, accomplished after four days of sampling and fishing 12 longline sets. Additional trips were scheduled for November 2013, January 2014, March 2014, and May 2014. However, our Endangered Species Permit expired in October 2013, and though we applied for the renewal more than a year prior to the expiration, it was not granted until March 2014. Therefore the trips planned for November and January were canceled. In March 2014, we completed four days at sea based out of the Keys Marine Lab. During this trip, we conducted 18 demersal longline sets in the middle Keys. However, due to high winds, no sets were made in offshore areas on the Atlantic side of the Keys where interactions with commercial longline fisheries have occurred. All sets were distributed in shallow waters in Florida Bay in areas with reported sawfish encounters in the NSED. We captured eight sawfish (3 in Conchie Channel and 5 in East Cape Canal in Florida Bay). Our Endangered Species permit only allows the capture of 20 large sawfish per year. Therefore, the May trip was canceled to avoid tagging all sawfish in the same season.

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

During the reporting period we captured and tagged 10 large individuals of the endangered smalltooth sawfish. Using NGO funds and previous funds from the NOAA Section 6 Program, we have completed 201 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 (Figure 1). We captured 30 adult or large juvenile smalltooth sawfish. 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 19 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 (Figure 2). Males use very shallow flats and channels in Florida Bay from January through August, but also occur in deeper water along the edge of the continental shelf at least from March through August. Adult females occur in Florida Bay at least between January and March. Additional sampling during winter months is needed to examine potential use of Florida Bay waters by females. Depth data obtained from satellite tags suggest only ephemeral use of shelf-edge habitats where most interactions with commercial fisheries occur (Figure 3). Adult sawfish spent the great majority of their time in waters less than 10 meters deep.

We also collect blood samples from captured sawfish. These samples have been analyzed by collaborators at the University of North Florida to examine cycling of reproductive hormones in an effort to determine timing and periodicity of vitellogenesis, sperm production, mating and parturition. In addition, during the reporting period, we began analyzing blood samples for physiological indicators of stress. Preliminary data suggest fishery-independent capture methods induce very low stress. These data will be useful as baselines to compare to sawfish captured using fishery-dependent methods.



Figure 1. Distribution of fishery-independent longline stations (N=201) sampled between 2011 and 2014 to capture and tag endangered smalltooth sawfish. Red flags = sawfish capture locations.

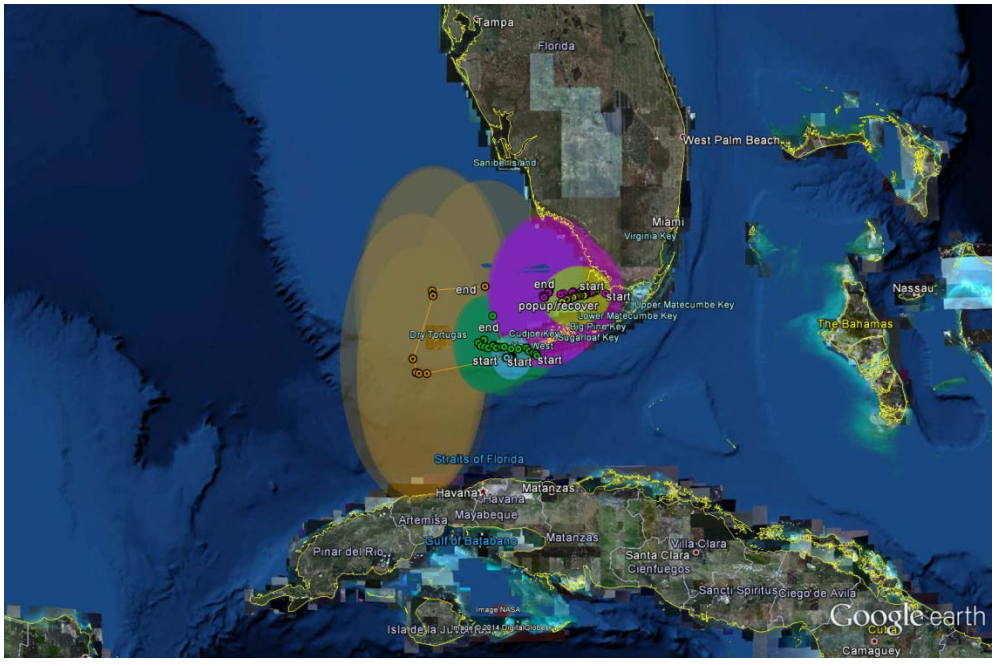


Figure 2. Most likely tracks of five satellite tagged sawfish tagged in Florida Bay and the Florida Keys following application of raw data to a Kalman Filter. Ellipses represent 95% confidence around tracks.

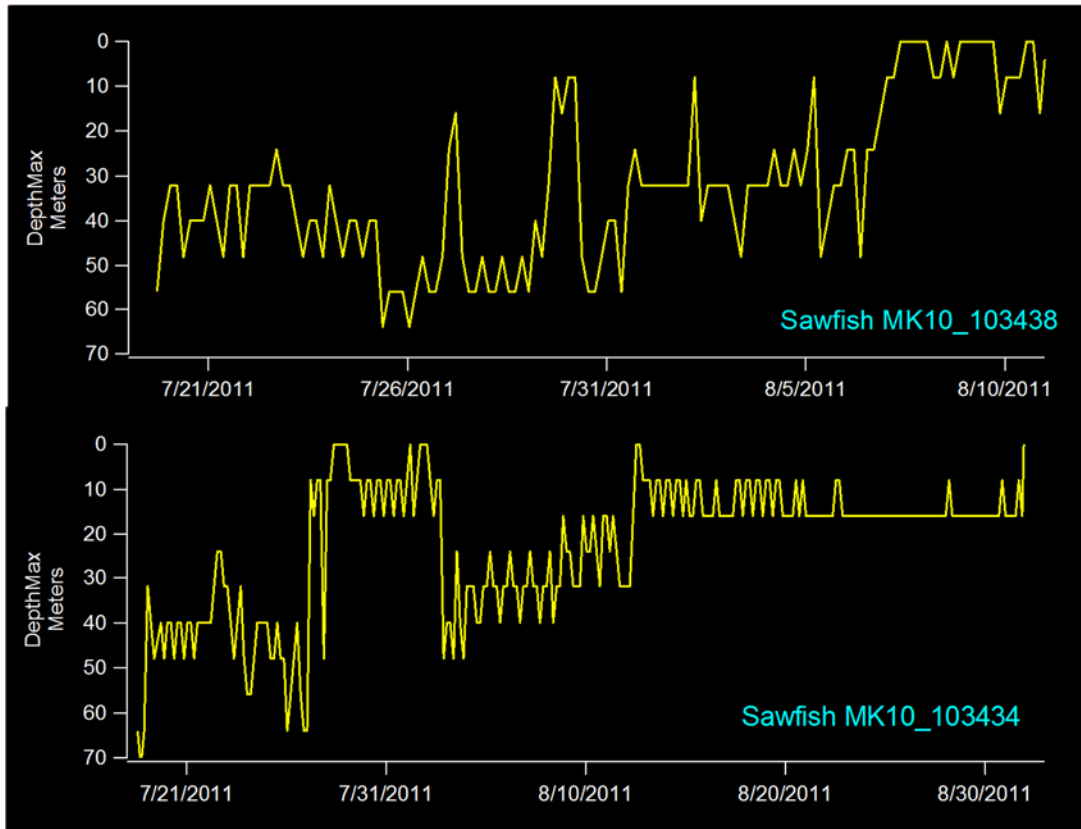


Figure 3. Depth data obtained from two sawfish tagged on the edge of the continental shelf indicating ephemeral use of this habitat.

Information on collaborators/partners

- k. Name of collaborating organization: Dr. John Carlson, Dr. Shelley Norton - NOAA Southeast Fisheries Science Center and Office of Protected Resources
- l. Date collaborating established: November 2009
- m. Does partner provide monetary support to project? Amount of support? Monetary support through NGI
- n. Does partner provide non-monetary (in-kind) support? Yes, satellite transmitters and satellite time
- o. Short description of collaboration/partnership relationship: Our colleague from NOAA Fisheries supplies some the satellite transmitters that we deploy and the satellite time needed to download the data
- a. Name of collaborating organization: Dr. Jim Gelsleichter – University of North Florida
- b. Date collaborating established: November 2009
- c. Does partner provide monetary support to project? Amount of support? No monetary support
- d. Does partner provide non-monetary (in-kind) support? No
- e. 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.

- a. Name of collaborating organization: Gregg Poulakis, Dr. Phil Stevens – Florida Fish and Wildlife Conservation Commission
 - b. Date collaborating established: November 2009
 - c. Does partner provide monetary support to project? Amount of support? No current monetary support
 - d. Does partner provide non-monetary (in-kind) support? No
 - e. Short description of collaboration/partnership relationship: Our colleagues from FWC are conducting stable isotope analyses using samples we collected. We also deploy acoustic tags supplied by our FWC colleagues on captured sawfish. They were also our collaborators on work previously funded through the NOAA Section 6 program
- a. Name of collaborating organization: George Burgess – Florida Museum of Natural History, University of Florida
 - b. Date collaborating established: November 2009
 - c. Does partner provide monetary support to project? Amount of support? No current monetary support
 - d. Does partner provide non-monetary (in-kind) support? No
 - e. 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. We also download receivers belonging to our FMNH colleagues and deploy acoustic transmitters supplied by them.

Information on any outreach activities:

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

National Museum of Natural History and Science (MUHNAC) in Lisbon, Portugal. Invited Keynote/Plenary speaker for the Iberian Congress of Ichthyology. Endangered sawfish and deep-sea sixgills: using modern telemetry to study very large elasmobranch fishes. 26 June 2014.

Tallahassee Community College. Lecture for OCE1001. The Biology of sharks and rays, their diversity in Florida, and current shark and sawfish research at FSU. 03 December 2013

NOAA Southeast Regional Office. Lunch and Learn Series. Movement Patterns and Reproductive Status of Smalltooth Sawfish and Habitats of Importance in Areas of Commercial and Recreational Fishery Interactions. 13 November 2013.

University of Central Florida. Biology Seminar: Sawfish to sixgills: using tagging and telemetry to inform management and conservation of exploited, imperiled and poorly studied elasmobranch fishes. 16 September 2013

Carr Elementary and Middle School, Clarksville, FL. Coastal and deepsea sharks and rays of the Gulf of Mexico. 01 April 2014. Lecture to 60 7th and 8th grade students

Springwood Elementary School, Tallahassee, FL. Coastal and deepsea sharks and rays of the Gulf of Mexico. 28 February 2014. Lecture to 40 5th grade students

REEF Fish and Friends Lecture, REEF.Org, Key Largo, FL. Movement Patterns and Habitat Use of Smalltooth Sawfish in south Florida and the Bahamas, Research to Support Recovery of a Critically Endangered Species 08 April 2014

Grassroots School, (age 5-14) Tallahassee, FL. Sharks, Fact and Fiction. 10 December 2013

Maclay High School, Tallahassee, FL. Facts and fiction about sharks and rays, their diversity in Florida, and current research. 03 December 2013

Askew Student Life Cinema, FSU. Introductory Talk for Screening of Changing Seas: Creature of the Deep followed by panel discussion. 02 December 2013

Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology

NGI FILE #13-NGI2-63

Project Title: Support of NOAA's Marine Mammal Health and Stranding Response Program (MMSHRP) in the Northern Gulf of Mexico through the NGI: Alabama Marine Mammal Stranding Response

Project Lead (PI) name, affiliation, email address: Ruth H. Carmichael, Dauphin Island Sea Lab, rcarmichael@disl.org

NOAA sponsor and NOAA office of primary technical contact: Laura Engleby, NMFS

Project objectives and goals

The objective of this project was to support Dauphin Island Sea Lab's operation of the Alabama Marine Mammal Stranding Network (a member of the NOAA NMFS Southeast Region Marine Mammal Stranding Network) by providing funds for use of a 24-hour emergency phone and travel for some stranding response activities, and allow acquisition of important pieces of equipment to facilitate stranding response and improve quality data collection in Alabama and nearby waters.

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

All work was accomplished; this was not a research based proposal, but infrastructure and support for immediate and future stranding response.

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

Not applicable

Information on collaborators/partners:

- a. Name of collaborating organization: NOAA's NMFS, other members of the SER Stranding Network
- b. Date collaborating established: 2010
- c. Does partner provide monetary support to project? Amount of support? Not typically, except for NOAA support through this program or the competitive Prescott Grant program
- d. Does partner provide non-monetary (in-kind) support? Consultation on stranding response and occasional mutual aid
- e. Short description of collaboration/partnership relationship: Mutual aid for stranding response and consultation on response as needed; providing assistance with field response, data collection, and necropsy. All SER Stranding Network Partners provide mutual aid to each other.

Information on any outreach activities:

General Description: ALMMSN provides public education and outreach to notify the public of our program, who to call to report strandings, and what to do in case of live animal strandings. We also conduct training sessions for our volunteers and interns.

Type (speaker, workshop, training): Outreach booth

Name of event: Mobile Boat show

Date: 02/07-08/14

Location: Mobile Convention Center

Number of participants: 15,000

Type (speaker, workshop, training): Outreach booth
Name of event: Biloxi Boat show
Date: 02/21-22/14
Location: Mississippi Coast Coliseum
Number of participants: 15,000

Type (speaker, workshop, training): Training
Name of event: DISL Manatee/ALMMSN training
Date: 9/28/13
Location: Five Rivers Delta Center
Number of participants: 20

Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology

NGI FILE #13-NGI2-64

Project Title: Establishing Secure Long-Term Archival for NOAA/NMFS Preserved Specimens at USM's Plankton Archival Facilities

Project Lead (PI) name, affiliation, email address: William M. Graham, University of Southern Mississippi, monty.graham@usm.edu

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

Project objectives and goals

Provide secure storage for NOAA/NMFS preserved specimens

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

Acquired and maintained secure and controlled storage at USM facilities at Stennis Space Center

Information on collaborators/partners

- a. Name of collaborating organization: NMFS, SEFSC Mississippi Laboratories
- b. Date collaborating established: 10/01/2013
- c. Does partner provide monetary support to project? Amount of support? Grant via NGI. Total project support is \$ 29,384
- d. Does partner provide non-monetary (in-kind) support? No
- e. Short description of collaboration/partnership relationship: USM and NOAA/NMFS are collaborating to provide a secure plankton archival facility at the John C. Stennis Space Center in Hancock County, MS. The NMFS is providing funds for the lease arrangement between USM and NASA, while USM provides support for routine upkeep of the facility.

Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology

NGI FILE #14-NGI2-67

Project Title: Northern Gulf Institute Diversity Internship Program

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

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

Project objectives and goals

The primary objective of the NOAA-NGI Diversity Internship Program is 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.

The Diversity Internship Program places interns at various organizations and laboratories throughout the Northern Gulf of Mexico coastal region. Potential mentors indicate intern projects on the mentor application form found on the program's website (<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.

The program makes contributions to specific NOAA goals and 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.

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

The NOAA-NGI Diversity Internship Program supported 8 interns at 8 academic and federal locations across the Gulf coast in Summer 2013 (Table 1). Interns were from 3 demographic groups underrepresented in NOAA's workforce (African-American, Asian and Hispanic/Latino) and included undergraduate students and Master's candidates. Six of the eight interns were females. Internship activities and focus areas were very diverse. Project areas included water quality- monitoring and stormwater management, fisheries research- groundfish surveys, gut analyses, ichthyoplankton distributions, GIS analyses of landform changes, diatom distribution and abundance in the Gulf of Mexico after the DWH, the use of stable oxygen isotopes as tracers and social science research on the effects of oyster attributes on people's willingness to pay.

A two-day orientation session was at the beginning of the program, May 28-30, 2013. The session provided interns with an introduction to NOAA (given by Mr. Russ Beard), NGI (given by Dr. John Valentine) and a discussion of program obligations and opportunities (given by Dr. Tina Miller-Way). During this time, the interns also received training in data management and metadata given by Ms. Kathy Martinolich of NCDDC.

Table 1: NOAA-NGI Interns – Summer 2013

	Name	Ethnicity	Gender	Home institution	Educational Level	Internship Location	Internship Mentor
1	Bland, Charnelle	African-American	F	Emory University	undergraduate	Valdosta State University	James Nienow
2	Huynh, Sandra	Asian	F	University of South Alabama	undergraduate	Gulf Coast Research Laboratory	Frank Hernandez
3	Mayedo, Amy	Hispanic	F	University of Florida	undergraduate	Alcorn State University	Jairo Diaz
4	Subedee, Mukesh	Asian	M	Clark University	Master's	Harte Research Institute	James Gibeaut
5	Castro-Ortiz, Mara	Hispanic	F	University of Puerto Rico - Humacao	Master's	National Marine Fisheries Service - Pascagoula	Andre Debose
6	Oliveras, Miguel	Hispanic	M	University of Puerto Rico - Mayaguez	Master's	Mississippi State University - Geosystems Research Institute	John Ramirez-Avila
7	Acquah, Sara	African	F	Mississippi State University	Master's	Mississippi State University - Dept. of Agricultural Economics	Daniel Petrolia
8	Pathare, Mrunmayee	Asian	F	University of Southern Mississippi	Master's	Stennis Space Center	Alan Shiller

An Internship Summit was held at the conclusion of the program on August 1-2, 2013. On August 1st, the interns traveled to Stennis and had an opportunity to speak with NOAA and NGI staff and other federal agency personnel and to present results of their internship. In the morning, an informal roundtable discussion with several NOAA and NGI employees was held giving the interns time to ask questions about career paths and choices, discuss pros and cons of the various positions in STEM fields and strategies for seeking NOAA and other federal agency employment. In the afternoon, interns gave a short presentation (15-20 min) about their research to an audience of mentors and various NGI and NOAA staff members. The Summit also presented an opportunity for 2 interns from the National Data Buoy Center at Stennis to share their research. Electronic copies of these presentations have been submitted to the NGI Program Office. NOAA-NGI Interns returned to the Dauphin Island Sea Lab to complete program evaluations and took a half-day trip to Mobile Bay and the coastal Gulf of Mexico aboard DISL's research vessel.

Pre and post-program evaluations were conducted and interns reported high levels of overall satisfaction with the program. Specifically, results showed significant gains in the degree to which they 1) had an understanding of NGI's mission and research themes, 2) had an understanding of NOAA's mission, organization and its various entities, 3) had an understanding of career opportunities at NOAA, 4) felt comfortable analyzing data, 5) felt comfortable using software for the visual depiction of data, 5) felt comfortable using databases, and 6) accessed and used data from a federal or state organization website. Not surprisingly, they also reported

increased research experience, an increased understanding of metadata, and the degree to which they used and accessed metadata. Interestingly, they reported 1) increased confidence in finding and identifying credible scientific information on the web, 2) gains in knowledge about the ecology of the Gulf of Mexico, and 3) an increased understanding of the importance of the Gulf of Mexico to the nation. Evaluations used were similar to those used in the 2012 program to facilitate comparisons. Our office has stayed in touch with this cohort of interns through a group Facebook page. Several of the undergraduates have started graduate school in STEM fields and several of the Master's students have completed their degrees.

The project period covered by this report extended into the preparatory time needed for the 2014 NOAA-NGI Diversity Internship Program. Webpages, recruiting information, application materials, mentor surveys and Google maps of internship locations were updated. A new project coordinator was hired for the 2014 program as our 2013 Coordinator accepted a new position. In addition to the program advertisements & locations we used in 2013, the program is now included on the NOAA Office of Education Opportunities webpage which has appeared to increase recruitment.

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 have completed an evaluation of the internship program. These results are provided in the project summary above. Over the many years of implementing this program, we have developed a list of what we consider to be 'best practices'. Electronic copies of each of the 8 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 NGI website.

Information on collaborators/partners

- f. Name of collaborating organization: NOAA – NESDIS, NCDDC
- g. Date collaborating established: January 2010
- h. Does partner provide monetary support to project? Amount of support? Yes, monetary support through NGI
- i. Does partner provide non-monetary (in-kind) support? Yes
- j. Short description of collaboration/partnership relationship: Several NOAA line offices support these internships through financial contributions under the program's umbrella designation. NOAA also provides assistance in advertising the program. Mr. Russ Beard, our NOAA Liaison, facilitates these contributions.
- a. Name of collaborating organization: GoMRI Deep-C Consortium
- b. Date collaborating established: April 2013
- c. Does partner provide monetary support to project? Amount of support? Yes, \$6,700
- d. Does partner provide non-monetary (in-kind) support? Yes
- e. Short description of collaboration/partnership relationship: The Deep-C Consortium has contributed funds to support one intern position under the mentorship of a Deep-C scientist with the intern working on a Deep-C related project. The Deep-C Consortium also provides assistance in advertising the program, PR and blog support.
- a. Name of collaborating organization: NGI
- b. Date collaborating established: January 2010
- c. Does partner provide monetary support to project? Amount of support? No
- d. Does partner provide non-monetary (in-kind) support? Yes
- e. Short description of collaboration/partnership relationship: NGI supports these internships with administrative resources (e.g. hosting the Summit, advertising the program, presentations on the webpage).

Information on any outreach activities

Type (speaker, workshop, training): training

Name of event: An introduction to metadata (Ms. Kathy Martinolich, NCDDC)

Date: May 29, 2013

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: 10

Type (speaker, workshop, training): speaker

Name of event: NOAA Career Roundtable

Date: August 1, 2013

Location: Stennis Space Center

Description: A discussion of experiences, opportunities and career advice among NOAA personnel and interns

Approximate Number of Participants: 15

Type (speaker, workshop, training): educational field trip (=short workshop)

Name of event: Research vessel trip – Mobile Bay, coastal Gulf of Mexico

Date: August 2, 2013

Location: Dauphin Island Sea Lab

Description: A field trip to Mobile Bay and the coastal ocean to measure water quality, to sample nekton, plankton, benthos, to learn how common sampling gear are deployed and to discuss estuarine ecosystems and the Gulf of Mexico

Approximate Number of Participants: 8

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 #14-NGI2-68

Project Title: Telepresence and Information Management for Stennis Exploration Command Center

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

NOAA sponsor and NOAA office of primary technical contact: Sharon Mesick, NESDIS

Project objectives and goals

In 2010 NOAA launched the NOAA Ship *Okeanos Explorer*, the only vessel owned by the US government dedicated to exploring the world's oceans. Working with partners at the Inner Space Center and the Exploration Vessel *Nautilus*, the *Okeanos Explorer* has pioneered the use of telepresence-enabled systematic ocean exploration. Telepresence enables researchers, educators, and the public to participate remotely in shipboard activities in real time. Exploration Command Centers (ECC) provide shore-side locations where participants can gather, access data and collaborate with shipboard counterparts, in real-time, to provide shared analysis and mission guidance. In collaboration with a NOAA information management team, which consists of personnel from NCDCC, OER, the NOAA Library, NOAA Data Centers and several extramural partners, an ECC was developed at the MSU Science and Technology Center at Stennis Space Center (Stennis ECC).

Working closely with the OER *Okeanos Explorer* Program, a suite of iconographic information products, which are available via the OER Digital Atlas and online web portal, has been developed. Coupled with the high definition video streams from the *Okeanos Explorer* explorations, the post-cruise management of this data is challenging due to the spatial and temporal dimensions of the data, the data volume, and the need to extract empirical data from the video for scientific use. The goals of this project are to: 1) manage and operate the Stennis ECC during ocean exploration dives; 2) to provide a temporary backup repository for the high definition video streams and related data from exploration dives until they are able to be permanently archived on NOAA sites; and 3) to develop a publicly accessible data repository for ocean exploration data utilizing fault-tolerant storage system features and MSU's high-bandwidth network connections.

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

During the reporting period, the ECC was operated and utilized to support five live ocean exploration activities:

- July 2013: *Okeanos Explorer* / ROV Exploration NE Canyons, Leg 1
- July 2013: E/V *Nautilus* / Gulf of Mexico Marine Archaeology exploration of BOEM site 15577
- July 2013: *Okeanos Explorer* / ROV Exploration NE Canyons Leg II
- April 2014: *Okeanos Explorer* / Gulf of Mexico Exploration and Marine Archaeology

During non-dive times the ECC was utilized to replay high-definition video streams from the dives, to both demonstrate the ECC capabilities to visitors and dignitaries, as well as to support and promote ocean exploration and STEM in general.

More than 22 Terabytes of video stream data from the *Okeanos Explorer* dives have been

loaded into the temporary backup repository. The data includes historic information dating back to 2010. The temporary backup repository holds data for the following missions (a non-exhaustive list): EX1002L2, EX1003, EX1004L2, EX1004L3, EX1102, EX1103L2, EX1104, EX1202L2, EX1202L3, and EX1205L1. This data is archived to two distinct backup sets in the MSU High Performance Computing building and one backup set in the MSU Center for Advanced Vehicular Systems building; both of these buildings are part of the MSU High Performance Computing Collaboratory.

The storage components for the publicly accessible data repository were procured, installed and configured, however, funding for the procurement of the requisite server hardware was not received until approximately one month before the end of this reporting period. That hardware has now been ordered, and upon arrival, the installation/configuration of the server will be expedited to enable production usage of the repository. A temporary loaner server was deployed late in the reporting period allow development and testing of the data-ingest process.

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

The support and operation of the ECC has broadened the research opportunities associated with the ocean exploration activities of NOAA by allowing participation from a larger and dynamic group of scientists. The continuing deployment of the publicly accessible data repository will also enable broader usage of the ocean exploration data.

Information on collaborators/partners: None reported

Information on any outreach activities: MSU is utilizing the ECC and high definition video streams to promote ocean exploration as well as science, technology, engineering and mathematics (STEM) in general. Visitors are able to “experience” the live dives in the ECC or via a receive-only video setup in the lobby of the MSU High Performance Computing Building in Starkville, MS. Additionally, the high definition highlight video streams of the dives are frequently replayed in both the ECC and in the Starkville facilities for visitors. The Starkville facility is a regular tour stop for visiting and prospective students to MSU, and consequently provides for a unique outreach opportunities.

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

APPENDIX A. PUBLICATION DOCUMENTATION

All items listed are under award number NA11OAR4320199.

Publications completed during the reporting period:

Amend Number	Journal	Date	Vol	Pages	Citation
42	Applications of Advanced Satellite Microwave Radiances and Retrieval Products to NWP and Climate Studies				
	Journal of Geophysical Research	10/5/2013	118	13,214 - 13,229	10.1002/2013JD020399
	IEEE Transaction on Geoscience and Remote Sensing	12/1/2013	52	7290 - 7296	10.1109/TGRS.2014.2310702
	Journal of Geophysical Research	1/20/2014	119	3924 - 3941	10.1002/2013JD021037
	Frontiers in Earth Science	6/2/2014			
	Journal of Geophysical Research	9/30/2013	118	11,187 - 11,200	10.1002/jgrd.50840
	IEEE Transaction on Geoscience and Remote Sensing	9/1/2013	99	1 - 10	10.1109/TGRS.2012.2230634
	Climate Dynamics	11/1/2013			10.1007/s00382-013-2012-5
43	Ecosystem Approach to Management for the Northern Gulf				
	Marine Pollution Bulletin	6/30/2014	83	440 - 445	
49	Climate Variability in Ocean Surface Turbulent Fluxes				
	IEEE Transaction on Geoscience and Remote Sensing Letters	10/1/2013			10.1109/LGRS.2012.2231937
	Earth Interactions	Sept. 2013	17	1 - 9	10.1175/2013E1000521.1
	Journal of Applied Meteorology and Climatology	July 2013	52	1561 - 1575	10.1175/JAMC-D-12-0211.1
	Atmospheric Science Letters	2013			10.1002/asl2.473
50	Calibration and Validation of NPP VIIRS - Color and SST Ocean Products for Monitoring Oceans				
	Remote Sensing of Environment	12/1/2013	139	398 - 414	10.1016/j.rse.2013.08.013
52	U.S. Research Vessel Surface Meteorology Data Assembly Center				
	Journal of Applied Meteorology and Climatology	7/1/2013	52	1561 - 1575	10.1175/JAMC-D-12-0211.1
	Journal of Applied Meteorology and Climatology	7/1/2013	52	2434 - 2449	10.1175/JAMC-D-12-0273.1
59	Toward Operational Uses of Feostationary Imagery and FY-3 Polar-Orbiting Microwave Radiance Data in the GSI Analysis System				
	Journal of Geophysical Research	6/25/2014	119	6666 - 6680	10.1002/2014JD021455

Summary of publications reported above:

	Institute Lead Author	NOAA Lead Author	Other Lead Author
Peer-Reviewed	0	0	6
Non Peer-Reviewed	0	2	8

APPENDIX B. EMPLOYEE SUPPORT

Northern Gulf Institute Employee Support July 1, 2013 - June 30, 2014 Personnel (DISL, FSU, LSU, MSU, USM combined)				
Category	Number	B.S.	M.S.	Ph.D.
>= 50% Support				
Research Scientist	5	1	1	3
Visiting Scientist	2	0	0	2
Postdoctoral Fellow	0	0	0	0
Research Support Staff	7	3	4	0
Administrative	0	0	0	0
Total (>= 50% support)	14	4	5	5
Category	Number	B.S.	M.S.	Ph.D.
Employees w/ <50% support	28	4	10	13
Category	Number	B.S.	M.S.	Ph.D.
Undergraduate Students	14	14		
Graduate Students	34	9	11	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
Moorhead, Robert J	Modeling and Ocean Color Remote Sensing in Oceanic and Coastal Waters	N/A	Naval Research Laboratory (NRL) (DOD)	\$10,000.00
Moorhead, Robert J	Modeling and Ocean Color Remote Sensing in Oceanic and Coastal Waters	N/A	Naval Research Laboratory (NRL) (DOD)	\$33,000.00
Moorhead, Robert J	Modeling and Ocean Color Remote Sensing in Oceanic and Coastal Waters	N/A	Naval Research Laboratory (NRL) (DOD)	\$29,000.00
Moorhead, Robert J	Modeling and Ocean Color Remote Sensing in Oceanic and Coastal Waters	N/A	Naval Research Laboratory (NRL) (DOD)	\$15,000.00
Ritchie, Jarryl B	Ecosystem Services Provided by Gulf of Mexico Habitats: Tools, Valuation & Application	N/A	Texas A&M University (TAMU)	\$9,249.00
Ritchie, Jarryl B	GOMA Web Support Project	N/A	Gulf of Mexico Alliance	\$15,600.00
Ritchie, Jarryl B	GOMA BP Gulf of Mexico Research Initiative Web Support Project	N/A	Gulf of Mexico Alliance	\$190,307.00
Ritchie, Jarryl B	GOMA Web Support Project	N/A	Gulf of Mexico Alliance	\$7,800.00
			Total	\$309,956.00