Annual Progress Report
Northern Gulf Institute

Reporting Period covering
October 1, 2016 - June 30, 2017

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MISSISSIPPI STATE UNIVERSITY

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THE UNIVERSITY OF SOUTHERN MISSISSIPPI

NGI Northern Gulf Institute a NOAA cooperative institute

NGI Progress Report

Award NA16OAR4320199

Reporting Period: October 1, 2016 – June 30, 2017

Table of Contents

INTRODUCTION 5

NGI General Description and Core Activities 5

NGI Management, Mission, and Vision 6

Executive Summary of Important Research Activities 11

Distribution of NOAA Funding 15

PROJECT REPORTING (Note that the last 2 digits of the NGI File # correspond with the amendment # to NA16OAR4320199)

NGI File #16-NGI3-01: Further Refinements to Stepped-Frequency Microwave Radiometer Surface Wind Measurements in Hurricanes 18

NGI File #16-NGI3-02: Determination of Movement Patterns and Reproductive Status of Adult Smalltooth Sawfish 21

NGI File #16-NGI3-03: National Weather Service Social Science Curriculum Delivery FY17 29

NGI File #16-NGJ3-04: Development of Trace Element and Strontium Isotope Water Chemistry Baseline Data for the Pearl River Watershed 31

NGI File #16-NGI3-05: Examination and Validation of Reconnaissance Field Program Data in Multiple HWRF Frameworks 35

NGI File #16-NGI3-06: Climate Variability in Ocean Surface Turbulent Fluxes 38

NGI File #16-NGI3-07: Regional Geospatial Modeling 44

NGI File #16-NGI3-08: University of Southern Mississippi Mapping Center 48

NGI File #16-NGI3-09: Hypoxia National Office Technical Assistance, Observations, Monitoring, and Coordination 50

NGI File #16-NGI3-10: NOAA Weather Information and Dissemination All Hazards Stakeholder Needs Assessment Verification Project 54

NGI File #16-NGI3-11: Core infrastructure enhancements, operations, and preliminary research activities supporting VORTEX-SE 2017 field campaign activities - Phase 2 56

NGI File #16-NGI3-12: U.S. Research Vessel Surface Meteorology Data Assembly Center 62

NGI File #16-NGI3-13: Continuation of Comparative Metagenomics to Indicate Sites Under Anthropogenic Pressure: Year 2 68

NGI File #16-NGI3-14: Predicting the impact of anthropogenic climate change on physical and biogeochemical processes in the Northern Gulf of Mexico - Part 2 70

NGI File #16-NGI3-15: AOML-NGI South Florida Water Quality Data Analyses 76

NGI File #16-NGI3-16: Calibration and Validation of NOAA VIIRS Ocean Products for Monitoring Oceans 80

NGI File #16-NGI3-17: Continuation of Secure Archival Storage for NOAA/NMFS Preserved Specimens at USM's Plankton Archival Facilities 92

APPENDIX A. Publication Documentation.....93
APPENDIX B. Employee Support.....94
APPENDIX C. Other Agency Awards 95
APPENDIX D. Fact Sheet 96

INTRODUCTION

This Northern Gulf Institute (NGI) Annual Progress Report reviews and summarizes the research and the education and outreach activities accomplished during the reporting period of October 1, 2016 to June 30, 2017. The items in this report cover the research conducted under NOAA award NA16OAR4320199. The report consists of two (2) sections and appendices. The first section provides the General Description of NGI, the NGI Direction, Organization and Operations, Key Research and Economic Impact, and Distribution of NGI funding from NOAA. The second section is titled Project Reporting. The section describes the project objective and research conducted for each project and other project details, along with contact information and related NOAA sponsors and strategic goals. 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 six 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, the University of Alabama in Huntsville, and NOAA scientists at various laboratories and operational centers in the 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 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 Climate Change and Climate Variability Effects on Regional Ecosystems, Coastal Hazards, Ecosystem Management, and Effective and Efficient Data Management Systems Supporting a Data-driven Economy. 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 environments. Additional details are available in the second section on Project Reporting.

The NGI Education and Outreach Program provides an integrated comprehensive approach to educate the public on NGI priority issues associated with NGI research and to facilitate the transition of NGI research to NOAA operational centers. The program connects universities to NOAA and works closely with the educational programs at the Gulf of Mexico Alliance, the various Gulf of Mexico Sea Grant programs and the NOAA Gulf of Mexico Regional Collaboration Team. Together we develop communication and significant long term messaging campaigns to address identified priority issues.

As part outreach and part research planning, NGI participated in or hosted a variety of 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 Management, Mission, and Vision

The NGI leadership team adopted a ten year NGI Strategic Plan on June 24, 2011 (http://www.northerngulfinstitute.org/about/documents.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 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 Gulf of Mexico environmental research and education. NGI continued its international engagement in the Gulf of Mexico by continued interactions with the Consorcio de Instituciones de Investigación Marina del Golfo de México y del Caribe (CiiMar-GoMC).

Since its initial award on October 1, 2006, the NGI's leadership has worked diligently to build collaborations between the six academic institutions and NOAA research and education programs. NOAA's support for NGI in year one under award NA16OAR4320199 totals $6.6 million. NGI continues to use NOAA's investment to contribute to the recovery and future health, safety, resilience and productivity of the 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. In 2016, NGI successfully competed to

continue as a Cooperative Institute in the Gulf of Mexico. The University of Alabama in Huntsville was added to the CI at this time.

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-Directors assist in this role.

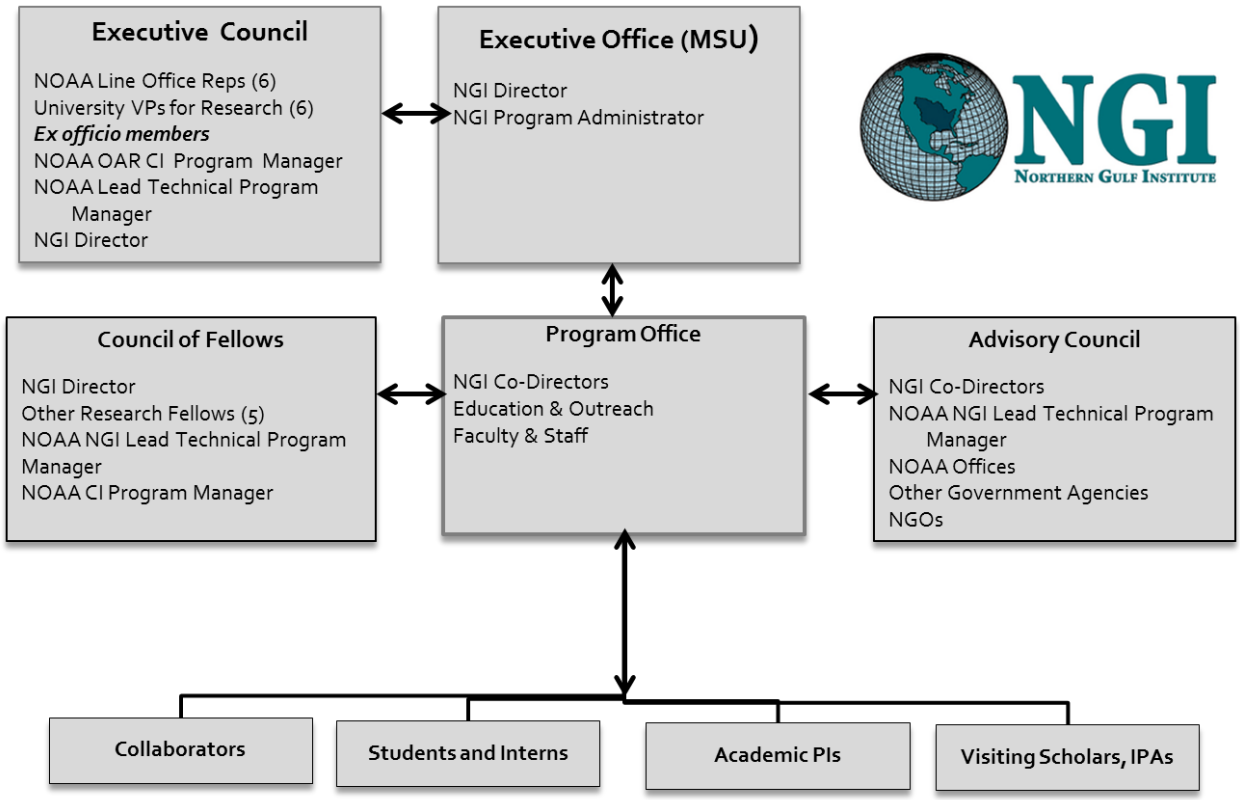

Figure 1. NGI organization diagram

NGI program operations and implementation is guided by the NOAA October 1, 2016 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 MSU Co-Director and research and outreach faculty. The Program

Office is responsible for maintaining regular interaction with the Council of Fellows and the NGI Advisory Council. It also has prime responsibility for the day-to-day management of the Institute that includes project management, development of student internships, and facilitating meetings of the Council of Fellows and 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 OAR CI Program Director. The Council is chaired by the NGI 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 the period of October 1, 2016 through June 30, 2017, the NGI Council of Fellows consisted of:

Robert Moorhead, Ph.D., Mississippi State University (chair, NGI Director)
Steve Ashby, Ph.D., Mississippi State University (MSU Co-Director)
Monty Graham, Ph.D., University of Southern Mississippi (USM Co-Director)
Eric Chassignet, Ph.D., Florida State University
Robert Twilley, Ph.D., Louisiana State University
John Valentine, Ph.D., Dauphin Island Sea Lab
Kevin Knupp, Ph.D., University of Alabama in Huntsville
Robert Atlas, Ph.D., NOAA/AOML Director, NOAA NGI Lead Technical Program Manager
Candice Jongsma, Ph.D., NOAA CI Program Director

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 the Vice Presidents of Research from all six NGI academic partner institutions. *Ex Officio* members include the NOAA Cooperative Institute Program Director, the NOAA Lead Technical Program Manager (TPM), and the NGI Director. The Executive Council is primarily responsible for broad policy and program direction for the NGI. The Council will transmit NOAA strategic plans and priorities to the NGI management to ensure program alignment with NOAA priorities. NGI is committed to transparency, accountability, governance control, and effective integration through the Executive Council.

Representative Council Members:

Robert Atlas, Ph.D., OAR AOML, Director, NOAA Lead Technical Program Manager
Alan Leonardi, Ph.D., OAR OER Director; Chair
John Cortinas, Ph.D., OAR OWAQ Director;
Steve Goodman, Ph.D., NESDIS GOES-R Program, Senior (Chief) Scientist
Paul Scholz, Ph.D., NOS Office for Coastal Management, Deputy Director

Mel Landry III, Ph.D., NMFS NOAA Restoration Center
David Shaw, Ph.D., MSU VP for Research and Economic Development
Gordon Cannon, Ph.D., USM VP for Research
Gary K. Ostrander, Ph.D., FSU VP for Research
K.T. Valsaraj, Ph.D., LSU VP for Research and Economic Development
Ray Vaughn, Ph.D., UAH VP for Research and Economic Development
John Valentine, Ph.D., DISL Director
Robert Moorhead, Ph.D., MSU, NGI Director

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 region, and meets regularly to identify and prioritize research and educational needs in the Gulf of Mexico 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 (Co-Chair)
Monty Graham, Ph.D., USM/NGI Co-Director (Co-Chair)
Duane Armstrong, NASA Stennis Space Center
David Brown, Ph.D,, NOAA National Weather Service, Southern Region
Alyssa Dausman, USGS, RESTORE Council
Lisa Desfosse, NOAA National Marine Fisheries Service
Ayesha Gray, Grand Bay National Estuarine Research Reserve
Judy Haner, The Nature Conservancy
Karl Havens, Ph.D., Florida Sea Grant College Program
Julien Lartigue, Ph.D., NOAA RESTORE Act Science Program Director
Kristen Laursen, NOAA Fisheries Service
Larry McKinney, Harte Research Institute
Sharon Mesick, NOAA National Centers for Environmental Information
Jamie Miller, Mississippi Department of Marine Resources
Helmut Portmann, NOAA National Data Buoy Center
Matt Romkens, USDA National Sedimentation Lab
Ben Scaggs, EPA Gulf of Mexico Program
Buck Sutter, Ph.D., Gulf Coast Ecosystem Research Council
LaDon Swann, Ph.D., MS-AL Sea Grant Consortium
Suzanne Van Cooten, Ph.D., NOAA National Weather Service LMRFC
Jeff Waters, US Army Corps of Engineers
Chuck Wilson, Ph.D., GOMRI Chief Scientist

Philosophy of Operations

NGI program operations and implementation will be guided by the NOAA 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 will 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. The fundamental philosophy of operations for this CI revolves around integration – integration of the land-coast-ocean-atmosphere continuum;

integration of research to operations; and integration of individual academic institutional strengths into a holistic research and educational program specifically geared to the needs of the GoM stakeholders.

The following precepts fit into this philosophy, and will drive the functions of the CI:

- Stakeholder Community Driven (e.g., State Coastal Resource Management Agencies) and Client Focused (e.g., Gulf of Mexico Alliance)
- Transition Oriented (i.e., most research and all technology activities must have a pathway to inform management decisions)
- Regional in Research Focus; Basin-Scale in Coordination
- Closely aligned with the Needs and Resources of its Federal Partner, NOAA (Headquarters, Line Units, and Laboratories)

Project Selection

NGI will work with its Advisory Council to select research projects that meet the following criteria: (1) projects that address the most pressing issues in the Gulf of Mexico and match NGI member expertise, capability, and capacity to address those issues, (2) projects for which NOAA labs and programs will provide funding at an appropriate level, and (3) projects that have sufficient funding longevity to provide appropriate graduate student and post-doctoral support.

Progress Review

Progress will be evaluated based on the measures of success stated on page 4 of the NGI Strategic Plan (http://www.ngi.msstate.edu/about/documents/strategicPlan2011-2021.pdf). In short, progress requires the creation of new or improved knowledge and technology, and their transition to applications for improved ecosystem-based management in the Gulf of Mexico.

Performance Measures

The success of NGI depends upon the extent to which the creation of new or improved knowledge and technology in core research areas is relevant and applicable to the Research Themes in the Gulf of Mexico. Determining success requires that we develop a Metrics Plan to track the NGI trajectory. The primary metrics we will use to determine success are: (1) research metrics that track progress towards accomplishing research goals and objectives; and (2) organizational metrics that track the level of engagement and contribution to educating a new workforce. Research project metrics drive organizational metrics. Together, these provide indicators about the effectiveness of NGI as a research institution and about the value of NGI research to stakeholders, thereby raising its visibility and stature in both research and management communities.

NGI will track two types of research use: (1) external use by the scientific community, resource managers, and by those involved in engagement and education efforts; and (2) internal use by other NGI funded researchers. External indicators include documentation of NGI-funded research in peer-reviewed journals, an established metric for measuring the quality, rigor, and significance of research; the degree to which NGI projects align with the needs of state and federal management agencies, including information about leveraging resources, extending impact, and strengthening NGI ties with stakeholders; and the contribution that NGI makes to science workforce development, accomplished by following the career trajectories of students who conducted research while mentored by NGI partners. Increasing NGI's visibility broadens recognition of the quality of its work and its value as an organization. Increasing knowledge

about NGI among its institutional partners promotes effective internal operations and coordinated, collective external communication.

Beyond the metrics indicated above, the NGI Metrics Plan will provide periodic updates in the following areas:

- Formal and informal recognition of NGI research
- Internal use of NGI research to support existing research or advance new opportunities
- Established framework that prepares research for use or improves the usability of research
- Leveraged efforts that extend the impact of NGI
- Acquisition of resources that sustain and grow NGI
- Allocation and alignment of resources with NGI goals
- Implementation plans that align with regional priorities and emphasize multi-institutional collaborations
- Collaborations and strong relationships with key stakeholders in the scientific and resource management communities and with partners involved in engagement and education efforts
- Effective internal processes and working relationships
- A comprehensive mechanism to preserve, discover, and access this data and information to maximize the investment made by the Government and various agencies by allowing multiple uses of the data while minimizing duplication of effort

The intent is to be transparent and strategic, while having the flexibility to adapt rapidly to correct course or take advantage of novel opportunities.

Executive Summary of Important Research Activities

Many of the research projects are providing new and improved tools and capabilities in support of NOAA's Weather - Ready Nation goal as briefly summarized below.

- Analysis by FSU researchers of the stepped-frequency microwave radiometers (SFMR) wind-induced emissivity measurements collocated with dropsondes identified two distinct wind speed regimes for which the distribution was statistically different. It was found that the 10 to 20 m/s SFMR wind-induced emissivity measurements had a low bias compared to the modeled wind-induced emissivity, but no apparent storm relative azimuthal asymmetry. For the 20 m/s or greater SFMR wind-induced emissivity measurements, there was a storm relative azimuthal asymmetry identified.
- Research continues to produce 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. The FSU winds (monthly averages of gridded winds over the tropical oceans) were produced and made available to a wide range of users such as ENSO and fisheries forecasters.
- The NOAA Office of Dissemination is evaluating the use and applications of NOAA Weather Radio All Hazards to determine user requirements to transform the current NOAA Weather Radio All Hazards broadcast network into a new integrated weather information distribution/dissemination system. The project team at the University of Alabama are currently conducting case studies of actual events to study modalities.

- Analyses of profiler and radar data continued to document the variability in low-level clouds, thermodynamics, and wind (wind shear) for cold-season tornado events. Ceilometer data were examined to determine cloud base height distributions and cloud cover fraction around tornadic storms (supercell vs. QLCS) to address the hypothesis that cloud fraction (cloud base height) tends to be high (low) for tornadoes in the Southeast.
- Activities of the U.S. Research Vessel Surface Meteorology Data Assembly Center (DAC) at the Florida State University (FSU) included continued implementation of the Shipboard Automated Meteorological and Oceanographic System (SAMOS) initiative (http://samos.coaps.fsu.edu/). The SAMOS initiative is focused on improving the quality of and access to surface marine meteorological and oceanographic data collected in situ by automated instrumentation on research vessels. During the reporting period (10/1/16-6/30/17), 28 research vessels routinely transmitted daily emails containing one-minute averaged meteorology and surface oceanographic data to the DAC. This project ensures that the highest quality marine meteorological and near surface oceanographic data are collected by research vessels, primarily from the U.S. fleet, and that they are distributed and archived in a manner that makes the data accessible and useful to a diverse research and operational user community.
- Additional assessment of data from the National Buoy Data Center (NDBC) provided validation and case study analyses of NOAA experimental HWRF products such as HWRF-HYCOM, HEDAS, and basin-scale HWRF. Tropical cyclone-tornado research from a previously funded AOML grant provided leverage in the validation and analyses.
- An Interactive Sea Level Model (*GeoCoast*) has been developed. Lidar data collected in 2015 for the 3 coastal counties of Mississippi were used to develop a 10-ft resolution DEM (digital earth model) as a base for assessing the impact of sea level rise on the road network. A road centerline dataset, developed in an earlier MDEM (Mississippi Digital Earth Model) award, was merged with the elevation raster cells to transfer elevation measures to segments of the road centerline dataset.
- A web-based GIS (*GeoDawg*) has been developed with the general public in mind. Popular spatial datasets (e.g., census of population, economics) may be accessed with a collection of commonly used GIS tools.

Studies are ongoing in support of NOAA's Healthy Oceans goal.

- Research on the endangered smalltooth sawfish continued and provided new insights into their mating grounds. During the reporting period, 12 large juveniles and adults of the endangered smalltooth sawfish were captured and tagged. This is the first time researchers have captured adult males and females together in the three different regions, during the same season. Interestingly, all three adults captured in Coot Bay showed very fresh signs of mating, with wounds and scars from rostral teeth on the dorsal and ventral surfaces. This is the first time that mating grounds have been verified. In addition to numerous news reports, the findings will also be included in Shark Week 2017.
- Research continued with expanded water quality sampling in tributaries and estuaries in the Northern Gulf of Mexico. This research is creating a baseline trace element and strontium isotope map of primarily the Pearl River and also a few of the rivers draining into Lake Pontchartrain. This map will be used to better understand habitat use of Gulf sturgeon in the system and will be used in conjunction with data previously collected in the Alabama and Florida panhandle in the eastern NGOM.

- An evaluation of the applicability of using UAS for oil spill detection in the Gulf of Mexico is currently underway. The focus of this task is to use an ultraviolet light source to “excite” hydrocarbons associated with oil deposits on the sea surface.
- A proceeding report from the 6th Annual Hypoxia Research Coordination Workshop was completed, identifying the partners and mechanisms necessary to implement and sustain a Cooperative Hypoxic Zone Monitoring Program. The complete report is available at: https://www.ncddc.noaa.gov/activities/healthy-oceans/gulf-hypoxia-stakeholders/workshop-2016/proceedings/.
- An ongoing project with the objective to provide a range of realistic scenarios of future environmental changes in the northern GoM (including the shelf region) for the research community and fisheries resource managers continues to develop the regional ocean model (GOM8). GOM8 reproduces reasonably well main circulation and hydrographic patterns, such as the Loop Current, mesoscale eddies, hypoxic region over Texas and Louisiana shelves, SST, and surface chlorophyll for a comparison between model and satellite chlorophyll). Modeling of small and large plankton components allows a better representation of ecological processes in the coastal and oceanic domain. Seasonal variability of phytoplankton biomass shows significant regional differences across the northern GoM. The next phase of this project will be to obtain future projections over the 21st century of physical & biogeochemical processes in the northern GoM under a high and a medium-to-low CO2 emission scenarios, using the model configured from task 1 and projected atmospheric fields from the Coupled Model Intercomparison Project phase-5 (CMIP5).
- The analysis of the Biscayne Bay water quality data indicated that following a significant bloom of a picophytoplankton (*Synechococcus*) in September of 2005, the oligotrophic system had shifted to a more phytoplankton dominated system than the benthic/submerged aquatic vegetation system that dominated prior to the 2005 bloom. Results of this analysis (with others ongoing) are being used to develop process studies for additional data collection that will be incorporated into a coupled hydrodynamic model for ecological assessments that will be used to inform watershed management and habitat restoration decisions.
- Calibration and validation of ocean products on NOAA VIIRS for monitoring oceans continued with several outcomes. As a result, new ocean products have been developed from the VIIRS orbital overlap and have been validated. Measurements of diurnal changes in ocean color in turbid coastal regions in the Gulf of Mexico were characterized using above water spectral radiometry. Protocols were developed for collection and processing of in situ optical data used for ocean color calibration and validation. These included the IOP floating hyperpro and above water ASD instruments. Results of protocols and all data from the ocean color cruises were transitioned to NOAA and put into cruise reports. The WavCIS platform is transitioning daily data to NASA and NOAA for calibration and validation of the Ocean Color on VIIRS satellite. These data are being used for maintaining high quality VIIRS products.

Data management activities with an emphasis on product development were initiated.

- An enduring mapping center to address research and development needs that advance the science and practice of hydrography and cartography has been established at the University of Southern Mississippi. The research plan encompasses five thrusts (e.g. Sensors/Platforms, Positioning, Water Levels, Data Management, Data Portrayal). An initial

effort included the use of Lidar data for several significant sections of the Northern Gulf Cast for comparison to shorelines depicted on existing charts.

- The *Continuation of Comparative Metagenomics to Indicate Sites Under Anthropogenic Pressure* project has greatly reduced a backlog of previously acquired data sets. Bioinformatic analysis of several new projects to serve core missions of NOAA was initiated. Preparations were initiated to embark on field operations to test the viability of 1) environmental sample processors on AUVs to match the sampling fidelity of shipboard sampling, 2) larval community metabarcoding to match the fidelity of manual counting, and 3) free environmental DNA as a proxy for recent fish population counts.

Distribution of NOAA Funding

NGI receives funding for all three NOAA CI tasks as well as each one of NGI's themes, with several projects having multiple themes (Figs. 2 and 3).

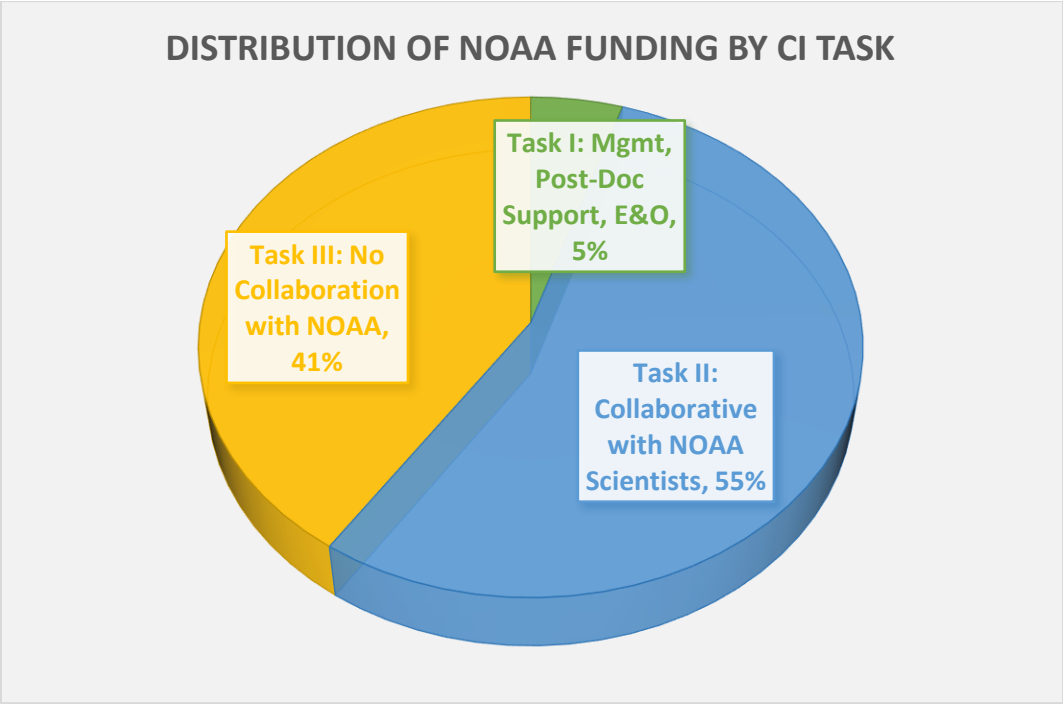

Figure 2. Distribution of NOAA funding by the three cooperative institute task categories

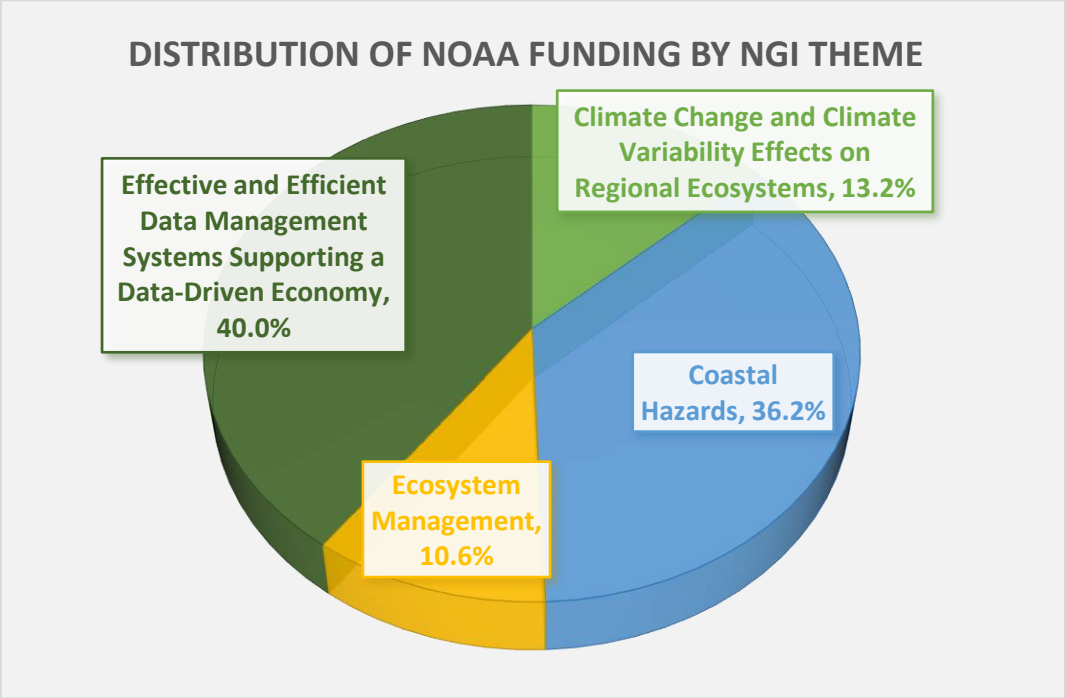

Figure 3. Distribution of NOAA funding by the four NGI themes

Task I Activities

Task I funding supports the central management and coordination of the six complementary academic partners working together with NOAA. Task I funding was used to support the administration of NGI, student activities, and education and outreach (Fig.4). Administration included leading the efforts of the CI as well as program and project management for each of the traditional CI projects active during the reporting period.

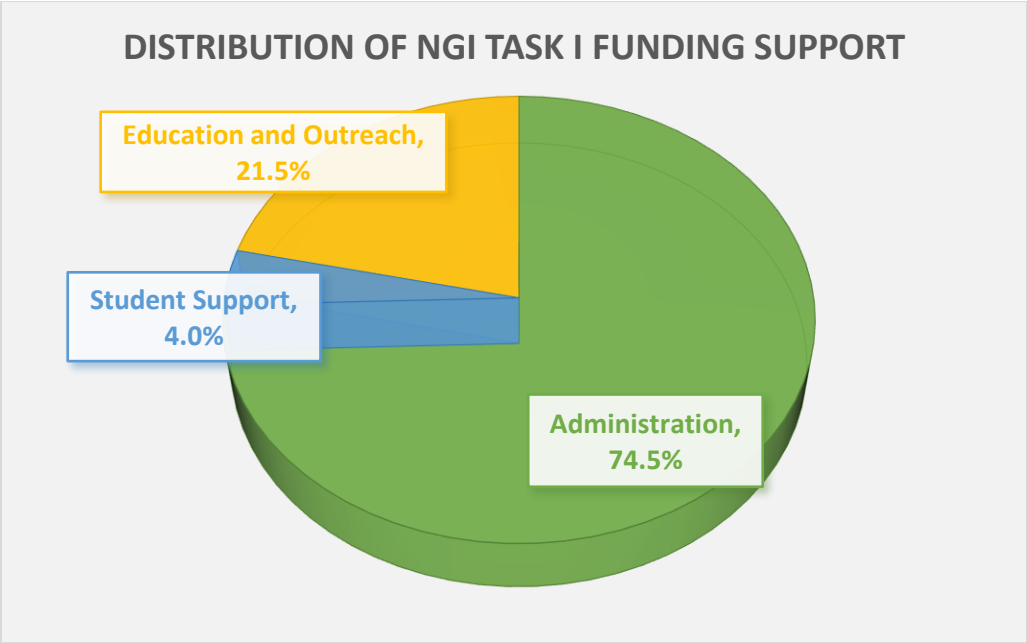

Figure 4. Distribution of NGI Task I funding

Education and outreach activities included several workshops, conference presentations, tours, and demonstrations.

- Regional geospatial modeling workshops were attended by a wide variety of endusers. During the period of this progress report (October 1, 2016 through June 30, 2017), 25 workshops were offered to 241 participants.
- In conjunction with the VORTEX-SE project, guided tours of the Severe Weather Institute and Radar & Lightning Laboratories (SWIRLL) building are conducted on a regular basis. Approximately 33 tours have been provided since July 2016. Groups include senior citizens, social clubs, K-12, foreign groups, Senate staffers, prospective graduate students, and other visitors. We also accept invitations to special conferences and “Weatherfests” when possible.
- Public outreach events during the period included the COAPS Open House (February 2017), during which DAC staff demonstrated the operation of marine meteorological instrumentation and computer programming concepts. This included demonstrations using a Lego robot to engage students and the general public in basic programming tasks and a second display of the scales of computing used by COAPS in general, and the DAC specifically. Dr. Mark Bourassa also participated in FSU-day at the Florida State Capitol (March 2017), where he met with the public and representatives from the FSU administration and several groups advocating for clean energy and sustainable development. Dr. Mark Bourassa focused on the need for sustained observations of marine

weather and physical oceanographic parameters to support informed policy making in our marine environment. In preparation for these and future outreach activities, the DAC (with support from COAPS personnel) developed a fact sheet focused on “Making use of a sea of data” (see Appendix D). The fact sheet focuses on the acquisition, evaluation, and dissemination of marine weather observations and gives examples of how these observations impact weather forecasting and decision making in several sectors of society. The goal of this project is to deliver a pilot series of a set of courses developed for a training program in social science applications to meteorologists and meteorology professionals in FY17. The program consists of 5 courses, 15 hours total. Training program students will learn how to interpret social science research, as well as conduct basic social science research in their field discipline.

- NGI participated in the Bays and Bayous Conference and provided a display that included highlights of ongoing research.
- NGI developed a summary document of research activities that was included as a handout at the NOAA display at the State of the Gulf Summit, GOMA All Hands Meeting, and the Restore America’s Estuaries Conference
- Dr. Steve Ashby also participates on the steering committee of the GOMA Education and Engagement Team. As part of this effort, GOMA and the NOAA Marine Debris Program have developed several collaborative project.
- Collaboration with other partners included interactions with the Naval Research Laboratory, the National Aeronautics and Space Administration, the US Environmental Protection Agency, the US Fish and Wildlife Service, the Gulf of Mexico Alliance, The Nature Conservancy, Ocean Conservancy, Pacific Marine Environmental Laboratory, the Gulf Coast Ocean Observing System, and several national and international societies and academic consortiums, and several state and local resource management agencies.

PROJECT REPORTING (Note that the last 2 digits of the NGI File # correspond with the amendment # to NA16OAR4320199)

NGI File #: 16-NGI3-01

Project Title: Further Refinements to Stepped-Frequency Microwave Radiometer Surface Wind Measurements in Hurricanes

Project Lead (PI) name, affiliation, email address: Mark Bourassa, Florida State University, bourassa@coaps.fsu.edu

NOAA sponsor and NOAA office of primary technical contact: Frank Marks, AOML

Award Amount: $114,360

Project objectives and goals
Surface wind speed observations from stepped-frequency microwave radiometers (SFMR) are a primary tool for aircraft reconnaissance-based estimates of hurricane intensity and size, both of which are critical for forecasting coastal wind and water impacts from land-falling storms. Variations in sea state, radially and azimuthally within a hurricane with respect to storm center and motion, related to wind and wave directions can lead to errors in the SFMR wind speed retrieval algorithm at nadir. To enhance instrument capabilities, the surface wind and wave directional impacts must be understood and quantified in high wind conditions. The goals of this project are:

- Obtain additional measurements from NOAA hurricane reconnaissance flights as necessary;
- Extend SFMR software algorithms to correct for the radial and azimuthal variations in the measurements post-flight;
- Develop a new SFMR data product revision to be made available to the research community;
- Transition software revisions for real-time operational use by NOAA aircraft.

Description of research conducted during the reporting period and milestones accomplished and/or completed
A preliminary analysis of storm relative nadir SFMR data collocated with dropsondes was completed to identify asymmetries in the data. Collocations were only used if the storm was a hurricane and if the SFMR rain rate was less than 10 mm/hr since there appears to be a high bias in the SFMR wind-induced emissivity measurements at higher rain rates. The collocations were then binned by wind speed into two groups, 10–20 m/s and 20 m/s or greater. The data were then analyzed as a function of storm relative azimuth angle and radius from storm center. Significance testing was also performed to determine if the identified differences were statistically significant. The findings were then compared with hurricane wave studies to try and explain the asymmetries.

Description of significant research results, protocols developed, and research transitions
Analysis of the SFMR wind-induced emissivity measurements collocated with dropsondes identified two distinct wind speed regimes for which the distribution was statistically different (Figure 5). It was found that the 10 to 20 m/s SFMR wind-induced emissivity measurements had a low bias compared to the modeled wind-induced emissivity, but no apparent storm relative

azimuthal asymmetry. For the 20 m/s or greater SFMR wind-induced emissivity measurements, there was a storm relative azimuthal asymmetry identified.

After further analysis of the ≥ 20 m/s data, an additional statistically different distribution was found for data at radii ≤ 50 km versus data at radii > 50 km from the storm center (Figure 6). The azimuthal variation appears to be larger in the wind-induced emissivity differences for the data at radii of ≤ 50 km than at radii > 50 km. Some of the differences in the wind-induced emissivity values between these two radii bins are greater than 0.01, which would be associated with about a 2 to 3 ms^{-1} or greater difference in the SFMR retrieved wind speeds at a given storm relative azimuthal angle in the storm for related to different radii from the storm center. It is hypothesized that the storm relative azimuthal differences may be related to changes in wind waves and swell throughout different regions of a hurricane. Wave spectra data will be used to investigate this hypothesis in the future. As more nadir SFMR data are collected, more collocations will be added to this analysis to increase the sample sizes. Upon completion of the analysis with the wave spectra data, a correction to the SFMR algorithm will be developed to account for the storm relative location differences identified. The updated SFMR algorithm will then be tested with collocated SFMR and dropsonde data not used in the study.

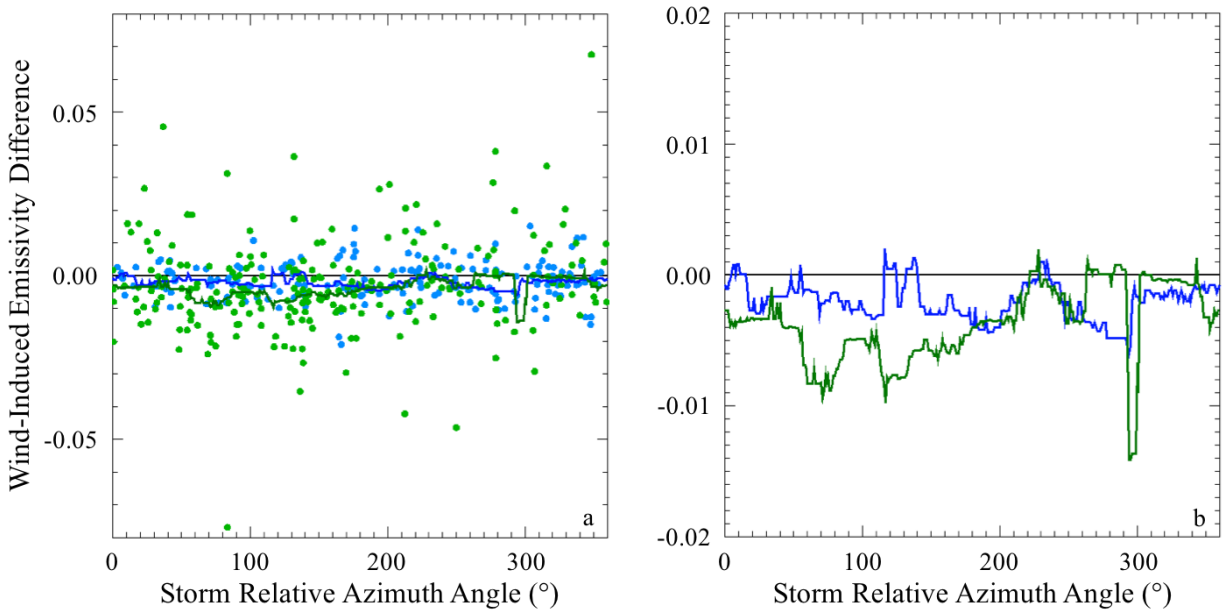

Figure 5. Wind-induced emissivity difference versus azimuth angle for two wind speed bins: 10 to 20 ms^{-1} (blue) and ≥ 20 ms^{-1} (green). The solid lines indicate the running medians for 30° azimuthal bins. (a) displays all of the individual points and the running medians while (b) displays only the running medians.

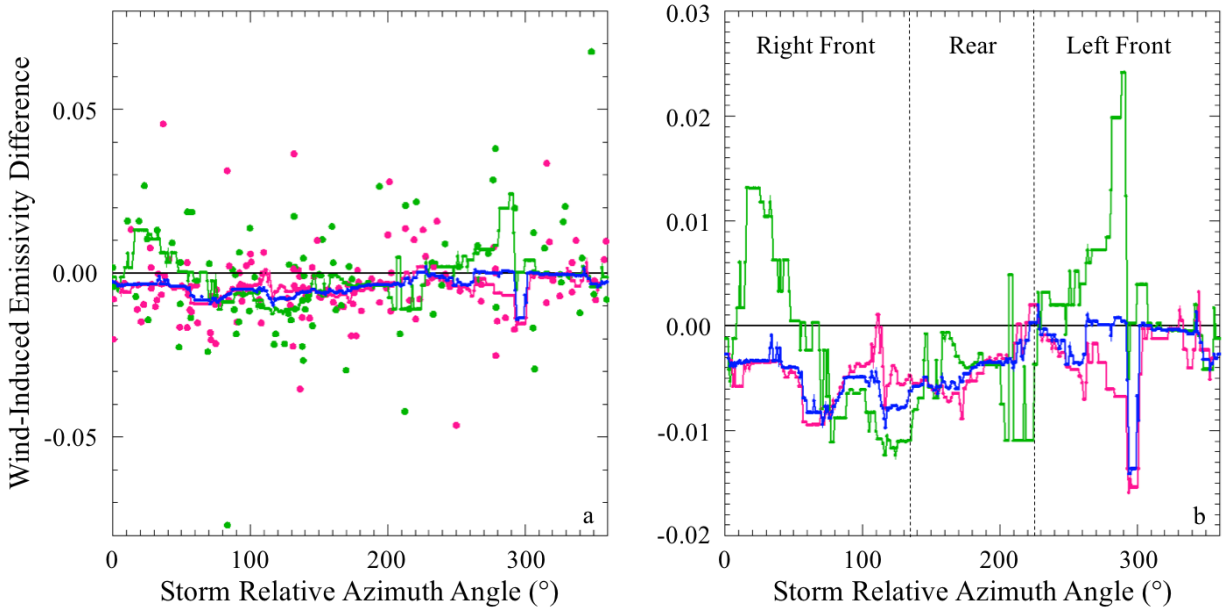

Figure 6. Wind-induced emissivity difference versus azimuth angle for the ≥ 20 ms^{-1} wind speed range separated by radii ≤ 50 km (green) and radii > 50 km (pink). The solid lines are the running medians for 30° azimuthal bins and the blue line is for all of the ≥ 20 ms^{-1} wind speed range data. The storm relative sectors are noted in (b) by the vertical dashed black lines and respective labels.

Information on collaborators/partners:

a. Name of collaborating organization: NOAA/AOML/HRD
b. Date collaborating established: February 2013
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: Mentor postdoctoral fellow; collect data

Related NOAA Strategic Goal: Weather-Ready Nation

Related NOAA Enterprise Objectives: Science and Technology

NGI File #: 16-NGI3-02

Project Title: Determination of Movement Patterns and Reproductive Status of 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: Adam Brame, NMFS

Award Amount: $64,509

Project objectives and goals
The primary goals of this project are to 1) investigate movements and migration of large juvenile and adult smalltooth sawfish (*Pristis pectinata*), particularly those captured in areas of elevated interaction with fisheries, using satellite and acoustic telemetry, 2) assess physiological stress in sawfish as a function of capture methods, and 3) use blood hormone cycling to determine reproductive timing and importance of aggregations sites to mating. We seek specifically to answer the following research questions:

A) Are there spatial and temporal patterns to the distribution of adult smalltooth sawfish in the areas of interaction with commercial trawl and longline fisheries?
B) Do adult sawfish have affinities for specific habitats (e.g. depths, bottom types, current regimes) and is there fidelity to specific areas?
C) Could bycatch rates be mitigated by seasonally limiting access to specific areas and habitats?
D) What are the stress profiles of captured sawfish using different gears and how do they compare with other elasmobranchs?
E) What is the reproductive status of captured sawfish and are the areas of high fisheries interaction the sites of mating aggregations?
F) What are the long-term residency and migration patterns of adult smalltooth sawfish?

This is a continuation of a long-term project; each year of this project we seek to conduct up to 24 days of fishery-independent sampling to capture and tag adult smalltooth sawfish. However, actual days at sea are often limited by permitted captures of endangered sawfish and inclement weather. Due to the size of the animals (often over 400 cm in length and 300 kg in weight), relatively calm weather is necessary to handle and tag the animals while maintaining the safety of the sawfish and the researchers.

Sampling locations are based on known records of interactions with commercial shrimp and longline fisheries, recreational fisheries, or our research surveys. The shelf edge at water depths of 40-55 meters from offshore of Key West the Marquesas Keys is a known area of sawfish interactions with commercial longline and shrimp trial fisheries. Our data suggest this may be a year-round, but ephemeral aggregation site for adult smalltooth sawfish. 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 (≥ 16/0) and longlines are anchored and marked with a buoy and/or highflier at

each end. Soak times are typically one hour but do not exceed two hours. Once brought alongside the boat, each sawfish is restrained by placing a line around the rostrum and the caudal peduncle. Sex and length measurements are recorded. Fin clips are collected for population genetics studies and blood samples are collected to assess reproductive status and physiological stress. Beginning in 2016, we have been permitted to surgically implant coded acoustic transmitters in sawfish. These transmitters are recorded by acoustic receivers for up to ten years. There are now large arrays of several hundred receivers along the East Coast of the U.S., in the Florida Keys and in the Gulf of Mexico thus providing the potential to gather long-term insights into the movements, migration timing, site fidelity and aggregation behavior of smalltooth sawfish. Transmitters are implanted by making a 15mm incision with a sterile scalpel, on the ventral surface of the sawfish into the peritoneum. The placement of the incision is off-center and just posterior to the liver. The transmitter is inserted into the peritoneum and the incision closed with three stitches using sterile Vicryl braided absorbable sutures with a CT-1 needle.

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

During the reporting period (01 October 2016 – 30 June 2017), three research trips (19 total days, 13 days at sea) were completed and 74 total fishery independent longline sets were made (Figure 7), all aboard an FSU research vessel (a 26' Calcutta). This was among our most successful periods in the 6-year history of this work. Twelve sawfish (10 adults and 2 large juveniles) were captured and tagged (Figure 7). The first trip to the Florida Keys was conducted in January 2017. We made 23 sets, and most of these were in offshore areas where we found adult sawfish aggregated in prior years. However, no sawfish were captured during this trip. The second trip was conducted in late March and early April in conjunction with the conclusion of the Smalltooth Sawfish Recovery Implementation Team meeting in Key Largo. Again, 23 sets were made and were divided between offshore areas (50-75 m deep), Florida Bay, and the Everglades National Park back-country from Shark River to Coot Bay. We captured two large juvenile sawfish (one male and one female) in northern Florida Bay, three adult sawfish (two females and one male) offshore on the Queen of Nassau wreck at a depth of 65 m, and three adult sawfish (two females and one male) in Coot Bay north of Flamingo in the Everglades back-country. The third trip was conducted in mid-April 2017. Most of the sampling during this trip took place in the lower Keys inshore between Cudjoe Key and Key West. Inclement weather prevented sampling offshore areas where we captured adult male and female in the past. During the mid-April 2017 trip we captured four adult sawfish, two males and two females, in the same channel near Sugarloaf Key where we tagged a sawfish in July 2016.

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

During the reporting period we captured and tagged 12 large juveniles and adults of the endangered smalltooth sawfish. This is the first time we have captured adult males and females together in the three different regions, during the same season. Interestingly, all three adults captured in Coot Bay showed very fresh signs of mating, with wounds and scars from rostral teeth on the dorsal and ventral surfaces. This is the first time we have witnessed this (https://www.oceanfdn.org/blog/researchers-discover-critical-clue-mystery-sawfish-mating). Similarly, the females captured in mid-April in the lower Keys also had fresh mating scars. However, the adults captured offshore showed no signs of mating suggesting they may be in the "resting" year of reproduction.

Using NGI funds and previous funds from the NOAA Section 6 Program, we have completed 438 demersal longline sets during the last six years in the Middle to Lower Florida Keys, off the Marquesas Keys and Dry Tortugas, and between Ten Thousand Islands National Wildlife

Refuge and Florida Bay (Figure 8). We captured 57 adult or large juvenile smalltooth sawfish on longlines and an additional 9 sawfish on rod and reel. Of the 57 captured on longline, 24 of these sawfish were captured in relatively deep water (40-70 meters) on the edge of the continental shelf in the middle to lower Florida Keys and 28 were caught in the shallow waters of Florida Bay. Five were caught in shallow water on the Atlantic side of the Florida Keys.

Over the past year, we have tagged 18 large sawfish internally with acoustic transmitters with 10-year battery lives. These tags can be detected by the hundreds of receivers distributed along the Atlantic and Gulf coasts of Florida and up the East Coast as part of the i-TAG, ACT and FACT receiver arrays as well as by receivers distributed throughout the Bahamas. This will allow researchers to determine if Florida-tagged sawfish leave the U.S. and cross the Straits of Florida into Bahamian waters.

To date, detections from six of these large sawfish have been reported to us on more than 30 receivers maintained by researchers from the Florida Fish and Wildlife Conservation Commission, The Kennedy Space Center, Florida Atlantic University and the University of Miami. In total, more than 2,000 detections have been received. Three of these six sawfish were detected as far north as Cape Canaveral. Many researchers are currently downloading receivers so we expect to get far more detections in the coming months. One adult female was detected off Cape Canaveral only 36 days after being tagged offshore of Key West and one male was detected off Ponce Inlet, FL only 23 days after being tagged near Sugarloaf Key (Figure 9). Each of these represent most direct northern movements of nearly 600 KM.

We also collect blood samples from captured sawfish for use in assessing physiological capture associated with stress as well as reproductive status. Our data to date suggest sawfish are hardy and capture stress is extremely low suggesting post-release survival in many fisheries is likely high (Figure 10). Blood samples have been analyzed by our co-PI at the University of North Florida to examine cycling of reproductive hormones in an effort to determine timing and periodicity of vitellogensis, sperm production, mating and parturition. Preliminary data suggest spermatogenesis takes place in fall and winter in preparation for mating in spring (Figure 11). Follicle development in females appears to occur from July through April, followed by mating and ovulation. Gestation is likely one year and therefore, sawfish likely reproduce on a two year cycle. In addition to using blood for reproductive analyses, we are analyzing blood samples for physiological indicators of stress. Preliminary data suggest fishery-independent capture methods induce very low stress regardless if captured on deep longlines, shallow longlines, or rod and reel. These data will be useful as baselines to compare to sawfish captured using fishery-dependent methods.

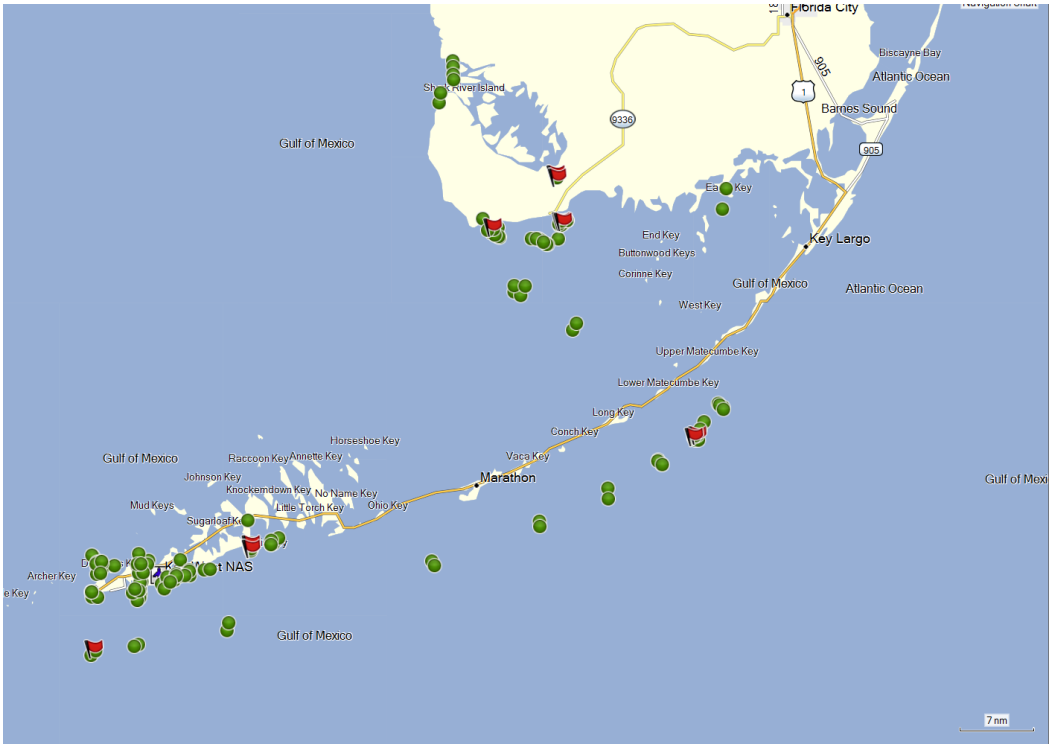

Figure 7. Distribution of fishery-independent longline stations (N=74) sampled during the October 2016-June 2017 reporting period to capture and tag endangered smalltooth sawfish. Red flags = sawfish capture locations.

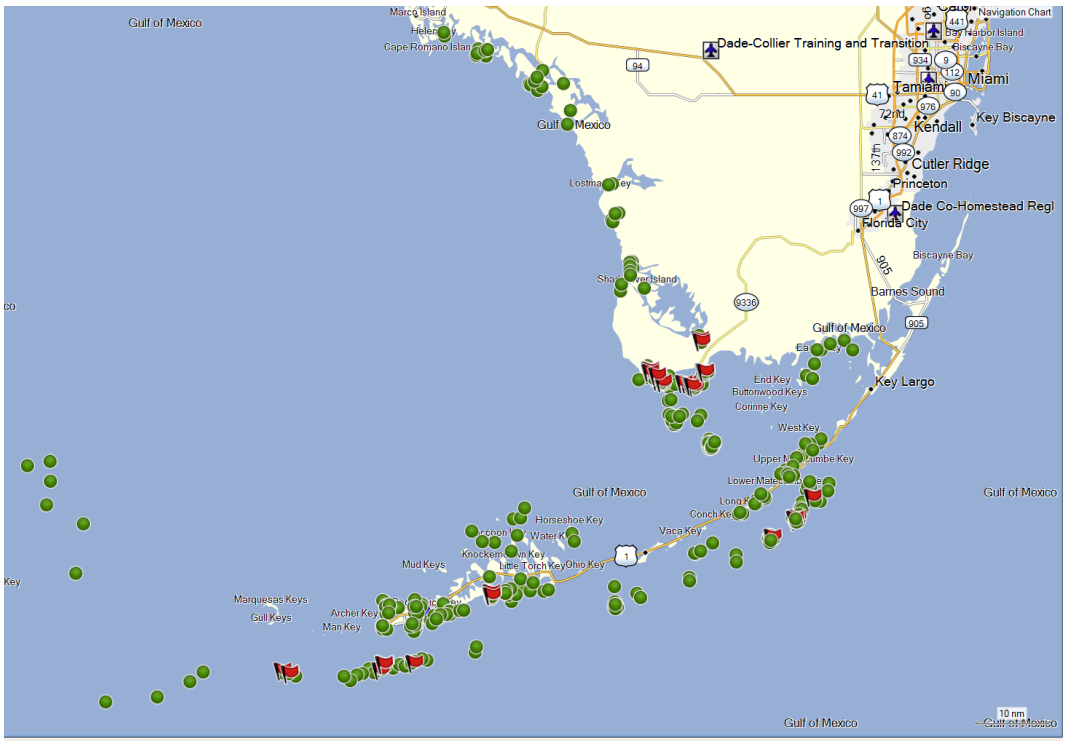

Figure 8. Distribution of fishery-independent longline stations (N=438) sampled during the 2011-2017 period to capture and tag endangered smalltooth sawfish. Red flags = sawfish capture locations (N=57).

Figure 9. Northernmost detections of sawfish 20868 and 20857 on FACT array receivers.

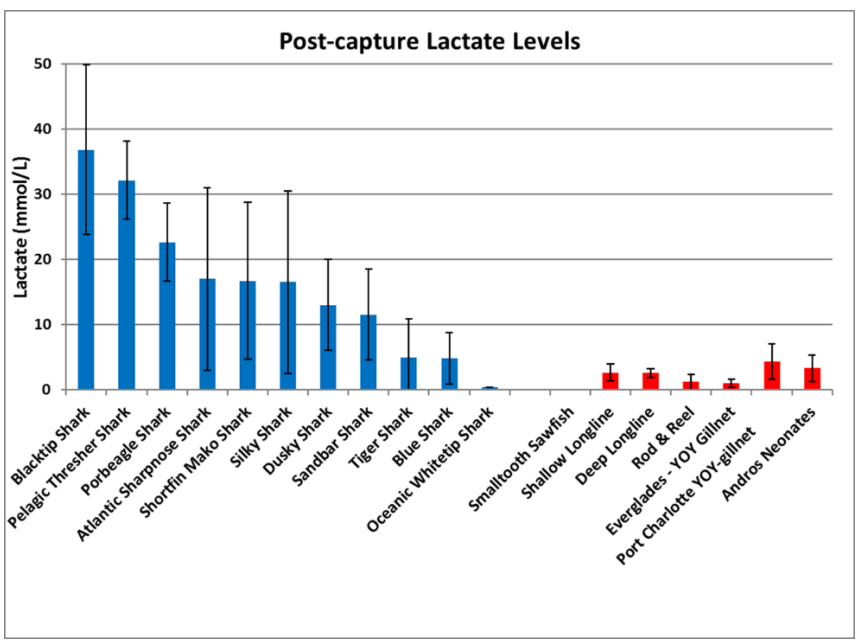

Figure 10. Blood lactate levels of smalltooth sawfish captured using deep longlines (45-70 m), shallow longlines (2-5 m), rod and reel, and gillnets during this study compared to lactate concentrations for coastal and pelagic sharks captured in longlines from Marshall et al. (2012). Rising lactate is an indication of metabolic acidosis resulting from physiological stress and exhaustion (Mandelman and Skomal (2009). These data suggest juvenile and adult sawfish suffer very low stress associated with capture.

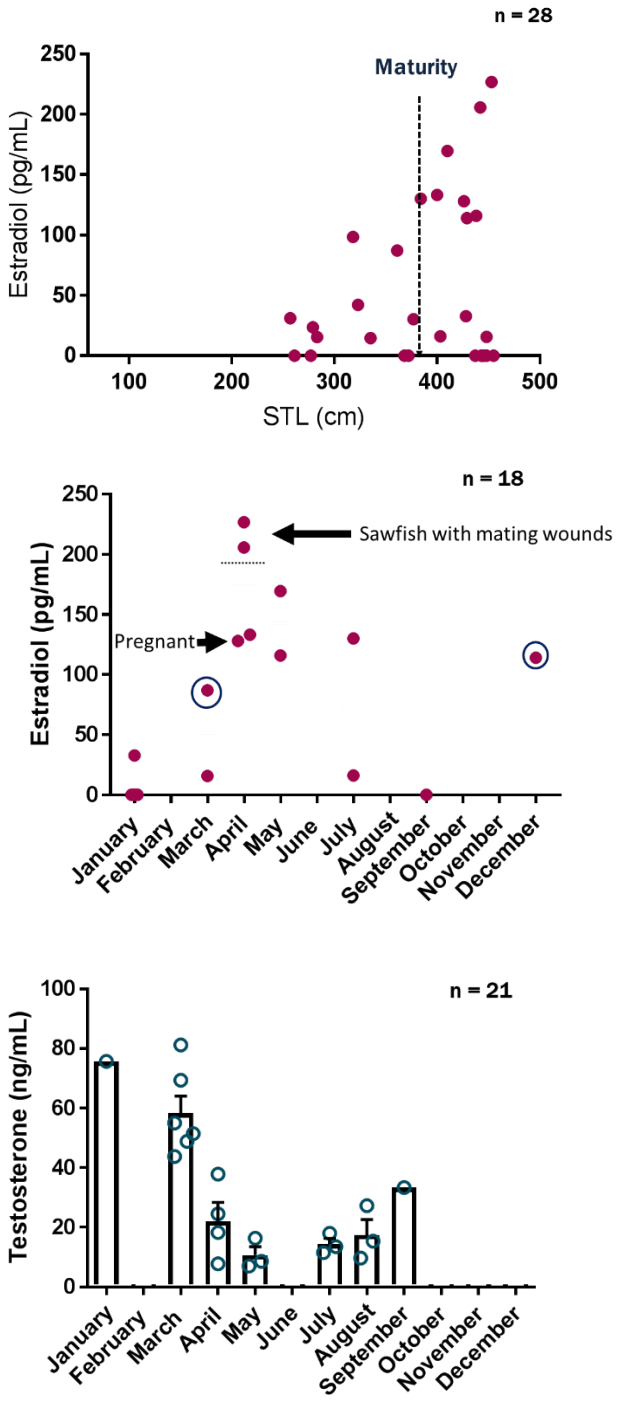

Figure 11. Preliminary results from plasma hormone analyses: Top – estradiol concentrations indicate female maturity at ~380 cm TL. Middle: estradiol concentrations in large females exhibit spring vitellogeneis and mating. Bottom - testosterone concentrations in mature males, demonstrating increased levels in Mar-Apr suggesting mating.

Information on collaborators/partners:

a. Name of collaborating organization: Dr. John Carlson, Adam Brame – NOAA Southwest Fisheries Science Center and Office of Protected Resources
b. Date collaborating established: November 2009
c. Does partner provide monetary support to project? Yes, funding through NGI
d. Does partner provide non-monetary (in-kind) support? Yes, satellite transmitters and satellite time
e. 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? $5,000 subcontract for 2015, 2016, No support requested for 2017.
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: Dr. Gregg Poulakis – Florida Fish and Wildlife Conservation Commission
b. Date collaborating established: November 2009
c. Does partner provide monetary support to project? None currently
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? None currently
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 and the U.S. Department of the Navy.

Information on any outreach activities:
Our NGI supported research was highlighted in numerous national documentaries:
WPBT – “Changing Seas” Series – “Saving Sawfish”
Discovery Channel: Shark Week, “Alien Sharks: Return to the Abyss”

It will be highlighted again during Shark Week 2017.
Discovery Channel Canada – Daily Planet
Our discovery of potential sawfish mating ground received media coverage through various outlets:
https://www.usatoday.com/story/sports/outdoors/2017/04/14/sawfish-mating-grounds-may-have-been-found/100477906/

https://www.oceanfdn.org/blog/researchers-discover-critical-clue-mystery-sawfish-mating
https://twitter.com/i/web/status/853603033766404096
https://twitter.com/FSUCML/status/852994080585994240
https://marinelab.fsu.edu/news-around-the-lab/researchers-discover-critical-clue-in-the-mystery-of-sawfish-mating/

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

Plymouth Marine Laboratory – Seminar Series. Using state of the art telemetry to study very large elasmobranch fishes: endangered sawfish and deep sea sharks. Plymouth, United Kingdom, 31 October 2016.
Our work was presented to the Smalltooth Sawfish Recovery Implementation Team in March 2017

Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology

NGI File #: 16-NGI3-03

Project Title: National Weather Service Social Science Curriculum Delivery FY17

Project Lead (PI) name, affiliation, email address: Laura Myers, The University of Alabama, laura.myers@ua.edu

NOAA sponsor and NOAA office of primary technical contact: John Ogren, NWS

Award Amount: $30,973

Project objectives and goals
The goal of this project is to deliver a pilot series of a set of courses developed for a training program in social science applications to meteorologists and meteorology professionals in FY17. The program consists of 5 courses, 15 hours total. Training program students will learn how to interpret social science research, as well as conduct basic social science research in their field discipline. The courses are designed to provide training program students with an applied social science research overview, developed through each course of the program, culminating in a presentation with policy recommendations from their research. Dr. Laura Myers will be the social science SME working in collaboration with NOAA social scientists and the Office of the Chief Learning Officer (OCLO) to deliver the courses in FY17.

Description of research conducted during the reporting period and milestones accomplished and/or completed
The course content for all five courses was developed and presented to OCLO in June 2016 for approval and feedback. The feedback was used to revise the course content and processes, prior to actual eLearning construction. ELearning construction of all courses and modules took place from June until September, 2016. This process involved the recording of the content and the placement of the recordings in the eLearning environment with visualization of the content. The first pilot course was delivered in February 2017. From April to June 2017, webinars and feedback were provided to the participants.The final class of courses is set to be delivered in July 2017.

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

- LMS eLearning work completed
- Course content edited in preparation for pilot delivery of courses in February 2017
- Worked with Dr. Brown and Training Center to develop request for participants
- Worked with potential participants and their supervisors to help Training Center select participants for the pilot delivery
- Developed all course activities and integrated them into LMS
- Worked with Training Center to set up LMS for participants
- Delivered first course of five in person (1 week) to 30 participants in February 2017 in Kansas City at the NWS Training Center
- Provided feedback to all course activities as completed by the students in preparation for final report due at last course delivery in person in July 2017
- Provided regular webinars on course topics for participants from April to June 2017
- Final course delivery scheduled for July 2017

Information on collaborators/partners:
Vankita Brown, National Weather Service
Darrell Arnold, CAPS Team, The University of Alabama
Sara Gallman, CAPS Team, The University of Alabama

Information on any outreach activities:

- Provided abbreviated social science application materials to meterologists in the field seeking to conduct social science research
- Provided social science assistance to meteorologists in the field wanting to partner with a social scientist or to enlist their expertise and opinion

Related NOAA Strategic Goals: Weather-Ready Nation

Related NOAA Enterprise Objectives: Organization and Administration

NGI File #: 16-NGI3-04

Project Title: Development of Trace Element and Strontium Isotope Water Chemistry Baseline Data for the Pearl River Watershed

Project Lead (PI) name, affiliation, email address: Peter Allen, Mississippi State University, peter.allen@msstate.edu

Co-PI(s) name, affiliation, email address: Brenda Pracheil, Oak Ridge National Laboratory, pracheilbm@ornl.gv

NOAA sponsor and NOAA office of primary technical contact: Jason Rueter, NMFS

Award Amount: $42,194

Project objectives and goals
The goal of this project is to develop a watershed map of trace element and strontium isotope water chemistry for the Pearl River Watershed. This goal will be accomplished through the following objectives:

- *Objective 1*: Collect water samples throughout the Pearl River Watershed and nearby watersheds flowing into Lake Pontchartrain, LA.
- *Objective 2*: Analyze water samples for trace elements and strontium isotopes (i.e., ^{87}Sr and ^{86}Sr)
- *Objective 3*: Use data to develop a map of water chemistry in the Pearl River Watershed.

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

- *Objective 1*: Water samples have been collected throughout the Pearl River Basin including the Bogue Chitto River. Water samples have also been collected from drainages along the northern edge of Lake Pontchartrain and Lake Maurepas, LA, including the Tchefuncte, Tangipahoa, Tickfaw and Amite Rivers. Water was collected from the limits of accessibility to sturgeons in the upper reaches to regions near confluence with saline water.
- *Objective 2*: Water samples have been evaluated for trace elements using solution inductively coupled plasma mass spectrometry (ICPMS) and are currently being analyzed for strontium isotope concentrations using solution multi-collector ICPMS.
- *Objective 3*: Preliminary maps of water chemistry in the Pearl River Watershed have been developed, and are being updated.

Description of significant research results, protocols developed, and research transitions
Only preliminary results are available at this time. More comprehensive results for water analyses will be developed as the analyses continue. Additional water samples may be collected in the near future.
Preliminary results indicate longitudinal changes in some trace elements within the Pearl River and adjacent watersheds (Figures 12-14).

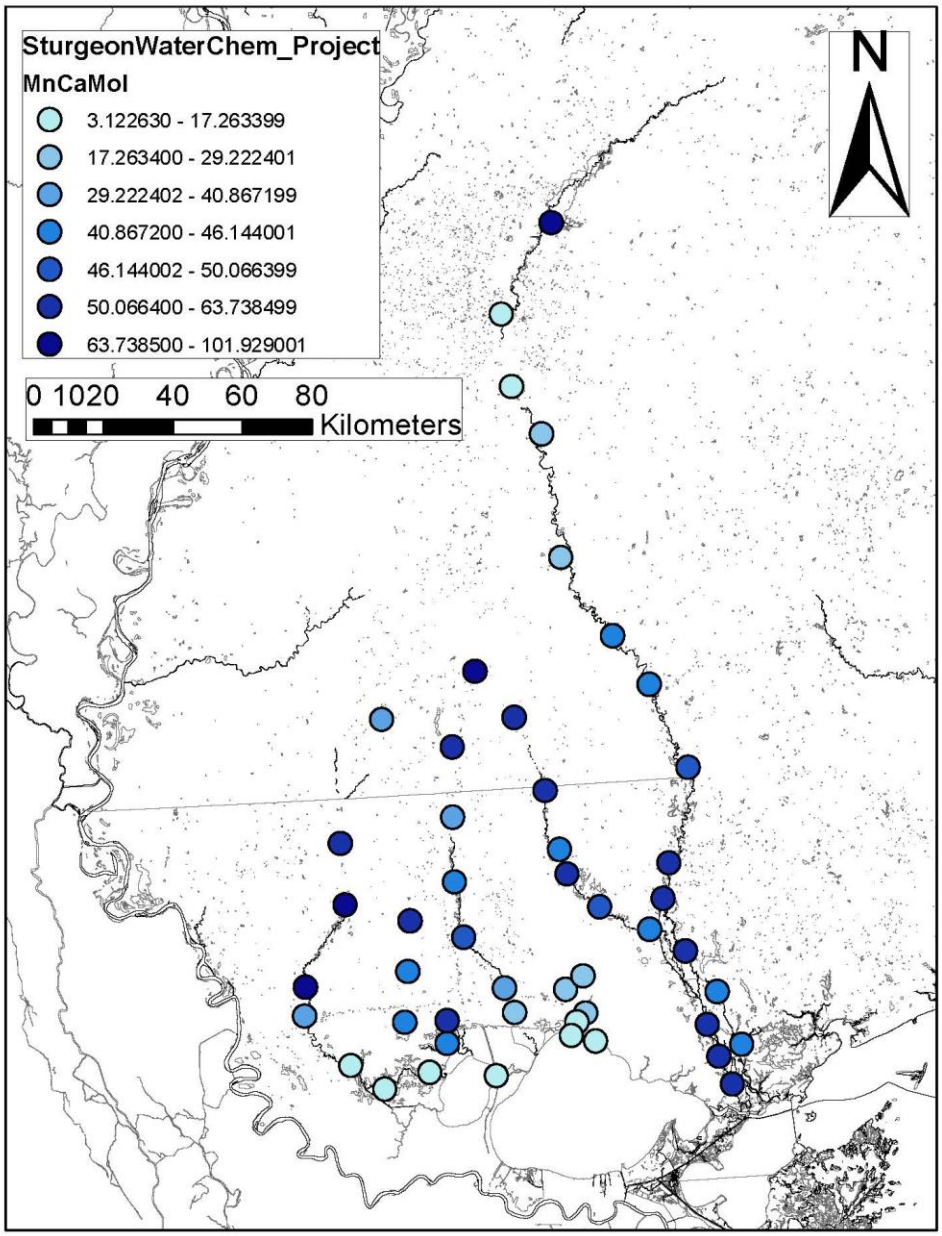

Figure 12: Preliminary changes in water manganese concentrations within the Pearl River and associated watersheds

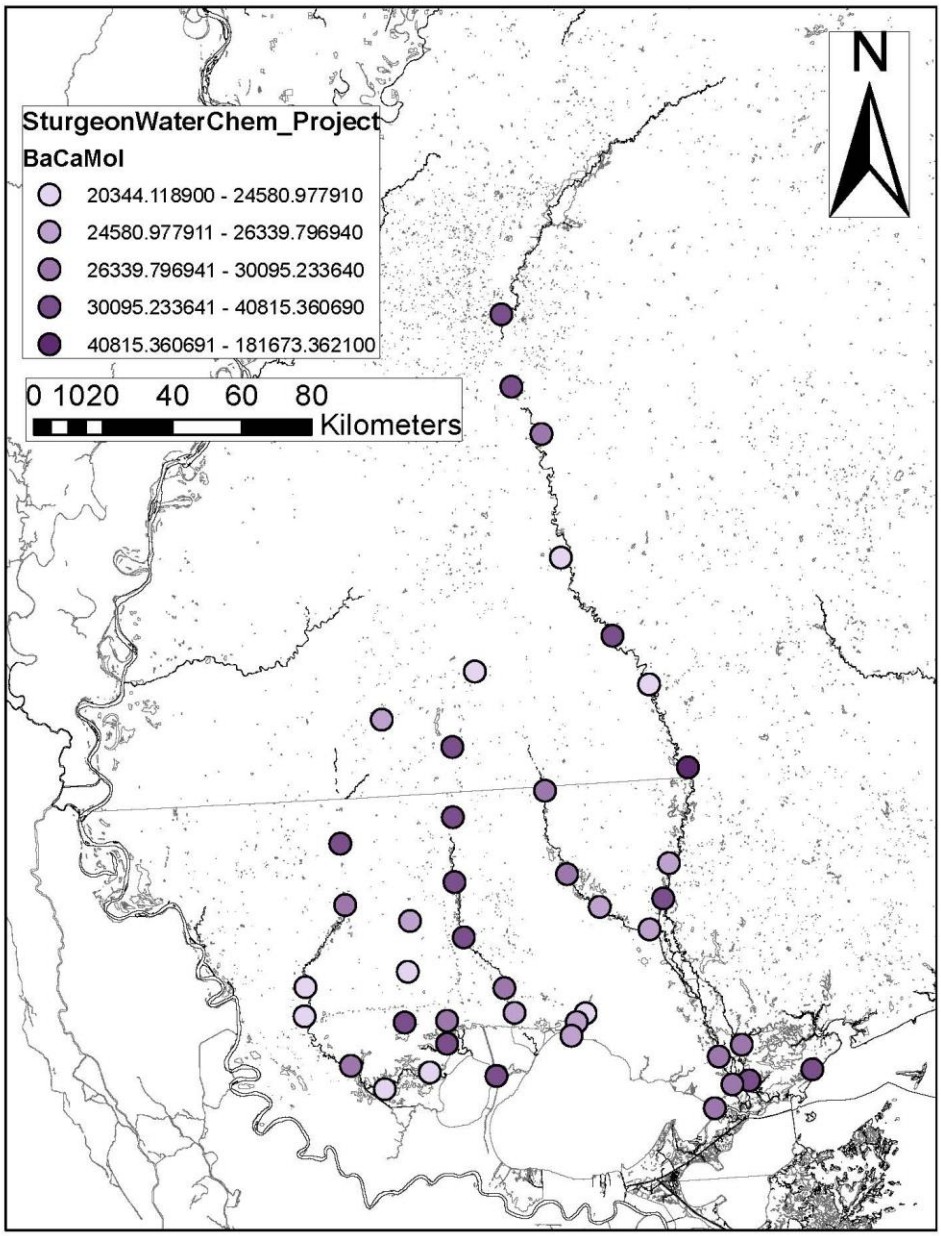

Figure 13. Preliminary changes in water barium concentrations within the Pearl River and associated watersheds

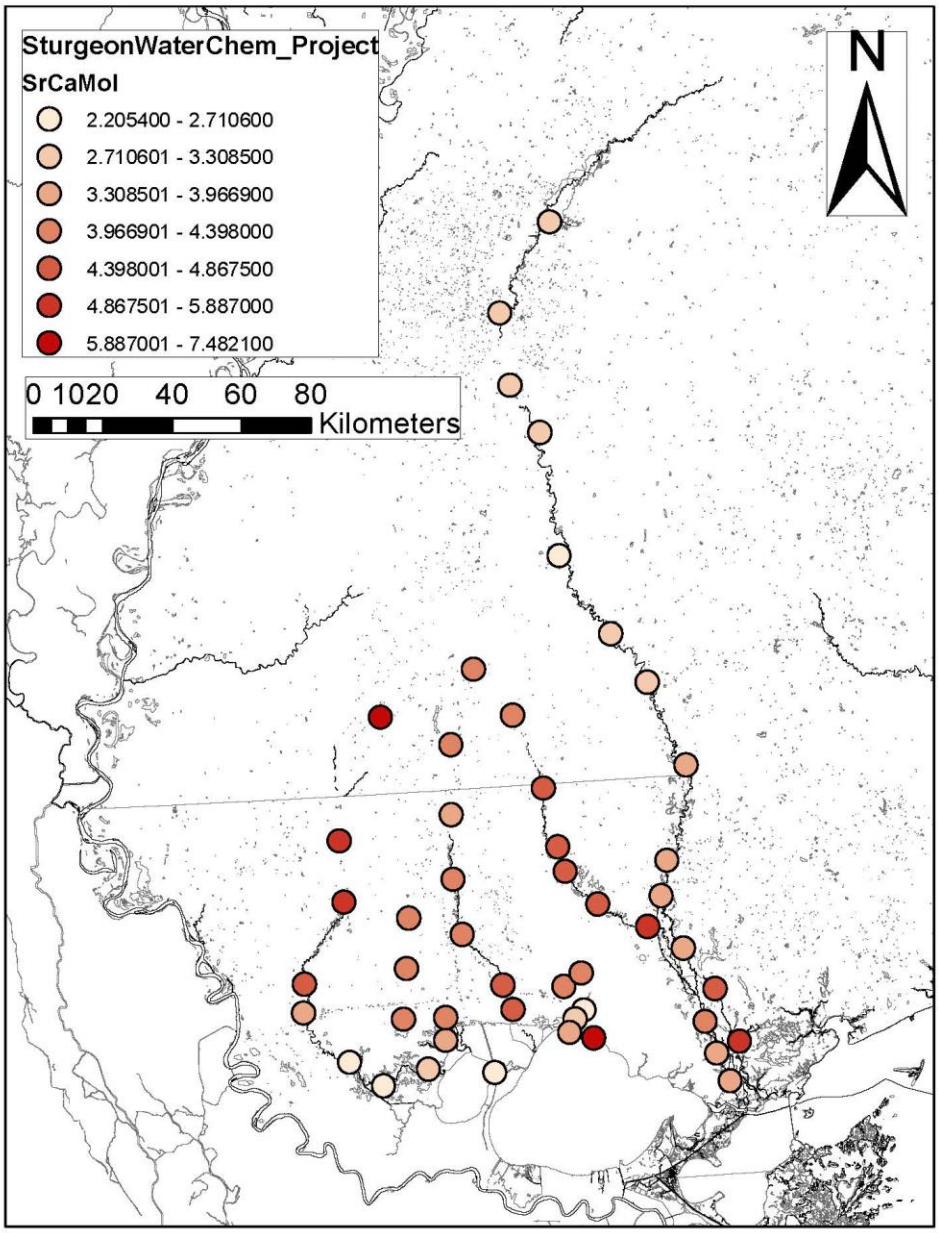

Figure 14. Preliminary changes in water strontium concentrations within the Pearl River and associated watersheds

Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology

NGI File#: 16-NGI3-05

Project Title: Examination and Validation of Reconnaissance Field Program Data in Multiple HWRF Frameworks

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: Molly Baringer, AOML

Award Amount: $66,498

Project objectives and goals
The overarching goal is to perform validation and case study analyses of NOAA experimental HWRF products such as HWRF-HYCOM, HEDAS, and basin-scale HWRF. We also desired to leverage tropical cyclone-tornado research from a previously funded AOML grant.

Description of research conducted during the reporting period and milestones accomplished and/or completed
As a first step, we validated the current HRD operational HWRF products for the previous two Atlantic hurricane seasons in collaboration with Miami NOAA AOML HRD staff. Examination of HWRF-HYCOM water temperature sensitivity experiments for Hurricane Edouard were also performed with NOAA NCEP staff. Finally, in a previously funded travel grant, Frank Mark encouraged research proposals on tornadoes and inner-core convection during tropical cyclone landfall. These proposals were not funded, but unique historical documentation was assembled which could be published in a peer-reviewed paper of Dr. William Gray's legacy.

Description of significant research results, protocols developed, and research transitions
Research results are summarized as follows:

- HEDAS evaluated for 2015 Atlantic hurricane season. Basin-scale HWRF evaluated for 2016 Atlantic hurricane season.
- Validation utilized a new ranking technique (Fitzpatrick and Lau 2013a; Zaron et al. 2015) that blends absolute error, bias, acceptable absolute error percentages, outlier metrics, model efficiency, Pearson correlation, Spearman correlation, Kendall's tau, reliability index, multiplicative bias, normalized dispersion, normalized bias, root mean squared differences, and root centered mean square difference.
- Track forecasts were evaluated against AEMN, GFDL, GHMI, operational HWRF, HWFI, LBAR, NHC official, and TVCA. HWRF ranked 4-5 place behind NHC official and consensus products. In a limited sample, HEDAS was in first place for track magnitude but direction was lower half of products. HWRF basin-scale outperformed the operational HWRF but ranked below consensus and NHC official. Along- and cross-track were also evaluated with similar results.
- Intensity forecasts were evaluated against AEMN, DSHIPS, GFDL, GHMI, operational HWRF, HWFI, IVCN, LGEM, NHC official, and SHIPS. HWRF ranked 3rd behind NHC official and the consensus product. HWRF basin-scale ranked 8 out of 11 products.
- Structure forecasts were evaluated against operational HWRF, HWFI, and NHC official using the Radius of 34 knot winds. HWRF basin-scale ranked 3rd or 4th in these metrics.

- HWRF tests for Hurricane Edouard are ongoing examining the sensitivity to different SST sources, such as GFS, RTOFS, NCODA, and various configurations to warm pools. We are currently quantifying the sensitivity to SST timing and duration of fluxes. We have confirmed that the environmental forcing in all cases is relatively consistent, hence the intensity changes are due to surface fluxes.
- Paper in press: Klotzbach, P. J., J. C. L. Chan, P. J. Fitzpatrick, W. M. Frank, C. W. Landsea, and J. L. McBride, 2017: The science of William M. Gray – his contributions to the advancement of tropical meteorology and tropical cyclones. *Bull. Amer. Meteor. Soc.*, in press. The NOAA research contributed to the section regarding inner-core tropical cyclone convection and landfalling processes, including right-front quadrant concentrations of tornadoes as first documented by Bill Gray and his students.
- Poster at annual AMS conference: Dong, C. J., L. Zhu, H.-S. Kim, P. J. Fitzpatrick, and A. Mehra, 2017: Impact of initial SST fields on Hurricane Edouard (2014) forecasts with the HWRF model. 97th American Meteorological Society Annual Meeting, Jan. 22-26, Seattle, WA.

Information on collaborators/partners:

- Interactions with NOAA NCEP scientists Jili Dong and Hyun-Sook Kim regarding operational HWRF sensitivity experiments to warm pool configurations
- Dr. Chris Landsea of NOAA's National Hurricane Center was a co-author on the published paper
- The validation work involved collaborations NOAA AOML HRD scientists Frank Marks, Sim Aberson, John Kaplan, Sundararaman Gopalakrishnan, Ghassan Alaka, and Hua Chen.

Information on any outreach activities

- Interactions with NOAA scientists, Wood Holes, NRL, and University of Miami on The Ocean Model Impact Tiger Team (OMITT). Monthly paper to the *Bulletin of the American Meteorological Society* in preparation.
- Participation in AOML HRD monthly science meetings
- Participation in AOML HRD daily tropical discussions, and including meteorology students from Jackson State University
- Interdepartmental Hurricane Conference videoconference, 3/14-3/16, 2017
- Attended 2017 NASA TROPICS Applications Workshop, 5/8-5/10, Miami, FL
- Traveled to HRD in Miami, FL, 2/13-2/16 in 2017; 5/7-5/12 in 2017
- Dr. Chris Landsea of NOAA's National Hurricane Center was a co-author on the published paper
- Fitzpatrick coordinated three National Hurricane Conference sessions in New Orleans. All sessions were crowded and standing room only. One session discussed the development of the levee systems, the ambitious plans to counter pervasive flooding with the revolutionary wood screw pump as the centerpiece, the impact of the 1947 hurricane on city mitigation, and the Hurricane and Storm Damage Risk Reduction System (HSDRRS). Speakers included: Robert Turner, the Director of Engineering & Operations, from the Southeast Louisiana Flood Protection Authority-East; David Bernard, Fox 8 News chief meteorologist; and Joseph Becker, General Superintendent,

New Orleans Sewerage and Water Board. The second session recalled the 25th anniversary of Hurricane Andrew, still one of the costliest natural disaster in U.S. history and the last landfalling Category 5 hurricane. Speakers included: Michael Westin, the Red Cross director in Miami during the storm's landfall; Bryan Norcross of The Weather Channel, who was a Miami TV meteorologist during Andrew and credited with saving many lives with shelter advice; and Lynne McChristian of the Insurance Information Institute, an expert on the aftermath of Andrew on the insurance market. The third session discussed the history of the satellite era with specific relevance to hurricanes, the new GOES-R satellites, and the new polar-orbiting satellites including the upcoming Cubesat missions. Speakers included: Bradley Zavodsky of the NASA Marshall Space Flight Center; Mike Brennan of the National Hurricane Center; and Pat Fitzpatrick of Mississippi State University.

- Member of the Scientific and Technological Activities Commission (STAC) Committee on the Coastal Environment (CE) for the American Meteorological Society. Its primary duty is to organize the Symposium on the Coastal Environment held at AMS meetings. We also review applicants for the Reichelderfer Award, judge student presentations, and act as session chairs.

Related NOAA Strategic Goals: Weather-Ready Nation

Related NOAA Enterprise Objectives: Science and Technology

NGI File #: 16-NGI3-06

Project Title: Climate Variability in Ocean Surface Turbulent Fluxes

Project Lead (PI) name, affiliation, email address: Dr. Mark A. Bourassa, Florida State University, bourassa@coaps.fsu.edu

Co-PI(s) name, affiliation, email address: Mr. Shawn R. Smith, Florida State University, smith@coaps.fsu.edu

NOAA sponsor and NOAA office of primary technical contact: Kathy Tedesco, OAR

Award Amount: $84,482

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.

FSU produces both monthly in-situ based and hybrid satellite/numerical weather prediction (NWP) fields of surface winds (the 'FSU Winds') for the tropical Pacific and Indian Oceans. We are also developing a much higher quality surface flux product that assimilates satellite and in situ data. Our long-term monthly fields are well suited for seasonal to decadal studies. They are available in time for monthly updated ENSO forecasts, within eight days after the end of the month. The flux-related variables are useful for ocean forcing in models, testing coupled ocean/atmospheric models, ENSO forecasts, and for understanding some aspects of climate related variability.

The tasks pertain to the continued development/production of products and the dissemination of scientific results. 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˚ 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

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

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. We produced the Pacific and Indian Ocean FSU Winds products, with 100% success in meeting our timeliness goal. Improved data returns from the TOA/TRITON array almost certainly positively impacted the quality of the tropical Pacific Ocean product. The data-related problem in Indian Ocean, associated with a lack of sampling in the northwestern Indian Ocean due to fears of piracy, has diminished resulting in more observations from this region. Our prior examination of this problem found an enormous impact on the accuracy of in situ-based products in this region[1], and we now see the sampling improving.

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). Fisheries managers abroad (e.g., France's IRD) make use of all our wind products. Discussions with a major user at IRD indicated continued high value in the products.

Our satellite winds are currently undergoing a vast improvement. They were not released during this funding cycle; however, they should be released in at least a beta testing mode during the next funding year. Pending improvements based on this beta testing (and based on a first round of beta testing), the wind product will be released in near real time for oceanographic applications (we are aiming for release within two days of acquisition of the satellite data, which is typically within 12 hours for satellite data). Two years ago our satellite wind product suffered from the limitation that the technique worked only poleward of 20° (e.g, the benefits of that model on fluxes are shown in Figure 15. Three years ago we improved the physics and can produce the winds poleward of 15°; however, that general approach was found to be a dead end. In the prior funding cycle, we revised one of Stommel's models to solve this problem. We have coupled a log-layer model with an Ekman layer model to a geostrophic winds model. Preliminary testing indicates that all the desired physics are represented in the new model, and that the model works globally. We have begun comparison with the University of Washington PBL model, which was the model we were using two years ago. However, we found that the new model was not numerically stable in a small set of conditions that are unfortunately certain to occur in nature. Over the last funding cycle we have solved this problem, giving us confidence that we can move on in coding and producing a beta product. This is a major milestone in the development of this product, indicating solving of the single greatest barrier to success. The satellite sensible and latent heat fluxes will continue to be in a development phase, pending implementation of the above model as a soft constraint in our objective analysis.

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

We have addressed many key issues in producing a high quality product, and we are working towards integrating these many parts into a high resolution surface flux product that can be

[1] Smith, R.S., M.A. Bourassa, and M. Long, 2011: Pirate attacks affect Indian Ocean climate research. *Eos*, 92, 225-226.

produced with a two day or less delay provided that collaborators can provide the input data within slightly less than two days.

The key impediments to moving forward in better understanding two way atmospheric and oceanic coupling have been:

1. Ability to realistically model and observe small scale variability,
2. The need for a constellation of observing systems and the consequent need to for very carefully intercalibrated data to avoid spurious small scale variability,
3. Satellite observations for near surface air temperature and humidity have vastly improved in the last five years, however, they are not yet planned for near real time production, and
4. An appropriate mechanism for assimilating the observations and retaining the small scale features in a realistic fashion.

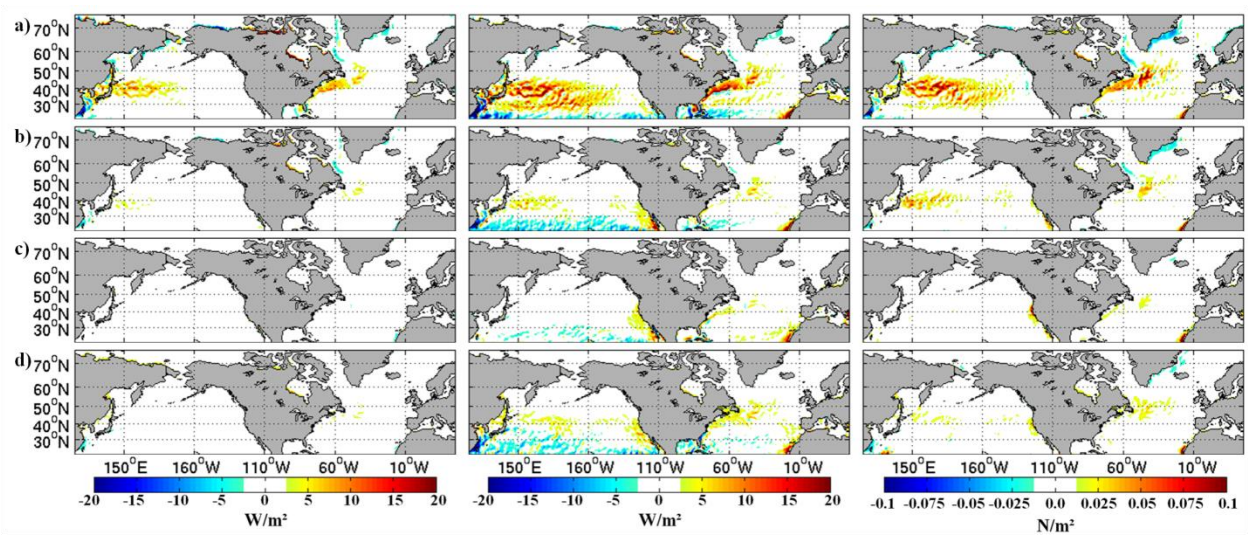

Figure 15. Seasonal biases in sensible heat flux (left), latent heat flux (center) and stress (right). From top to bottom seasons are winter, spring, summer and fall. On daily or six-hourly time scales the changes can by roughly a factor of ten greater.

The key to greatly reduced problems related to (1) and (4) has been developed (the model mentioned above). In the last year, there has been tremendous progress on (2), and additional funding has been obtained to address much of the remaining differences.

We have collaborated with colleagues at NOAA, NCAR and abroad to improve the intercalibration between satellite and visually estimated ship winds. This is a different approach to calibration that has been used in the past because satellite winds are equivalent neutral winds, which are different than winds measure by an anemometer. Interestingly, this approach removes a bias of 0.15 ms^{-1} observed between anemometer and ship winds. This finding is likely because both satellite winds and visual winds are more related to a wind stress than an earth-relative wind.

Box and whisker plots are shown for three collections (referred to as decks) with ICOADS in Figure 16. The common features of these three figures are (1) a large overestimation at low wind speeds ($0ms^{-1}$-$3ms^{-1}$) of collocated estimated ship winds versus the scatterometer winds; and (2) collocated match pairs at higher wind speed area (e.g., larger than $20ms^{-1}$ for Deck 792

and Deck 926, and larger than 18 ms^{-1} for Deck 992) are rarely found (less than 100 collocated match pairs) in the collocation. The medians on these whisker boxplots for wind speeds (greater than 3 ms^{-1}) largely follow the reference line. This bias near the lower limit of wind speeds has been previously shown to be due to random errors in the observations. We estimated the random errors as described below used that to simulate this bias. We found that observation noise is an excellent explanation of this feature, indicating that the actual bias in the data was much smaller. We subtracted our estimate of this artificial bias to determine the actual bias relative to satellite winds

Uncertainty estimation for each major deck (792, 926 and 992) were determined from standard deviations of each been between 5 and 10 ms^{-1}, indicating the Root-Mean-Square (RMS) differences between satellite scatterometer winds and collocated ship winds are 2.51 ms^{-1}, 2.42 ms^{-1} and 2.46 ms^{-1}, respectively. This is a total variance, combining noise from the visual winds and from the scatterometer of roughly 6.25 m^2s^{-2}. Recall that the variances of noise from scatterometer winds is <1 m^2s^{-1}, indicating that the variance for uncertainty in visual winds is greater than roughly 5.25 m^2s^{-2}. We can numerically and statistically simulate the comparison between the scatterometer winds and collocated estimated ship winds for decks 792, 926, and 992 by generating a uniform distributed dataset and adding noise following normal distribution to match the collocated ship winds. This technique is known as “histogram matching.”

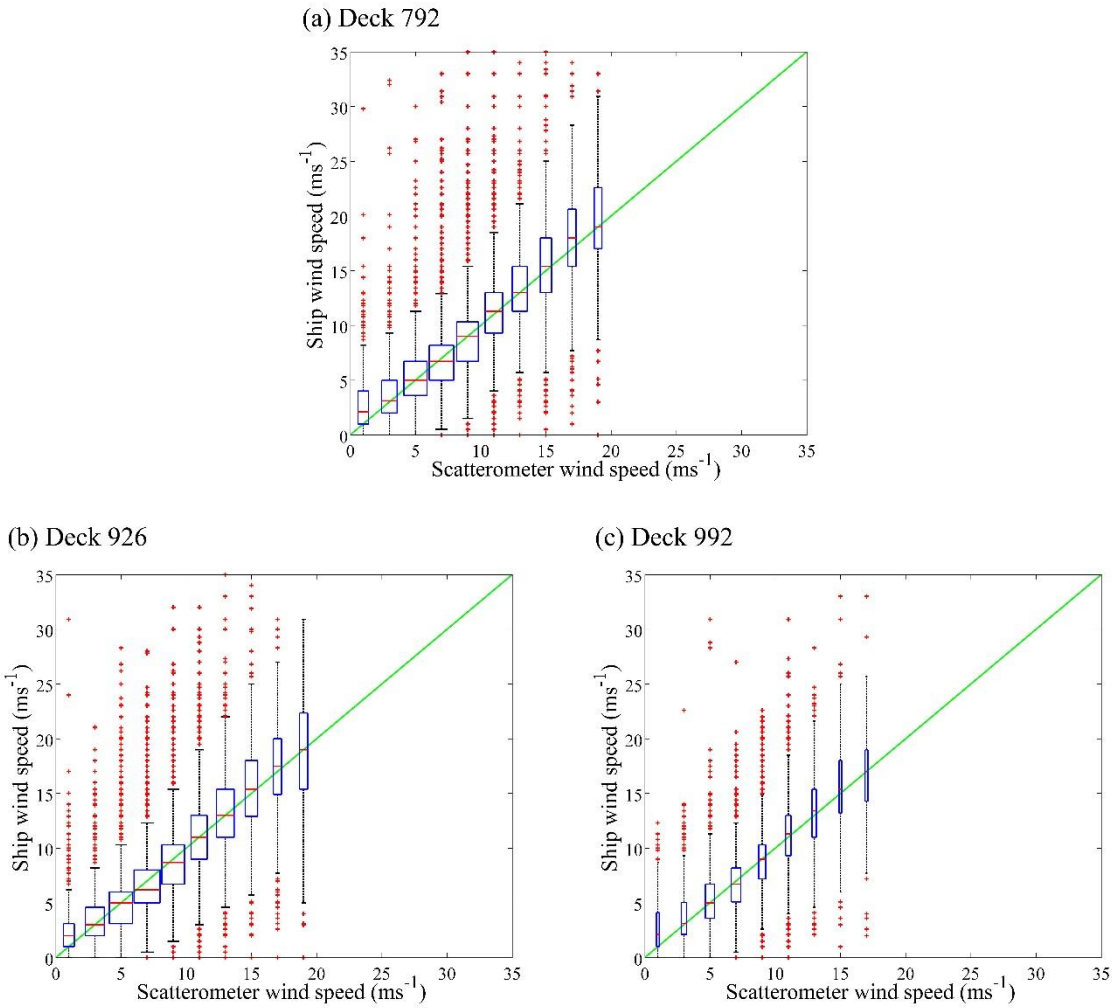

Figure 16. The boxplots for the three different decks (a) 792, (b) 926 and (c) 992. Each one of the whisker boxes is associated with the number of data points in a range of $2ms^{-1}$ of scatterometer wind speed (only for those bins contain 100 more collocated pairs). The width of each whisker box is proportional to the data points within each $2ms^{-1}$ bin.

We are working with NOAA researchers to obtain timely observations of near surface temperature and humidity. We have collaborated with Darren Jackson and Gary Wick, and they have provided us with satellite estimates of these critical data fields. In the prior year, we validated these through comparison to data from research vessels.

Information on collaborators/partners:

Visual ship wind calibration collaboration

This project began with funding for a ICOADS Value Added Dataset (IVAD) several years ago. The proof of concept was developed and tested with that funding, but the final bias adjustment for visual wind estimates was recently completed under this funding. The IVAD partners were NCAR (Steve Worely), NOCS (David Berry and Elizabeth Kent) and NOAA (Scott Woodruff and Eric Freeman). The partners brought expertise with aspects of data management (NCAR and NOAA), and different observables. The US partners were supported in part through a NOAA grant. It is only the final bias correct produced at FSU that is supported by NOAA/NGI.

Satellite retrievals of air temperature and humidity collaboration

Satellite retrievals in air temperature were provided (through support from NASA NEWS) by NOAA partners Darren Jackson and Gary Wick. The NASA project was led by Bourassa, with Jackson as a sub-contract. This same data set will be used to produce the gridded flux product supported by this grant. This specific partnership is in its 3rd year, although we have long collaborated.

Information on any outreach activities:

- We advertised our plans for gridded satellite winds and the International Ocean Vector Winds Science Team Meeting (May 2-4) at Scripps. This is an international meeting that had roughly 95 attendees, many of whom use gridded wind products. The advantages of the physical constraints in the model described above where clearly shown and appreciated.

- The PI served as Co-Chair, GCOS/GOOS/WCRP Ocean Observation Panel for Climate (OOPC)
  GCOS (Global Climate Observing System) sets the climate-related observational requirements and goals for the earth observing system. The Ocean Observation Panel for Climate (OOPC) focuses on the ocean observations. Over the last year the panel has gathered information for a report on the status of the observing system, sponsored a very necessary and urgently needed workshop on the future of the Tropical Pacific Observing system, and begun to work on the approach for the next Implementation Plan. Part of these tasks have been working with the Atmospheric Panel to convey the importance of the ocean for their work, and to push surface fluxes forward as nominees for status as Essential Climate Variables. I have also been closely involved in developing metrics for assessing if the observing system is 'fit to purpose' and key identifying purposes.

- The PI Co-chaired or organizer of meetings and session on topics closely tied to the observing system. E.g., an ASLO session on ocean surface currents.
- The Co-PI is Co-Chair of the Ship Observation Team (SOT)

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 #: 16-NGI3-07

Project Title: Regional Geospatial Modeling Grant

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

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

Award Amount: $2,830,401

Project objectives and goals
The Regional Geospatial Modeling Grant was developed to promote geospatial technology to the public through: workforce training in geographic information systems (GIS) for government employees of Mississippi as well the general public; develop web-based geospatial tools for public access; and the creation of new geospatial data for public consumption.

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

- Interactive Sea Level Model: Lidar data collected in 2015 for the 3 coastal counties of Mississippi was used to develop a 10-ft resolution DEM (digital earth model) as a base for assessing the impact of sea level rise on the road network. A road centerline dataset, developed in an earlier MDEM (Mississippi Digital Earth Model) award, was merged with the elevation raster cells to transfer elevation measures to segments of the road centerline dataset.

  The new road network dataset was used to develop a web-based, interactive model to assess the impact of sea level rise in 1-foot increments. Users may identify an origin and a destination on a basemap to evaluate the impact of sea level rise on traffic patterns as well as accessibility to points of critical infrastructure. An areal display of inundated landscape is displayed over basemaps (both aerial imagery and generalized landmark features).

  The *GeoCoast* sea level rise model may be accessed at: http://geoproject.hpc.msstate.edu/Html5Viewer/index.html?viewer=GeoCoast.

  Status: completed

- A web-based GIS for the people of Mississippi: Instruction in the concepts and applications of geographic information systems (GIS) has a long learning curve to use the tools of GIS properly. The infrequent user of a GIS may find it difficult to recall the operation of desktop GIS software. For this reason, a web-based GIS has been developed with the general public in mind. Popular spatial datasets (e.g., census of population, economics) may be accessed with a collection of commonly used GIS tools.

  GeoDawg is a “HTML” web application with compatibility with all computer operating systems. Tools to create point, line, polygon and text overlays as well as linear and areal measurements on an assortment of basemaps are easy to use. The system is also designed to allow users to upload spatial datasets, such as “GPX” data associated with inexpensive GPS units. Users may also publish products may be exported through a

variety of graphic format images, social media outlets or to ESRI's ArcGIS Online.

While the initial task for the development of *GeoDawg* has been met, enhancements to the application is ongoing.

Status: completed

- The following tasks are on-going and will be completed before the termination of the award.

    - A flood-risk model is under development for the Mississippi Gulf Coast area. Several scenarios focusing on rainfall events and surface conditions will be made available to the public in similar manner to *GeoDawg* and *GeoCoast*. The intent of this web-based application is to allow planners and developers in the coastal counties to assess the probable flooding risks based on the scenarios in development.

      Status: approximately 75 % completed

    - An evaluation of the applicability of using UAS for oil spill detection in the Gulf of Mexico is currently underway. The focus of this task is to use an ultraviolet light source to "excite" hydrocarbons associated with oil deposits on the sea surface. Current remote sensing sensors used for oil spill detection deliver a high level of false positives in the identification of the areal extent of oil deposits. Ultraviolet-based remote sensors are in use over many European and Asian oil fields to monitor oil leaks around oil drilling platforms. Unfortunately, the cost of these systems are high and require a dedicated aircraft.

      A 400-watt ultraviolet light source used on ocean craft has been acquired and is currently under modification to reduce the weight of the light and battery support system. Due to FAA restrictions on weight and altitude levels for non-military UAS, the modified ultraviolet light system will be evaluated on a land-based platform to assess the potential for the system to be used on future UAS platforms.

      Status: approximately 50% completed

    - A subcontract to the Mississippi Department of Environmental Quality covers 70% of the current award. The task associated with the subcontract is to develop 1:4800-scale surface hydrology databases for over 13,000 square miles of HUC-8 watersheds in southeastern and coastal Mississippi. Products are developed according to guidelines established by the U.S. Geological Survey for 1:4800 enhanced hydrologic mapping. Completed products are delivered to the U.S. Geological Survey.

      Status: approximately 80% completed

Information on any outreach activities

In order for geospatial data products developed in Mississippi to be used by governmental and commercial entities, it is necessary to have a user community knowledgeable of the concepts and software systems associated with geographic information systems. The GEO (geospatial education and outreach) Project was developed 11 year ago to develop a professional GIS community across Mississippi. Since the inception of the GEO Project approximately 3,600 participants in over 365 2-day GIS workshops have been delivered across the state.

Content of workshops range from introduction to GIS to multi-user database systems, using commercial as well as “open source” software. The GEO Project employs 2 mobile classrooms to teach the workshops in a variety of facilities near the workshop participants.

During the period of this progress report (October 1, 2016 through June 30, 2017), 25 workshops were offered to 241 participants. A detailed listing of courses, dates, locations and number of participants is on the following page. All workshops are covered over 2 days (the last day of a workshop is displayed in the listing).

Course Name	Date	Location	Number of Participants
Introduction to ArcGIS Desktop	June 15, 2017	NASA Stennis Space Center	7
Intermediate QGIS	June 9, 2017	NASA Stennis Space Center	11
Introduction to ArcGIS for Desktop	May 17, 2017	Itawamba Community College	6
Introduction to QGIS	April 28, 2017	NASA Stennis Space Center	7
Introduction to ArcGIS Online	April 27, 2017	Holmes Community College	11
Introduction to ArcGIS Online	April 21, 2017	Itawamba Community College	12
Advanced QGIS	April 21, 2017	Holmes Community College	11
Advanced QGIS	April 18, 2017	NASA Stennis Space Center	10
Intermediate QGIS	April 12, 2017	Holmes Community College	7
Introduction to ArcGIS for Desktop	April 7, 2017	Holmes Community College	8
Intermediate QGIS	March 29, 2017	NASA Stennis Space Center	10
Parcel Mapping using ArcGIS for Desktop	March 9, 2017	NASA Stennis Space Center	5
Intermediate QGIS	March 8, 2017	Holmes Community College	9
Introduction to ArcGIS for Desktop	February 23, 2017	Holmes Community College	11
Introduction to ArcGIS for Desktop	February 16, 2017	NASA Stennis Space Center	12

Introduction to QGIS	February 9, 2017	Holmes Community College	11
Introduction to ArcGIS for Desktop	January 19, 2017	NASA Stennis Space Center	12
Advanced QGIS	December 9, 2016	Holmes Community College	8
Advanced QGIS	December 6, 2016	NASA Stennis Space Center	7
Introduction to ArcGIS for Desktop	December 2, 2016	Holmes Community College	12
Introduction to ArcGIS for Desktop	November 17, 2016	NASA Stennis Space Center	11
Intermediate QGIS	October 21, 2016	Holmes Community College	10
Introduction to ArcGIS for Desktop	October 19, 2016	Holmes Community College	12
Intermediate QGIS	October 18, 2016	NASA Stennis Space Center	9
Intermediate QGIS	July 22, 2016	Holmes Community College	12

Related NOAA Strategic Goals: Coastal Hazards, Effective and Efficient Data Management Systems Supporting a Data-Driven Economy

Related NOAA Enterprise Objectives: Engagement

NGI File #: 16-NGI3-08

Project Title: University of Southern Mississippi Mapping Center

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

NOAA sponsor and NOAA office of primary technical contact: Lorraine Robidoux, NOS

Award Amount: $1,600,707

Project objectives and goals
The goal of this project is to establish an enduring mapping center to address research and development needs that advance the science and practice of hydrography and cartography. The research plan encompasses five thrusts (e.g. Sensors/Platforms, Positioning, Water Levels, Data Management, Data Portrayal) that capture the legislative visions of a mapping center. Tasks within the five thrust areas focus on:

- Innovative Use of Lidar Data
  - Gulf of Mexico Shoreline Analysis
  - Great Lakes Lidar Data to Charts
  - Lidar vs MBES Object Detection
  - JALBTCX Great Lakes Database

- Precise Positioning
  - GPS Block IIF Third Frequency Algorithms
  - GPS-GLONASS-Galileo-Beidou Performance Synergies

- Precise Water Level Determination
  - V-Datum Validation and Expansion
  - Sea Level Rise/Land Subsidence
  - Bottom Mounted Tide Gauge Performance

- Integrated Ocean & Coastal Mapping
  - Enhance IOCM efforts

- Cartography and ECDIS
  - Educating the Next Generation Cartographer
  - Transition to S-100
  - Re-constitute ECDIS Lab

Description of research conducted during the reporting period and milestones accomplished and/or completed
Innovative Use of Lidar Data – Lidar data for several significant sections of the Northern Gulf Coast shoreline have been retrieved and compared to shorelines depicted on existing charts. Great Lakes lidar data sets have been analyzed using the methodology previously developed by USM; however, the volume of lidar data for the great Lakes, compared to the coastal data sets previously used, are substantially larger and not optimum for the USM methodology. A new methodology is being adopted that manages the larger data sets more efficiently. Data density

and object detection analysis was performed using coincident CZMIL lidar and U.S. Navy multi beam echo sounder data.

Precise Positioning - One graduate research assistant has prepared and submitted procurement documents for the necessary receivers to conduct the investigations into the enhancements that may be realizable from innovative use of the third frequency transmitted from GPS Block IIF satellites and from the synergistic use of the four international constellations.

Precise Water Level Determination - One graduate research assistant used existing water level data collected from the USM 3m buoy moored in the MS Bight as a comparison to the water level values derived from V-Datum. The research staff and faculty are coordinating with CO-OPS and USM's Gulf Coast Geospatial Center to schedule the installation of tide gauges on the MS Barrier Islands and in the Port of Gulfport to form a framework for the validation and densification of V-Datum along the MS Gulf Coast. This network of gauges, which will be collocated with GNSS receivers, will also provide the time series records from which sea level rise/land subsidence studies can be based.

Integrated Ocean & Coastal Mapping - Documents and activities of the Interagency Working Group on IOCM were reviewed.

Cartography & ECDIS - IHO standards publications S-5 and S-8 were reviewed and compared to determine what new material is necessary for cartography Category A and B recognition.

Description of significant research results, protocols developed, and research transitions
Innovative Use of Lidar Data - The results of the analysis of data density and object detection was presented at the 18th Annual Airborne Coastal Mapping and Charting Workshop on 6 June 2017. A new protocol for assessing large quantities of lidar data and preparing those data for inclusion into the nautical chart update workflow is completed and the initial dataset is being prepared for submission.

Precise Positioning - This investigation is in its preliminary phase with no results to date.

Precise Water Level Determination - The preliminary analysis of the data from the USM 3m buoy indicates the uncertainties associated with transformations using V-Datum along the MS Gulf Coast are greater than the published values. These findings provide impetus for a rigorous and robust V-Datum validation and densification effort proposed in this effort.

Integrated Ocean & Coastal Mapping - This investigation is in its preliminary phase with no results to date.

Cartography & ECDIS - This investigation is in its preliminary phase with no results to date.

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

Related NOAA Enterprise Objectives: Science and Technology

NGI FILE #: 16-NGI3-09

Project Title: Hypoxia National Office Technical Assistance, Observations, Monitoring, and Coordination

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: Alan Lewitus, NOS

Award Amount: $324,590

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

Technical Assistance and Coordination

NGI provided technical assistance to support scientific and research efforts conducted by the Hypoxia National Office related to hypoxia forecasting and modeling, social and economic impacts, and impacts on marine resources. Regional working groups continued to inventory ongoing monitoring related to hypoxia in the respective regions. A meeting with representatives from the work groups is being planned.

A workshop with the NGOMEX funded hydrodynamic and water quality modelers was planned for March of 2017 but was cancelled due to inclement weather.

Observations and Monitoring

NGI provided support for observations and monitoring in hypoxic regions of the Gulf of Mexico in support of NOAA's goals associated with the Gulf of Mexico Hypoxia Task Force and NOAA's Ecological Forecasting Roadmap (EFR) and specifically the EFR-Hypoxia pilot for operationalization. A cruise is scheduled for July 2017 to be conducted by LUMCON to acquire oceanographic and biological data in the hypoxic zone. Objectives of this cruise are to:

- Collect data and samples from established stations;
- Collect hydrographic profiles of temperature, salinity, dissolved oxygen, fluorescence (chl a), and turbidity using a SeaBird 911 plus CTD unit with 5-L Niskins;
- Underway flow-through system for near surface temperature, salinity, in vivo fluorescence, and percent light transmission with GPS and meteorological information - MIDAS
- Collect dissolved nutrients and bottle oxygen samples for chemical analysis;

- Collect samples for phytoplankton biomass estimates and classification;

Three deterministic models developed through NGOMEX and currently in prototype testing through the IOOS COMT program for transition to operations will use data from the cruise to characterize the dynamics of the dead zone from spring through late summer.

- Justic and Wang's (2009) 3-D coupled hydrodynamics (FVCOM-LATEX)-water quality model;
- Hetland and DiMarco's (2012) 3D dynamically coupled (ROMS hydrodynamic model);
- Fennel et al.'s (2012) 3D dynamically coupled (biogeochemical model).

The findings will be presented to the Gulf Hypoxia Task Force at their 2017 public meeting

Hypoxia research coordination workshop: Discussions are ongoing to plan the 7th *Annual NOAA/NGI Hypoxia Research Coordination Workshop* which will be co-led by NGI and NOAA, and will focus on coordination of the activities of eight Monitoring Workgroups toward building a Cooperative Hypoxia Monitoring Program:

Monitoring Workgroup	Lead(s)
Autonomous Vehicle	Steve DiMarco (TAMU)
Hypoxia Task Force	Danny Wiegand (EPA Gulf Program), Alan Lewitus (NOAA NOS)
Fisheries	Kevin Craig (NOAA NMFS), Alan Lewitus (NOAA NOS)
Oil&Gas/Ocean Acidification	Barb Kirkpatrick (GCOOS), Nancy Rabalais (LSU/LUMCON), Steve DiMarco (TAMU)
Louisiana	Angelina Freeman (Louisiana CPRA), Dubravko Justic (LSU)
Mississippi/Alabama	Steve Ashby (NGI), Stephan Howden (USM), Brian Dzwonkowski (U. So. AL/DISL)
RESTORE Act	Steve Giordano (NOAA NMFS)
Texas	Steve DiMarco (TAMU)

The leads of these Workgroups form the Hypoxia Monitoring Program Implementation Team. Preliminary discussions were held regarding plans to bring this Implementation Team together at the *7th Annual NOAA/NGI Hypoxia Research Coordination Workshop* to document the successes of these workgroups in producing program building blocks, update and refine the implementation plan, and re-engage partners to build off this new monitoring foundation.

Description of significant research results, protocols developed, and research transitions
Near real-time data were posted to the web site (http://www.gulfhypoxia.net) along with graphic representation of the data.

Plans were developed to move a buoy asset from the Mississippi Bight to the hypoxic zone. The intent is to add a dissolved oxygen sensor for bottom observations. The initial location chosen was near the LUMCON water quality station and LSU WAVCIS station CSI-06 (W90º29', N28º52') pending final approval from the U.S. Coast Guard.

A proceeding report from the 6th Annual Hypoxia Research Coordination Workshop was completed, identifying the partners and mechanisms necessary to implement and sustain a Cooperative Hypoxic Zone Monitoring Program.

Citation: Meckley, T.D., S. Ashby, S.D. DiMarco, S.D. Giordano, R.M. Greene, D.M. Hilmer, S.F. Howden, B. Kirkpatrick, A.J. Lewitus, T. Pierce, N.N. Rabalais, R.C. Raynie, D.L. Scheurer, and M.D. Woodside. 2017. Building a cooperative monitoring program for Gulf of Mexico Hypoxia and interrelated issues. Proceedings Paper from the 6th Annual NOAA/NGI Hypoxia Research Coordination Workshop: Establishing a Cooperative Hypoxic Zone Monitoring Program, 12-13 September 2016, at the Mississippi State University Science and Technology Center at NASA's Stennis Space Center in Mississippi, 36 pages. The complete report is available at: https://www.ncddc.noaa.gov/activities/healthy-oceans/gulf-hypoxia-stakeholders/workshop-2016/proceedings/.

Information on collaborators/partners:

a. Name of collaborating organization:
   - The Steering Committee members for the *6th Annual NOAA/NGI Hypoxia Research Coordination Workshop* were all collaborators on this project. The committee members are: Steve Ashby (Northern Gulf Institute), Alan Lewitus (NOAA NCCOS), Dave Scheurer (NOAA NCCOS), Steve Giordano (NOAA OHC), Trevor Meckley (NOAA NCCOS), David Hilmer (NOAA NCCOS), Rick Greene (EPA Gulf Breeze Laboratory), Troy Pierce (EPA Gulf of Mexico Program), Nancy Rabalais (LUMCON), Steve DiMarco (TAMU), Barbara Kirkpatrick (GCOOS), Stephan Howden (USM), and Rick Raynie (LACPRA)
   - Gulf of Mexico Alliance
   - IOOS
   - LUMCON, Louisiana State University, Texas A&M University, Dalhousie University, and the University of South Florida
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 outreach activities
Dr. Alan Lewitus participated in the Gulf of Mexico Alliance All Hands Meeting in March of 2017 and, specifically, with the Water Resources Priority Issues Team where he presented information on the Hypoxia National Office Activities.

Presentations of project findings were given to the Gulf Hypoxia Task Force (HTF) at their December 2016 Public Meeting and on their April 2017 HTF Member Conference Call.

Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology

NGI File #: 16-NG13-10

Project Title: NOAA Weather Information and Dissemination All Hazards Stakeholder Needs Assessment Verification Project

Project Lead (PI) name, affiliation, email address: Laura Myers, The University of Alabama, laura.myers@ua.edu

NOAA sponsor and NOAA office of primary technical contact: Luis Cano, NWS

Award Amount: $100,000

Project objectives and goals
The NOAA Office of Dissemination is evaluating the use and applications of NOAA Weather Radio All Hazards to determine user requirements to transform the current NOAA Weather Radio All Hazards broadcast network into a new integrated weather information distribution/dissemination system. A significant component of this evaluation involves stakeholder engagement at all levels of the weather enterprise. The SME/PI will provide high-level research and evaluation guidance and support to the Office of Dissemination (DIS) team for the specific engagement of stakeholders relevant to the evaluation of the NWR.

Description of research conducted during the reporting period and milestones accomplished and/or completed
Prior to October 1, 2016, Dr. Myers has developed a strategy to obtain NWR user needs from relevant stakeholders to provide input on future system requirements, potential technologies to augment and/or replace obsolete equipment, and design and engineering scope. The strategy includes the protocol for the research design to engage stakeholders. This includes the data collection design, which incorporates on-line survey, phone, and in-person modalities for reaching various identified types of stakeholders. This strategy was used to collect extensive amounts of data starting in August 2016 to develop multiple reports for the Office of Dissemination.

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

- Began data collection in August 2016 and engaged in extensive phone and in-person interviews, focus groups, and workshops to collect data
- Developed and presented Phase 1 report of stakeholder needs in October 2016
- Engaged in multiple webinars on report for feedback from Dr. Brown's team
- Developed and presented Phase 1 results for AMS Partners meeting in January 2017
- Continued data collection with new partner groups and started revisting original respondents with Phase 1 results for their feedback
- Developed functional requirements gap report and presented to Team in March 2017
- Conducting case studies of actual events to study modalities, February 2017 to present
- Developed models of dissemination report in June 2017

Information on collaborators/partners:
Tyra Brown, National Weather Service
Susan Jasko, California University of Pennsylvannia
Sara Gallman, CAPS, The University of Alabama

Information on any outreach activities:

- Provided Phase 1 results on modality functionalities to meterologists in the field seeking to improve warning dissemination to vulnerable and impacted populations

Related NOAA Strategic Goals: Weather-Ready Nation

Related NOAA Enterprise Objectives: Engagement

NGI File #: 16-NGI3-11

Project Title: Core infrastructure enhancements, operations, and preliminary research activities supporting VORTEX-SE 2017 field campaign activities - Phase 2: Operations and research supporting the VORTEX-SE 2017 field campaign

Project Lead (PI) name, affiliation, email address: Kevin Knupp, University of Alabama in Huntsville, kevin.knupp@uah.edu

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

Award Amount: $318,588

Project objectives and goals

A. Conduct analysis of existing data relevant to VORTEX-SE science goals
B. Acquire field measurements from the Mobile Alabama X-band (MAX) radar, Mobile Integrated Profiling System (MIPS), Mobile Doppler Lidar and Sounding System (MoDLS), Rapidly Deployable Atmospheric Profiling System (RaDAPS), and balloon soundings on events of interest prior to the VORTEX-SE field campaign
C. Participate in the design and execution of the VORTEX-SE field campaign for the period 7 March to 7 May 2017.
D. Begin data quality control and analysis of data collected under items B and C.

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

1. <u>Data analysis</u>

A M.S. graduate student has continued analyses of profiler and radar data to document the variability in low-level clouds, thermodynamics, and wind (wind shear) for cold-season tornado events. Ceilometer data were examined to determine cloud base height distributions and cloud cover fraction around tornadic storms (supercell vs. QLCS) to address the hypothesis that cloud fraction (cloud base height) tends to be high (low) for tornadoes in the Southeast. This database includes other regions in the Southeast U.S. after MIPS data are compared with data from the KHSV ASOS, located 15 km SW of the MIPS site. This project component has also compared measured cloud base with the surface-based LCL for all proximity tornado events to validate and extend results presented in Craven et al. (2002). The database and also been stratified to examine differences in cloud base height between daytime (12-18 LST) and nocturnal (00-06 LST) periods. Cloud base is lower in the more frequent nocturnal events, and the subcloud stability is weakly to moderately stable. We hypothesis that this stability reduces subcloud turbulence and hence maintains high vertical shear of the horizontal wind (and hence high 0-1 km storm-relative helicity).

Tim Coleman directed an analysis of an unanticipated and isolated EF-2 tornado occurrence on 1 March 2016 near Birmingham, Alabama. The boundary layer environment of the tornado was very heterogeneous in space and unsteady in time, with what would typically be considered an excellent proximity sounding severely underestimating instability, and SPC mesoanalyses significantly underestimating wind shear. Tornadogenesis occurred near a frontogenetical thermal boundary. The boundary produced a local maximum in surface dewpoint values (and

instability) due to moisture flux convergence, and locally enhanced wind shear and helicity. The low-level forcing associated with this boundary appeared to intensify the rather shallow parent supercell storm, and tornadogenesis occurred shortly afterward.

2. Pre-VSE and post VSE deployment activities

UAH facilities were deployed on potentially severe weather days between November 2016 and June 2017 in association with: (a) pre-VSE field campaign activities prior to 3/7/17 (Table 1), (b) VSE field campaign activities during the 3/7/17 – 5/7/17 period (next section, Table 2), and (c) post VSE field campaign activities during events of opportunity in May 2017.

Table 1. Summary of Pre-VORTEX-SE deployments

Date	Type of system	Systems deployed (and location)	IOP Summary
11/28/16	QLCS, no severe weather	MAX @ Tanner MIPS @ SWIRLL MoDLS @ SWIRLL	Evolution of a shallow QLCS in a very high shear (up to 70 kt at 850 mb), low CAPE (about zero) environment; 18 km dual Doppler baseline between MAX & ARMOR
11/29/16	Tornado outbreak over N AL	MAX @ Powell (Sand Mtn), RaDAPS @ NACC (Sand Mtn), MoDLS in Tenn R. Valley, MIPS @ SWIRLL	MIPS sampled mesocyclone of supercell storm that was tornadic before and after the observations; RaDAPS and MoDLS documented substantial differences in SRH (1 km) between Sand Mountain (~450 $m^2 s^{-2}$) and the adjacent Tennessee River Valley (<300 $m^2 s^{-2}$)
12/17/16		MAX and MoDLS @ Courtland MIPS @ SWIRLL	Boundary layer evolution around deep convection from afternoon into the nocturnal period. MoDLS documented variations in surface layer airflow downwind of a rough (tree-covered) surface at the Courtland airport.
2/8/17		MAX @ Grove Oak, MoDLS @ Ft Payne, MIPS @ Scottsboro	QLCS and other parallel precipitation bands moved over domain during the nocturnal period. The leading QLCS split into cells during ascent over Sand Mountain. Well documented by KHTX and MAX
3/1/17		MoDLS on Sand Mtn, RaDAPS in Valley, MIPS at SWIRLL	Good boundary layer deployment, which documented reduction in vertical shear over Sand Mountain as the convective BL produced a mixed wind profile and lowering of SRH.

3. VORTEX-SE field campaign activities

VORTEX-SE field campaign activities (including support) are summarized in the following sections.

a. *IOPs during the VSE formal field campaign, 3/7/17 – 5/7/17*

UAH facilities were deployed on potentially severe weather days, as summarized Table 2. UAH personnel assumed the primary responsibility of providing daily forecasts for potential VORTEX-SE IOP days, and nowcasts during IOP events. The SWIRLL Research Operations Center

served as the primary location from which operations were conducted and coordinated. UAH personnel operated the Advanced Radar for Meteorological and Operational Research (ARMOR), the Mobile Alabama X-band (MAX) radar, the Mobile Integrated Profiling System (MIPS), the Mobile Doppler Lidar and Sounding System (MoDLS), and the RaDAPS.

Table 2. Summary of VORTEX-SE field deployments

Date IOP #	Type of system	Systems deployed (and location)	IOP summary
3/9/17 UFO* 1	Rapid ABL evolution; supercells and QLCS	MIPS @ SWIRLL, MoDLS at SWIRLL, ARMOR	No general VSE ops due to unfavorable fcst. Rapid advection case. Most UAH facilities were located at SWIRLL to document ABL changes. Rapid advection of water vapor occurred from late afternoon into the early nocturnal period. Rapid increase in 0-2 km shear ahead of QLCS which passed around 0430 UTC. QLCS evolved to bore-driven system over CLAMPS.
3/25/17 IOP 1A	QLCS with bow	MAX @ Tanner MIPS @ SWIRLL MoDLS @ Courtlnd	Turbulent BL with strong winds, evolving wind profile, bow echo. Possible tornado (focused damage path) NE of Brown's Ferry NPP
3/27/17 IOP 1B	BL, multiple QLCS event	MAX @ Brn Ferry XPOL @ Tanner MoDLS @ Brn Ferry, MIPS @ SWIRLL	Gust front, bore, and QLCS passages were sampled over the network for a 4-h period. MoDLS sampled two gust fronts and one bore during the event.
3/30/17 IOP 2	Sand Mtn: ABL and wake low; startiform precip	MAX @ Section RaDAPS @ NACC MoDLS @ Geraldine MIPS @ Scottsboro	ABL measurements over Sand Mountain initially, decaying QLCS moved over Sand Mtn and produced a wake low with significant w at MoDLS site
4/3/17 IOP 3A	W Domain: ABL evol.	MIPS @ SWIRLL MAX at Brn Ferry MoDLS at NACC, RaDAPS at Madison-Athens	Focus was on ABL and recovery as early morning MCS stabilized the atmosphere. Only a few showers were sample. Potentially good data set for ABL surface roughness effects. ABL transitioned from strong shear to nearly mixed on Sand Mtn during aftn
4/5/17 IOP 3B	E Domain Supercells ahead of dry line. ABL evol.	MIPS @ SWIRLL MoDLS at NACC, RaDAPS at SM MAX at Section. SR-2, NOXP,X-Pol, and RaXPOL	Early ops beginning around 1130 UTC documented the complete evolution of the ABL over SM. Nice shear during the day, scattered deep convection (s/c like) ahead of dry line. As the dryline moved over MoDLS, sustained updraft of >10 m/s was

		formed the SM Doppler net	sampled. Deep convection intensified/expanded around DL passage. Good case of SM processes documented by profiler and radar net.
4/22/17 IOP 3.5B (UFO 2)	Tornadic supercell near RaDAPS, sampled by P-3	RaDAPS at Jackson Co., MoDLS at NACC, MAX @ Sylvania, MIPS at SWIRLL, P-3 operations around UAH fac.	The was an excellent case despite limited facilities. An HP supercell developed over S central TN and moved over the E domain, very near RaDAPS and CLAMPS. The P-3 sampled the front side of the storm with multiple legs. One tornado occurred 8 km W of RaDAPS, and a second formed as the storm ascended Sand Mtn. Best case of the project from the UAH point of view
4/26/17 IOP 4A	Nocturnal QLCS over W part of W domain by 0430 Z	West Domain MoDLS at Priceville exit, MAX @ Killen, MIPS @ SWIRLL, RaDAPS @ Leighton	Non-severe QLCS transitioned from leading convective / trailing stratiform to leading stratiform / trailing convective system.
4/28/17 IOP 4B	Convective boundary layer experiment	East Domain MAX at Brn Ferry RaDAPS at Leighton, MIPS at SWiRLL, MoDLS at Decatur	Initially assets were deployed to target possible CI and potentially severe deep convection. When this did not materialize by 20 Z, the experiment defaulted to a CBL evolution and surface roughness experiment. Clear air backscatter was adequate to achieve wind retrievals in the mobile radar network.
IOP 4C 4/30/17	QLCS and prestorm BL	East Domain MAX at Sylvania MoDLS at NACC RaDAPS: 7 NW Hollywood, MIPS at Macedonia School on SM	Prestorm BL was sampled prior to the passage of a weakening QLCS. Areas of rotation were measured within the SM radar network, and visually observed along the leading edge over SM. MIPS observed a well-defined, surface-based updraft at the leading edge of the QLCS.

* UFO: Unofficial Field Operation (UAH operations only)

b. *Use of SWIRLL for research and operations support during the 2017 field campaign*

The SWIRLL facility provided storage support for He canisters for four other groups, and for equipment and parts for three groups.

c. *Forecasting and real-time operations*

UAH assumed the lead on forecasting for potential IOPS during the entire VSE campaign. Daily briefings were provided six days in advance of potential IOPs, and special meetings were

conducted to determine the final deployment locations for mobile facilities. During IOPs, the SWIRLL Operations Center was used to coordinate operations.

d. *Utilization of research facilities*

The following UAH research facilities were utilized during all IOPs:

- ARMOR
- MAX
- MIPS
- RaDAPS
- MoDLS
- M3V (mobile mesonet, available in April)

e. *Field surveys for instrument siting*

Prior to the VSE field campaign, field surveys were conducted to determine mobile radar locations in both the East and West domains. UAH personnel arranged to acquire permission and power for the NSSL CLAMPS and University of Massachusetts FM-CW radar at the Scottsboro airport in the Tennessee River Valley. UAH also made a request for an electrical contractor to provide power access for the MoDLS platform at the Northeast Alabama Community College (NACC) campus for long-term measurements at that site on Sand Mountain.

f. *Damage surveys*

Damage surveys were performed for tornadoes that occurred within the VSE domain on 4/5/2017 (IOP3B), 4/22/2017 (IOP 3.5B, or UFO 2), and 4/30/2017 in Cullman County. Other damage surveys were completed for the 29-20 November 2016 tornado outbreak (pre-VSE), and for a QLCS spawned tornado 5 km east of ARMOR on 20 May 2017. Notably, NWS HUN did not survey the latter tornado event, and the NWS survey of the Cullman County tornado on 4/30/2017 was significantly modified (shortened) by UAH personnel for use on our research database. These errors and omissions by the NWS personnel underscore the need to conduct detailed surveys on all potentially tornadic events.

Outside of the formal VSE field campaign, surveys were completed on 11/30/2016, 12/18/2016, 2/8/2017, 3/1/2017, and 5/21/2017. In total, about 100 man-hours were dedicated to these surveys.

g. Data quality control

We are finalizing the QC on data acquired from the MIPS, MAX, RaDAPS, and MoDLS during the pre-VSE and VSE field campaigns. These data will be uploaded to the EOL VORTEX-SE 2017 web site.

Information on collaborators/partners
NOAA/NSSL was a primary collaborator during this project. This collaboration was established in during early 2015 and continues to the present. NSSL provided funds for field campaign activities and data analysis. UAH worked closely with Dr. David Turner in siting the CLAMPS at the Scottsboro airport and coordinating the logistics for power and internet connection.

Information on any outreach activities
We have continued to conduct guided tours of the SWIRLL building on a regular basis.

Approximately 33 tours have been provided since July 2016. Groups include senior citizens, social clubs, K-12, foreign groups, Senate staffers, prospective graduate students, and other visitors. We also accept invitations to special conferences and “Weatherfests” when possible. The VORTEX-SE project represents a primary focal point of these tours.

Related NOAA Strategic Goals: Weather-Ready Nation

Related NOAA Enterprise Objectives: Science and Technology

NGI File #: 16-NGI3-12

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

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

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

NOAA sponsor and NOAA office of primary technical contact: Sidney Thurston, OAR

Award Amount: $405,954

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.

Description of research conducted during the reporting period and milestones accomplished and/or completed
To date in the reporting period (10/1/16-6/30/17), 28 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 in near-real time (within five minutes of email receipt) via the SAMOS web pages (http://samos.coaps.fsu.edu/data.shtml). 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 on the SAMOS web site 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 and archived at the National Centers for Environmental Information (NCEI)-Maryland on a monthly basis.

During this period, the DAC was also assessing the quality of full-resolution (sampling on the order of once per second) data collected by the Scientific Computing System (SCS) software deployed on NOAA research vessels. Additionally, the DAC operated an issue tracking system to coordinate feedback and response related to SCS devices (starting with meteorology and flow-water sensors) between NOAA technicians, the Office of Marine and Aviation Operations (OMAO), and the U.S. Voluntary Observing Ship scheme office. SAMOS observations from the recruited NOAA vessels represent only a fraction of the data collected by SCS while a NOAA vessel is at sea. The DAC is working to ensure that a complete record of the full-resolution (as sampled by the individual sensors) SCS data are received by NCEI following each cruise and cross-referenced to quality-processed data subsets derived from the original SCS observations (e.g., SAMOS datasets). Data collected by SCS on NOAA vessels represent a significant investment by the American taxpayer. Archival of complete and well documented SCS data at

NCEI ensures these data are preserved for future generations of scientists, policy makers, and the public.

Description of significant research results, protocols developed, and research transitions
Accomplishments in the reporting period centered around the core mission to collect one-minute sampling interval underway meteorological and oceanographic data via the SAMOS initiative (funded by COD) and to expand the DAC at FSU to evaluate the quality of SCS data provided by NOAA vessels to NCEI (funded by OMAO). Deliverables in the reporting period for COD include the following:

C1 – Continue daily monitoring and automated quality control of data received by all vessels contributing to the SAMOS DAC.
C2 – Continue routine research-quality visual evaluation of meteorological data for all NOAA vessels contributing to the SAMOS DAC.
C3 – Distribute all quality-controlled SAMOS observations via web, ftp, and THREDDS services and ensure routine archival at NCEI.
C4 – Continue to update SAMOS instrumental metadata for all recruited vessels supported by NOAA.
C5 – Limited engagement of new user communities via meetings, publications, and electronic communications.
C6 – Continue collaborations with U.S. and international (limited) partners and throughout the marine climate community
C7 – Write formal data management plan and update documentation on SAMOS data processing and quality control.

And for OMAO include the following:
O1 – Modify SCS DAC processing at FSU as needed verify contents of each post-cruise SCS data package submitted to NCEI for completeness, and other metrics as requested by OMAO. Implement changes for additional vessels in the NOAA fleet.
O2 – Conduct preliminary development of file-level data quality control for a subset of devices in the post-cruise SCS data packages and work with OMAO to include parameter-level quality control into SCS.
O3 – Provide OMAO with metrics of file completeness, data quality, etc. at a daily granularity for each SCS package via web pages and web services.
O4 – Coordinate with personnel at NCEI to augment/enhance the documentation and metadata associated with each SCS dataset in the archive (including providing a quality assessment report for each evaluated archive package).
O5 – Coordinate feedback to operators regarding device problems in collaboration with key U.S. partners via issue tracking software.
O6 – Liaise with UNOLS R2R, NOAA R2R, OMAO, and NCEI to ensure that ship-repository-NCEI data pathways are consistent with broader data management plans for the U.S. research vessel fleet.
O7 – Develop training materials for “how to collect SAMOS data” using SCS.

These deliverables collectively support an ongoing effort by the DAC to ensure that the highest quality marine meteorological and near surface oceanographic data are collected by research vessels, primarily from the U.S. fleet, and that they are distributed and archived in a manner that makes the data accessible and useful to a diverse research and operational user community. Unlike the standard marine weather reports collected and transmitted to support operational marine weather forecasting, the data collected in near-real time by vessels recruited to the SAMOS initiative and the post-cruise underway data collected by SCS on NOAA vessels are

primarily used in marine climate and ocean process studies, numerical modeling, and surface oceanographic data analyses. Examples include creating estimates of the heat, moisture, momentum, and radiation fluxes at the air-sea interface, improving our understanding of the biases and uncertainties in global air-sea fluxes, benchmarking new satellite and model products, and providing high quality observations to support modeling activities (e.g., reanalysis) and global climate programs. Underway meteorological and surface oceanographic data continue to be used NOAA ESRL (D. Jackson, personal communication, 2016) to improve algorithms that retrieve air temperature and humidity near the ocean surface using space-based satellite observing platforms. These improved satellite retrievals can then be applied to develop improved estimates of air-sea exchanges of heat, momentum, and freshwater and can further be incorporated into numerical weather prediction and climate models that are used by NOAA for forecasting and decision making for the general public. Similarly, wind observations and sea surface temperature data from SAMOS and SCS datasets can be used to evaluate satellite ocean vector wind products (and derived surface currents) and SST products that are subsequently used to model the circulation and temperature structure of the ocean (e.g., ocean heat content and transport).

In summary, the U.S. research vessel DAC at FSU provides the foundational high-quality meteorological and near-surface oceanographic data to support an expanding research and operational user community, which in turn is addressing many questions of primary interest to COD and NOAA. Additionally, archiving all quality-evaluated SAMOS data at NCEI along with evaluation of post-cruise underway SCS data that OMAO submits to NCEI ensures that these data collected at taxpayer expense by U.S. research vessels are complete, accurate, and accessible for future generations of scientists, policy makers, and the public.

<u>COD</u>

The primary achievement is the continuation the SAMOS initiative, founded by COD in 2005, which collects, evaluates, distributes, and archives underway meteorological and near surface ocean observations from research ships. The total number of vessels routinely transmitting meteorology and surface oceanographic data to the SAMOS DAC remained stable in the past year with a slight decrease in the number of days of data received and processed (only slightly below our 2016 performance metric of 5100 days). One new vessel was recruited (*Neil Armstrong*). These data span the global ocean, but were more limited in the Southern Ocean and eastern Atlantic than in previous years. The extent of these data from the tropics to the polar latitudes, along with many reports on the U.S. 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.

Our lead analyst, Jeremy Rolph, continues to conduct daily (not 24/7) visual inspections of all SAMOS observations [deliverable C1]. 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 by ensuring the highest quality data are available to research and operational users. In addition, operator feedback often results in updates to sensor metadata [Deliverable C4] when problems are the result of the need to change instrumentation on the vessel or simply because a change was made and the SAMOS DAC was not notified.

Kristen Briggs completed visual QC for all recruited NOAA vessels [deliverable C2]. Visual QC allows the analyst to review, add, or modify data quality flags on the merged files. Visual data QC identifies a number of problems (e.g., stack exhaust contamination of temperature/humidity sensors, water flow problems in scientific sea water system, diurnal ship heating errors) that are difficult to capture reliably with automated QC. The result is data from ships only receiving automated QC likely have erroneous data reaching data users without being marked/flagged as problematic. Ms. Briggs again was lead author of an annual report (Briggs et al. 2017) that summarizes the data quality for all vessels contributing data for the calendar year 2016. The report has been distributed to all operators of SAMOS vessels and posted to the SAMOS web site.

Members of the DAC team engaged the marine climate and wider user community [Deliverable C5 and C6] via presentations at meetings and Mr. Smith's ongoing involvement with the Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) Ship Observation Team (SOT) and the International Comprehensive Ocean-Atmosphere Data Set (ICOADS). Mr. Smith is the vice-chair of the JCOMM SOT, continues to serve on the SOT task teams focused on the Marine Climate Data System (TT-MCDS) and Instrument Standards (TT-IS), and leads the task team on high-resolution marine meteorology (TT-HR) from Voluntary Observing Ships. In March 2017, Mr. Smith chaired the 9th Session of the SOT in London, UK and developed numerous related JCOMM documents. Mr. Smith contributed extensively to the development of release 3.0 of ICOADS and was the lead author on the ICOADS technical format document.

Finally, we completed a formal data management plan (http://samos.coaps.fsu.edu/html/docs/SAMOS_DMP_for_NOAA_14Dec2016_v04.pdf) and added documentation on SAMOS data processing and quality control to the monthly SAMOS archive packages being submitted to NCEI [Deliverable C7].

<u>OMAO</u>

In 2016, modifications to the code used by the DAC to monitor the completeness of SCS data packages submitted to NCEI have been implemented and we have discontinued timeliness of delivery reporting at OMAO's request [Deliverable O1]. The tests access each archived SCS package at NCEI and builds statistics based on the number of devices enabled/not enabled that have data files reported in the SCS package. Tests also verify the md5 checksums for the files, determine if the files are readable, and identify zero byte files. Completeness percentages are determined from these counts. Completeness testing is operational for all NOAA vessels and is run once all SCS data for an entire cruise are submitted and archived by NCEI. Conducting completeness testing for all NOAA vessels puts the DAC ahead of the performance metric planned for 2016.

Development of file level QC, starting with post-cruise meteorology and TSG data, was planned to begin in late 2016 [Deliverable O2]; however, OMAO has discontinued this task.

Kris Suchdeve, the primary developer of SCS data processing at the DAC, has created a system to automatically process SCS data packages archived at NCEI and stores the daily completeness statistics in a relational database. The resulting statistics are made available to OMAO [Deliverable O3] via an interactive web portal (https://mdc.coaps.fsu.edu/scs-dac/reporting/completeness, note: login and password required) and JSON web services (https://mdc.coaps.fsu.edu/scs-dac/reporting/completeness/json-builder). For FY16, 60 SCS data packages have presently been archived at NCEI delivered from 13 NOAA vessels. The

overall average daily completeness of the SCS datasets is 50%, with daily completeness ranging from around 80% down to zero within each SCS dataset.

DAC personnel continue to engage NCEI personnel regarding procedures to link the completeness statistics back to the individual SCS archive packages at NCEI [Deliverable O4]. Kris developed extensible markup language (XML) data quality evaluation reports using an XML evaluation schema developed in collaboration with the NSF-funded Rolling Deck to Repository project [Deliverable O6]. These reports are now available to NCEI so they can be linked to the original SCS archive packages.

During 2016, Kris and Kristen Briggs continued to support a Google groups-based issue tracking system (ITS) that can be used to report and track problems with underway data systems connected to SCS [Deliverable O5]. In the initial implementation, the SAMOS team is reporting problems with underway meteorology and thermosalinograph systems to the operators using the ITS. Early adoption by techs has been slow.

Finally, Kris Suchdeve and Jeremy Rolph have led the development of training materials focused on “how to SAMOS using SCS” [Deliverable O7]. These materials focus on how to set up SAMOS data averaging and SAMOS data collection events in SCS and how to configure the SCS mail application to automatically submit data to the DAC on a daily basis. Delayed-mode methods to submit SAMOS data if a vessel’s mailer is having problems are also discussed. To facilitate hands-on training, the DAC team has purchased a portable computer and display and linked it to an existing Vaisala all-in-one meteorological sensor package that we had on hand at FSU. The latest version of SCS software has been installed on the computer along with the necessary mail services to simulate SCS as it would run on a ship. Training was presented at the UNOLS Research Vessel Technical Enhancement Committee meeting in November 2016 and at the NOAA SCS training event in December 2016.

Data and publication sharing

The core mission of the DAC is data stewardship. This includes ensuring all data, reports, and documentation are readily available and SAMOS data and metadata are submitted to a national archive for long-term preservation [Deliverable C3].

All near real-time (preliminary, 5-min delay from receipt) and delayed-mode (intermediate or research, 10-day delay from receipt) SAMOS data are available via web (http://samos.coaps.fsu.edu/, under “Data Access”), ftp (samos.coaps.fsu.edu, anonymous access, cd /samos_pub/data/), and THREDDS (http://coaps.fsu.edu/thredds.php) services. The most recent data can be identified by selecting “preliminary” data at http://samos.coaps.fsu.edu/html/data_availability.php, and are typically available within a few minutes of 0000 UTC. We routinely test our web services and respond rapidly to failures of the system. We upgraded our THREDDS catalog service and completed the migration of our web pages to new servers (see above) to improve reliability and speed data access. In addition to data access, 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, best practice guides, and training materials. SAMOS publications and technical reports supported by COD are available at http://samos.coaps.fsu.edu/html/publications.php and acknowledgements are included in each document.

SAMOS data are not distributed via the Global Telecommunication System. The DAC has an ongoing collaboration 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). 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 National Centers for Environmental Information (NCEI) - Maryland on a monthly schedule using automated submission protocols. 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. SAMOS data accessed from NCEI are linked to a collection level DOI via the landing page: http://data.nodc.noaa.gov/cgi-bin/iso?id=gov.noaa.nodc:COAPS-SAMOS. As of 14 June 2017, a granule search from the landing page located 4079 monthly SAMOS ship archive sets at NODC. Periodically, the PI downloads SAMOS data from NODC to ensure system integrity.

For OMAO, the DAC does not presently produce any datasets, but disseminates result of the evaluation of SCS data packages via emails to OMAO and NCEI personnel and a series of web services. OMAO support of the SCS data center at FSU has been acknowledged in all presentations to date and is included on an SCS DAC web site https://mdc.coaps.fsu.edu/scs-dac). The SCS-DAC web pages currently provide project information, personnel associated with the DAC, access to the ITS, and completeness statistics; however, some pages require login access to view statistics at this time.

Information on collaborators/partners
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. Our primary collaborators are John Katebini and Patrick Murphy at OMAO. In addition, we collaborate with Chris Paver at NCEI to ensure timely archival of all SAMOS datasets. In the funding period, NCEI did not provide any direct support for this activity, but they do provide in-kind support (travel and salaries) for their personnel to work with the SAMOS program.

Information on outreach activities
We continue to train the next generation data scientists. In the reporting period, one undergraduate student (William McCall-Parker) and one graduate student (Adam Stallard) studying computer science have worked part time for the DAC aiding our lead programmer with applications, database, and web service programming.

Public outreach events included the COAPS Open House (February 2017), during which DAC staff demonstrated the operation of marine meteorological instrumentation and computer programming concepts, and FSU-day at the FL State Capitol (March 2017).

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 #: 16-NGI3-13

Project Title: Continuation of Comparative Metagenomics to Indicate Sites Under Anthropogenic Pressure: Year 2

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: Molly Baringer, AOML

Award Amount: $128,800

Project objectives and goals:

1) Determine the taxonomic composition, richness and structure of the primary bacterial members of the microbial consortia from specific sentinel coastal water sites from the Gulf of Mexico as determined by NGS bacterial community sequence profiling and community metagenomic analysis.
2) Determine the microbial diversity, relative abundance, and Core Microbiome structure of these Gulf of Mexico OSD GO sites from different Gulf of Mexico habitats.
3) Determine whether genetic sequences of specific pathogens, fecal indicators, or markers of microbial contaminants from land-based sources of pollution can be detected in the population of metagenomic sequences from NGS profiling at OSD sites, and if so in what relative abundance.
4) Determine whether genetic signatures of specific selected pathogens, fecal indicators, source tracking markers of LBSP microbial contaminants, or metabolic genetic signatures of other potential anthropogenic stress (i.e. such as genes for virulence factors, metabolism of volatile anthropogenic compounds, etc.) can be independently detected in the population of metatranscriptomic sequences from NGS profiling at OSD sites, and if so in what relative abundance. Determine whether there is a relationship between detection of these signatures and proximity to known sources of anthropogenic stress.

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

A postdoctoral researcher with high level computational expertise and bioinformatics experience (Luke Thompson) was successfully recruited and hired on September 1, 2016 to analyze metagenomics NGS data. One paper has been published and another is under review in Nature. Luke Thompson resides in San Diego and is working closely with NOAA AMOL collaborator in La Holla, CA and Miami, FL.

As a bioinformatician, Luke's role expanded beyond that of a traditional post-doc working on a single project and/or narrow research program. He now serves a variety of projects with priority on analysis of existing datasets and on publishing the results of his findings. He brought to NOAA the latest analytical methods in bioinformatics and molecular ecology and have shared these tools with colleagues in the agency and with international collaborators on the Ocean Sampling Day (OSD) project. Also, as a lead on the Earth Microbiome Project (EMP), his role in OSD became larger than what one might surmise from the title of the current NGI project. In addition to investigating global patterns of biodiversity in two of the largest crowd-sourced microbial surveys (OSD and EMP), he is leading analysis on two historical Gulf of Mexico projects. One is looking at the ocean microbiome prior to the Deepwater Horizon spill. The other

is an ocean exploration project characterizing the microbiome of a rare deep-sea polychaete invertebrate, the methane ice worm.
In addition to moving through a backlog of previously-acquired data sets, he is spearheading the bioinformatic analysis of several new projects to serve core missions of NOAA. In particular, he is currently preparing to embark on field operations to test the viability of 1) environmental sample processors on AUVs to match the sampling fidelity of shipboard sampling, 2) larval community metabarcoding to match the fidelity of manual counting, and 3) free environmental DNA as a proxy for recent fish population counts. These 'omics-enabled' technologies will increase spatial sampling coverage while reducing ship costs. Given his current rate of output (~2-3 first-author publications per year), it's highly likely that significant progress will be made quickly to advance NOAA Omics.

We expect our work on Ocean Sampling Day to continue garnering significant press coverage and to highlight the collaborative work being carried out by NGI scientists with labs in the US and Europe. Likewise, the Earth Microbiome Project has received public interest since its inception in 2010, and when the paper is published (currently in review at Nature), we expect it to bring significant attention to our efforts to understand the organizing principles of microbial communities on Earth and in the ocean.

Description of significant research results, protocols developed, and research transitions
During the reporting period, this project has greatly reduced a backlog of previously acquired data sets. Bioinformatic analysis of several new projects to serve core missions of NOAA was initiated. Preparations were intiated to embark on field operations to test the viability of 1) environmental sample processors on AUVs to match the sampling fidelity of shipboard sampling, 2) larval community metabarcoding to match the fidelity of manual counting, and 3) free environmental DNA as a proxy for recent fish population counts.

Information on any outreach activities:
Participation by the postdoctoral researcher Luke Thompson in the Genomics Standards Consortium 19th Meeting in Brisbane, Australia

- Workshop
- Genomics Standards Consortium Annual Meeting
- 14-17 May 2017
- Stamford Plaza Brisbane, Queensland, Australia
- GSC is an international collaborative effort of scientists to write and improve standards for the collection and dissemination of genomic data and metadata. Given the rapid rise of genomics technologies, standards are critically important for sharing and leveraging this powerful data. Luke Thompson is currently analyzing OST data and is the project leader for the Earth Microbiome Project. His participation in the workshop enables him to shape the future of genomic data and metadata standards.
- Approximately 50 participants

Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology

NGI File #: 16-NGI3-14

Project Title: Predicting the Impact of Anthropogenic Climate Change on Physical and Biogeochemical Processes in the Northern Gulf of Mexico – Part 2

Project Lead (PI) name, affiliation, email address: Frank Hernandez, University of Southern Mississippi, frank.hernandez@usm.edu

NOAA sponsor and NOAA office of primary technical contact: Molly Baringer, AOML

Award Amount: $125,527

Project objectives and goals
The main objective of this project is to provide a range of realistic scenarios of future environmental changes in the northern GoM (including the shelf region) for the research community and fisheries resource managers. The first project task is to configure and validate a high-resolution ocean-biogeochemical model forced with historical environment conditions from 1979-2014. The second task is to obtain future projections over the XXI century of physical & biogeochemical processes in the northern GoM under a high and a medium-to-low CO2 emission scenarios, using the model configured from task 1 and projected atmospheric fields from the Coupled Model Intercomparison Project phase-5 (CMIP5).

Description of research conducted during the reporting period and milestones accomplished and/or completed
A coupled ocean-biogeochemical model was configured for the entire Gulf of Mexico, based on the Regional Ocean Model System (ROMS) (Shchepetkin and McWilliams, 2005), with horizontal resolution of 8 km and 37 terrain-following vertical layers (hereinafter refer to as GOM8). Open boundaries schemes are Flather for the barotropic velocity (Flather, 1976), Chapman for the free surface (Chapman, 1985), and a combination of radiation and nudging for baroclinic velocity and tracers (Marchesiello et al., 2001). Model bathymetry is from Smith and Sandwell (1997) data set version 12.1. The biogeochemical model is based on Fennel et al. (2006, 2013) and Kishi et al. (2007) parameterization, and includes the following 14 components: nitrate (NO_3), ammonium (NH_4), nanophytoplankton (small phytoplankton, SP), diatom (large phytoplankton, LP), nanophytoplankton chlorophyll (CHLPS), diatom chlorophyll (CHLPL), microzooplankton (small zooplankton, SZ), mesozooplankton (large zooplankton, LZ), small and large detritus (SD and LD), opal, labile dissolved organic nitrogen (DON), silicate ($SiOH_4$), and dissolved oxygen (O_2). The biogeochemical processes described by the model are nitrate and ammonium uptake by phytoplankton, including ammonium inhibition of nitrate, silicate uptake by LP, light limitation of phytoplankton growth, variable chlorophyll to phytoplankton-N ratio, phytoplankton extracellular excretion, SZ grazing on SP and LP, LZ grazing on SP and LP, and predation on SZ, zooplankton egestion, zooplankton excretion, phytoplankton and zooplankton mortality, nitrification, detritus remineralization, oxygen production during photosynthesis, oxygen consumption due to decomposition and nitrification, sinking of detritus, LP, and opal, sediment instantaneous remineralization, sediment coupled nitrification/denitrification. Phytoplankton growth, zooplankton grazing, mortality, and water-column remineralization (detritus and DON decomposition, nitrification, opal dissolution) rates which are temperature dependent.

Model initial and boundary conditions were derived from a 0.25° x 0.25° resolution basin model, built on the Modular Ocean Model version 5 (MOM5), which includes the Tracers of

Phytoplankton with Allometric Zooplankton biogeochemical model (TOPAZ) to simulate the cycles of carbon, nitrogen, phosphorus, silicate, iron, oxygen, considering three explicit phytoplankton groups (Dunne et al., 2010). GOM8 is forced with surface flux fields from ERA-Interim reanalysis (Dee et al., 2011). Besides, river runoff of 54 river sources (35 in the US) is explicitly represented. Daily water discharges from US Rivers were retrieved from the US Geological Survey (USGS) river gauges. Climatologies from Mexican river discharges were derived from He et al. (2011), Munoz-Salinas and Castillo (2015), and Martinez-Lopez and Zavala-Hidalgo (2009). Observations of dissolved inorganic nutrients (nitrate, ammonia, silicate) and organic nitrogen were retrieved from the USGS, scientific literature and technical reports (http://toxics.usgs.gov; Aulenbach *et al*., 2007; Dunn, 1996; He *et al*., 2011).

A 40 year model spin-up was completed before starting the historical simulation; boundary conditions and surface fluxes for the model spin-up in each model year were extracted from a randomly selected year from the period 1979-1996, following Lee et al. (2015). After spin-up, the model was run continuously from January 1979 until December of 2014, with daily monthly average fields saved. Besides the historical simulation, we ran two extra experiments: 1) climatological rivers, and 2) random atmospheric forcing. In the climatological rivers experiments, the setting is the same as in the historical simulation, but instead of time evolving river discharge we used monthly river climatologies. In the random atmospheric forcing, the setting is the same as in the historical simulation, but the surface atmospheric fluxes for each year were randomly selected from the period 1979-2014.

<u>Milestones accomplished</u>

1. Configuration MOM-TOPAZ ocean-biogeochemical model 0.25° horizontal resolution
2. 14-component biogeochemical model based on Fennel et al. (2006, 2013) and Kishi et al. (2007) models
3. Configuration of ocean-biogeochemical model ~8 km horizontal resolution (GOM8) and tuning of biogeochemical parameters
4. 40 year model spin-up and historical simulations for the period 1979-2014
5. Validation of GOM8 against satellite data and in-situ observations
6. Analysis of seasonal and interannual patterns of plankton biomass and dissolved oxygen during 1979-2014

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

The regional ocean model (GOM8) reproduces reasonably well main circulation and hydrographic patterns, such as the Loop Current, mesoscale eddies, hypoxic region over Texas and Louisiana shelves, SST, and surface chlorophyll (see Fig. 17 for a comparison between model and satellite chlorophyll). Modeling of small and large plankton components allows a better representation of ecological processes in the coastal and oceanic domain. Seasonal variability of phytoplankton biomass shows significant regional differences across the northern GoM (Fig. 18). In the MS delta, the greatest phytoplankton biomass is during spring and early summer. Diatoms grow faster than nanophytoplankton under non-limiting nutrient conditions, getting maximum production during May, mainly fueled by NO_3 (regenerated to total production ration is ~35%) and concomitant with the greatest Mississippi-Atchafalaya (MS-A) nutrient load (not shown). Instead, nanophytoplankton has the maximum production in early summer (June-July), mostly sustained by NH_4 uptake (~60% regenerated production). As phytoplankton growth becomes progressively nutrient-limited away from the MS-A delta, phytoplankton biomass declines. In the northwest outer shelf, phytoplankton biomass is 1/2 to 1/3 of the biomass in the delta region, showing a maximum during June. Diatoms do not have an early spring peak like in the delta region, doing a smaller contribution than nanophytoplankton to the summer phytoplankton maximum. Regenerated production during summer represents ~60% and ~70%

of the total diatom and nanophytoplankton production, respectively. In the oceanic region, nanophytoplankton clearly dominate upon diatoms, as the latter is strongly growth-limited by both silicate and nitrogen. The maximum nanophytoplankton biomass is during March-April, after the seasonal maximum in vertical NO_3 diffusion (the latter driven by winter surface cooling). During early spring, the percentage of regenerated production is ~50%, increasing to >75% during late spring and summer.

Dominant modes of interannual variability of model surface phytoplankton anomaly (SPA) are described using Empirical Orthogonal Function (EOF) decomposition (Fig. 19). The first SPA mode has maximum amplitude near the Mississippi-Atchafalaya delta, and is linked to interannual anomalies in water discharge and nutrient load. The second SPA mode represents a coastal alongshore dipole, mainly linked to wind-driven circulation anomalies (up and down-coast anomalies, or eastward and westward anomalies). The first two interannual-modes of SPA are consistent with the patterns derived from SeaWiFS (1998-2010) and MODIS (2003-2014) chlorophyll. Besides, the leading EOF modes of SPA are closely linked to the EOF modes of surface salinity anomaly, indicating strong association between salinity and phytoplankton distribution. Interaction between the two leading EOF modes also can have strong influence on bottom oxygen over the Louisiana-Texas shelf. Lowest bottom oxygen levels occur during periods with high river discharge and up-coast circulation anomalies, as those conditions lead to increased plankton production, vertical stratification, and bottom respiration. On the other hand, low river discharge and down-coast anomalies lead to decreased production, weaker vertical stratification, and reduced bottom respiration.

We explored the connection of the main mode of interannual variability of salinity and plankton biomass with El Nino-Southern Oscillation (ENSO). Extreme positive and negative anomalies of the first EOF mode of surface salinity tend to be associated with La Nina and El Nino conditions, respectively. Specifically, during Jan-Feb, 80% of the anomalous wet events are related to El Nino, and 75% of the anomalous dry events are related to La Nina. Winter time-series of model salinity, phytoplankton, and zooplankton, as well as satellite chlorophyll, are significantly correlated with El Nino 3.4 index (Fig. 20), but that association markedly decline during spring. Winter to spring differences in ENSO-related MS-A runoff anomalies explain the declining correlation between ENSO and plankton production, as the MS-A River discharge shifts from positive (negative) anomalies during El Nino (La Nina) winters to negative (positive) anomalies during El Nino (La Nina) springs. Still, ENSO influence can be expected in a more local scale during spring, linked to rivers other than MS-A, such as Apalachicola, Escambria, Mobile, Pearl, Sabine, Brazos, Colorado, San Antonio, and Guadalupe.

In the oceanic region, shoreward of the 200 m isobath, the interannual phytoplankton variability is weakly related to the patterns derived from the EOF decomposition. Instead, phytoplankton biomass is significantly and negatively correlated to SST. The SPA-SST correlation derived from the model has a seasonal variation, being the strongest during spring (March-April), which is consistent with pattern derived from satellite sensors. The underlying mechanism behind the SST-SPA correlation is vertical stratification, which modulates the vertical fluxes of dissolved inorganic nitrogen (DIN, NO_3 plus NH_4) within the photic layer, mainly linked to vertical diffusion (Fig. 21).

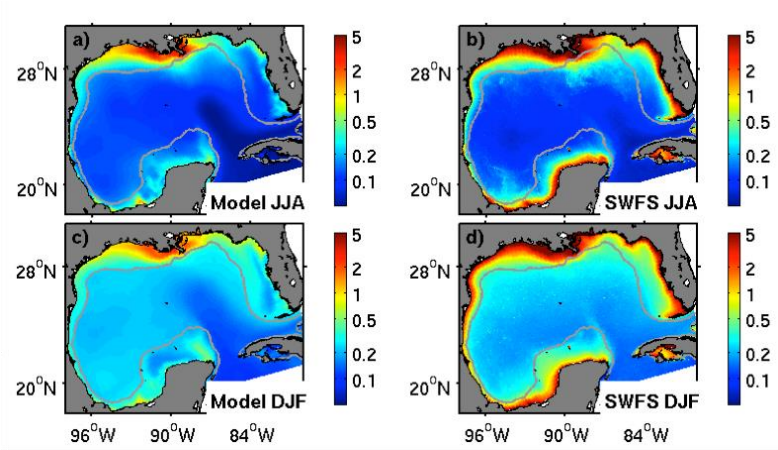

Figure 17. Comparison between chlorophyll (mg m^{-3}) derived from GOM8 biogeochemical model (CHL, left panels) and SeaWiFS (SWFS, right panels): summer (a, b) and winter (c, d)

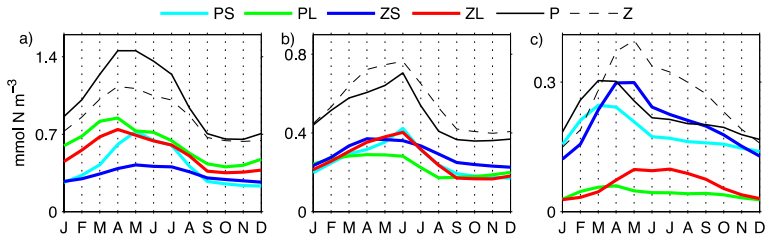

Figure 18. Seasonal patterns in plankton biomass within a) Mississippi delta, b) GOM western-outer shelf, and c) GOM deep ocean region. PS: nanophytoplankton; PL: diatom; ZS:microzooplankton; ZL: mesozooplankton. P and Z: total phyto- and zooplankton, respectively

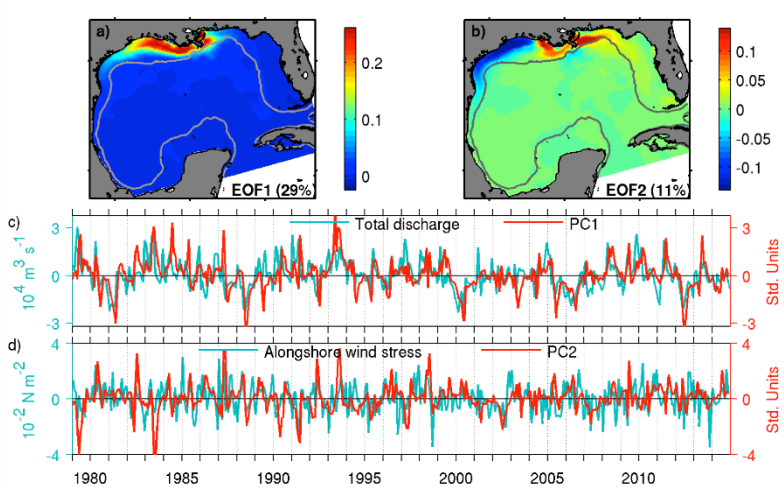

Figure 19. First and second EOF modes of surface phytoplankton: a, b) spatial patterns; c) first principal component time series (red) and total river discharge (cyan); d) second principal component (rec) and alongshore wind stress (cyan).

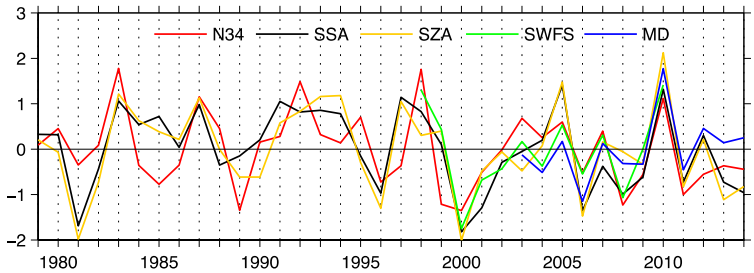

Figure 20. Winter series of El Nino 3.4 SST anomaly (N34), and the first principal component of surface salinity (SSA), surface zooplankton (SZA), and satellite chlorophyll from SeaWiFS (SWFS) and MODIS (MD).

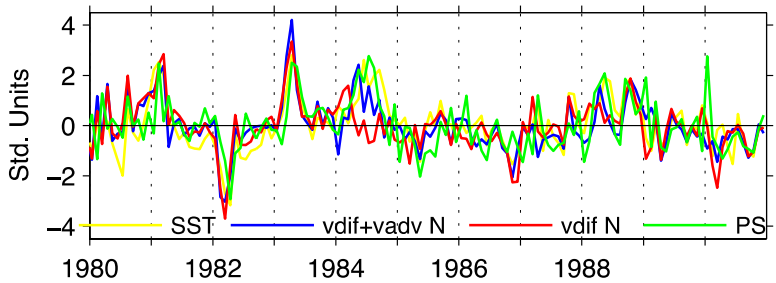

Figure 21. Surface anomalies of SST×(-1), vertical diffusion plus vertical advection of dissolved inorganic nitrogen (DIN), vertical diffusion of DIN, and nanophytoplankton (PS) concentration on oceanic region (bottom depth >1000 m; north of 24°N).

Related NOAA Strategic Goals: Climate Adaptation and Mitigation

Related NOAA Enterprise Objectives: Science and Technology

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NGI File #: 16-NGI3-15

Project Title: AOML-NGI South Florida Water Quality Analyses

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

Co-PI(s) name, affiliation, email address: Anna Linhoss, Mississippi State University, alinhoss@abe.msstate.edu, and Nicole Millette, Mississippi State University, nicole.millette@noaa.gov

NOAA sponsor and NOAA office of primary technical contact: Molly Baringer, AOML and Chris Kelble, AOML

Award Amount: $142,330

Project objectives and goals

The initial focus of this project is to analyze the temporal and spatial distributions of water quality parameters (particularly nutrients and chlorophyll a) in south Florida coastal systems. NOAA/AOML and its partners have over 20-years of water quality measurements in south Florida coastal and marine waters along with about 20-years of canal loading data for various canals in south Florida.

While focusing on the potential sources of nutrients to south Florida coastal waters, this analysis should develop hypotheses that can be tested with process studies during year 2 of the project. These process studies can be undertaken as added studies that will augment the existing field program in south Florida (www.aoml.noaa.gov/sfp). The process studies should focus on enhancing our understanding of water quality dynamics by addressing key gaps in our knowledge regarding nutrient cycling or sources or emerging issues of concern. These emerging issues of concern could entail investigating potential sources for nutrients from shoreline activities with a high potential to cause disturbance to Biscayne Bay (e.g. Turkey Point Power Plant, South Dade Landfill, wastewater treatment facilities, etc.).

Specific objectives for the first year of the study are:

1) Finalize a combined Quality controlled and Quality Assured data set for water quality in south Florida Coastal Waters from NOAA/AOML and partner's datasets
2) Develop a manuscript investigating temporal dynamics in water quality in south Florida focusing upon long-term trends and hypothetical causes for observed trends
3) Develop proposed process studies to investigate key gaps in our knowledge of south Florida water quality dynamics

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

A site visit was conducted by the team and a meeting was held with some NOAA/AOML partners to introduce the project.

Data from the aforementioned studies were compiled into a single database, reviewed for quality control, and statistically analyzed to evaluate trends, spatial and temporal patterns, and anomalies.

One manuscript was prepared and accepted for the Bulletin of Marine Science (Millette, et al., Shift in Baseline Chlorophyll *A* Concentration Following a Three-Year *Synechococcus* Bloom in South Eastern Florida). Results from this study will be presented by Dr. Millette at the 2017

Coastal and Estuarine Research Federation Conference. A second manuscript is being prepared for a similar study for Florida Bay. A third manuscript is being prepared to describe the statistical methods employed to assess the data.

Recommendations for additional process studies are included in the draft manuscripts and are currently being vetted with the entire team and NOAA/AOML partners.

Description of significant research results, protocols developed, and research transitions
Review of the data indicated that sufficient data were available to conduct assessments of trends and spatial and temporal distribution of selected water quality parameters (e.g., chlorophyll *a*, temperature, salinity, phosphorus, and nitrogen species).

The analysis of the Biscayne Bay data indicated that following a significant bloom of a picophytoplankton (*Synechococcus*) in September of 2005, the oligotrophic system had shifted to a more phytoplankton dominated system than the benthic/submerged aquatic vegetation system that dominated prior to the 2005 bloom.

Multiple statistical analyses were conducted resulting in a potential protocol for analyzing water quality data in oligotrophic system. This protocol is being evaluated for applications in other systems.

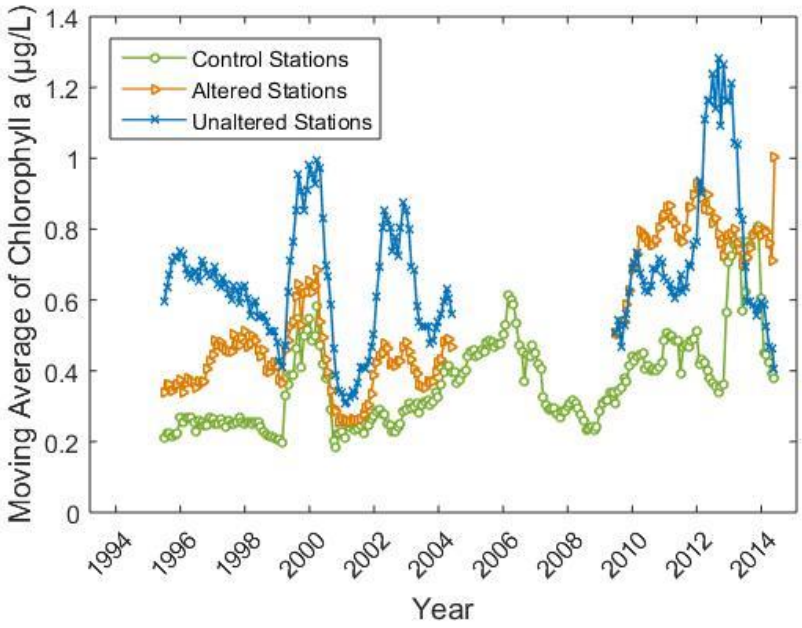
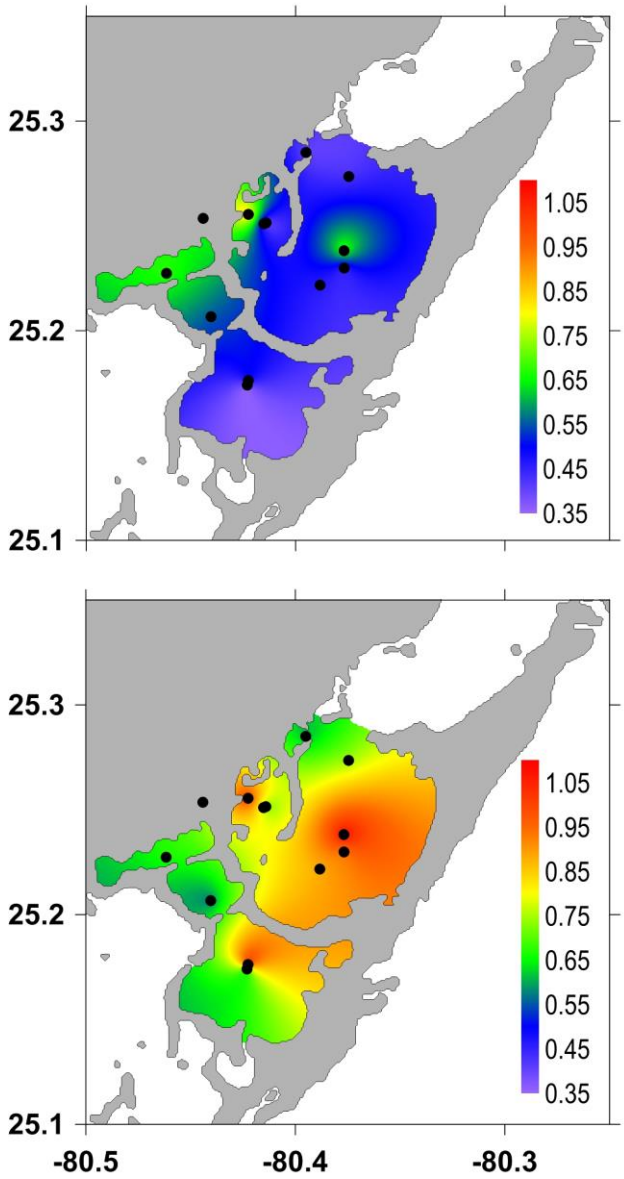


Figure 22. The 12-month moving average of chlorophyll *a* concentrations (µg L^{-1}) at control stations (green circles), altered stations (orange triangles), and unaltered stations (blue x). For altered and unaltered stations data from 2005-2008 during the bloom was removed but data during this range was left in for the control stations.



A spatial map of interpolated average monthly chlorophyll *a* (µg L^{-1}) concentrations at each station (Figure 23) pre-bloom (1995-2004) and (Figure 24) post-bloom (2009-2014). The black arrows refer to stations where chlorophyll a concentrations were significantly higher ($P<0.05$) post-bloom compared to pre-bloom from Millette et al., in review.

Currently there is one manuscript in review – Millette et al., "SHIFT IN BASELINE CHLOROPHYLL *A* CONCENTRATION FOLLOWING A THREE-YEAR *SYNECHOCOCCUS* BLOOM IN SOUTHEASTERN FLORIDA."

Currently there are two manuscripts in preparation - Millette et al., "The cause of long-term increase in chlorophyll *a* concentrations in Biscayne Bay, Florida, USA" and Millette et al., "Detecting long-term changes of water quality in an oligotrophic system."

Information on collaborators/partners:

a. Name of collaborating organization: NOAA Biscayne Bay Habitat Focus Area, NOAA/AOML
b. Date collaborating established: 6/1/16
c. Does partner provide monetary support to project? Amount of support? None
d. Does partner provide non-monetary (in-kind) support? Yes, technical input/review, technical input to studies, use of study results to improve management of Biscayne Bay nutrient loading
e. Short description of collaboration/partnership relationship: The Biscayne Bay Habitat Focus Area (BB-HFA) has as one of its primary objectives halting the increase in eutrophication of Biscayne Bay. This study helps to determine where Biscayne Bay is showing signs of eutrophication to prioritize where BB-HFA should focus on working with partners to reduce nutrient loading.

Information on any outreach activities

The team met with Dr. Roland Samimy and Dr. Anna Wachnicka to present the project concept and discuss potential collaboration. The team has been talking with Miami Waterkeepers about potential outreach opportunities. Nicole Millette will be presenting results to the Biscayne Bay Regional Restoration Coordination Team in June 2017.

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

Related NOAA Enterprise Objectives: Science and Technology, Engagement

NGI File #: 16-NGI3-16

Project Title: Calibration and validation of Ocean Products on NOAA VIIRS for Monitoring Oceans

Project Lead (PI) name, affiliation, email address: Robert Arnonne, University of Southern Mississippi, Robert.Arnone@usm.edu

Co-PI(s) name, affiliation, email address: Bill Gibson, Louisiana State University, bgibson@lsu.edu; Sherwin Ladner, Naval Research Laboratory, Sherwin.Ladner@nrlssc.navy.mil

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

Award Amount: $169,801

Project objectives and goals
The 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 VIIRS sensor will be used aboard follow-on NOAA satellite missions, therefore it is important to determine calibration and validation procedures for the sensor which can be applied for future missions such as J1 is to be launched in 2018, J2 etc). The project is coordinating with NOAA, NASA, University, and Navy scientists and has demonstrated the capability for VIIRS ocean products to reach maturity within the JPSS program. As a member of NOAA's national JPSS calibration validation team for the United States, we coordinate with many team members for calibration of ocean satellite products.

The project goal is to improve and evaluate ocean products through enhanced calibration and validation of the ocean products of ocean color products. Ocean color products include the water leaving radiance (nLW and RRS), chlorophyll, and bio-optical properties. Improving ocean products will significantly enhance the capability to monitor coastal and open waters for both near real-time operational and scientific products. Monitoring the VIIRS calibration for stability and consistency is required to establish a long term climate trend of the ocean's properties. The VIIRS NOAA's environmental satellites fulfill a critical national requirement for monitoring ocean properties in supporting operations (CoastWatch) and science research.

NOAA Center for Satellite Applications and Research (STAR) is processing VIIRS ocean products using MS12 for ocean color products. The project goals for ocean color are to collect accurate in situ data to be used for validation and calibration of the VIIRS sensor and to evaluate the long term trends of the sensor calibration in MSL12 processing. Improvements in the in situ accuracy and variability of in situ optics are required for enhanced calibration.

The project goal is to support the NOAA – STAR and JPSS programs to track the stability of the VIIRS sensor and satellite products and support the JPSS program. The VIIRS cal val team will thoroughly investigate the sensor characterization as well as the software used to derive ocean products.

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

The project has major research areas which include:

A. Maintaining WavCis platform for in situ ocean color validation
B. Coordination and participation in the Ocean color cal val Cruise for characterizing in situ validation
C. Participation in NOAA's VIIRS Calibration and Validation telecons and annual meeting

A. Maintaining WavCIS – Coastal Calibration Site: The WAVCIS site (CSI 6) is located SW of Grand Island Louisiana and is equipped with an AERONET Sea Prism instrument and is part of an international network for ocean color cal val site (http://aeronet.gsfc.nasa.gov/new_web/ocean_color.html). There currently are four Sea Prism sites in the US. The WAVCIS Sea Prism site is reporting daily spectral water leaving radiance (nlw) and aerosol optical depth every 30 minutes during daytime operations. The platform is visited periodically and the Sea Prism sensor is monitored for high quality data and consistent communication and calibration. WAVCIS sends daily data to the NASA AERONET network that provides daily real-time Sea Prism data to scientists. The WAVCIS site has been providing excellent highly accurate data stream for the ocean color community for the last 5 years. The NOAA – JPSS team has shown the matchups of VIIRS satellite to be quite good at WAVCIS site compared to the other sites on the east and west coast of the US. The Stennis team is using the WAVCIS to maintain a consistent and reliable data base for monitoring the satellite performance in coastal water algorithms. The WAVCIS data go through a level 0 to 1 to 2 processing at NASA. The WAVCIS data were identified as good data and has reached the highest level 2, for data prior to Sept 2016.

The WavCis site had some issues this year. In fall 2016 the yearly replacements of the Sea Prism sensor (#610) with a loaner from NASA (#638) was performed so that the 610 sensor could be calibrated by NASA. There were changes on the platform where WAVCIS is located with the mounting and communication and there were problems keeping the loaner operational. The sensor 610 was sent back from NASA in Dec 2016 to be replaced on the platform. However, due to a change in platform ownership, a new platform boarding agreement was required and completed in March, 2017. Due to the weather conditions being bad, the ability to remove the #638 and installed the #610 sensors on the platform was not able to be completed until Mid-April. Also, the main Generator failed on April 16th, causing catastrophic damages to the power systems of the WAVCIS Equipment. New battery chargers, new batteries and a new computer power supply was installed and the WAVCIS system was back on line but due to heavy clouds and high winds on April 19th, the Sea Prism could not be changed out at that time. On April 30th, the platform took a suspected lightning strike and caused catastrophic damage to many of the WAVCIS subsystems and to the #638. The lightning strike caused the sensor to fail and several parts had to be replaced. #610 system was replaced in May 8, 2017 and the loaner sent back to NASA. The data from the WAVCIS sensors was all retrieved and the system continues to be operational. Another problem occurred during high winds of Tropical Storm Cindy on June 20th, 2017, which moved the Satellite antenna and stopped transmitting. WavCis was revisited and saved WavCis data is being sent back to NASA and NOAA for operations. The recalibration of the #610 and #638 sensors is being applied to the data is being updated, and the annual update to level 2 is being applied so that the new calibrations for Sept 2016 to Spring 2017 can be used.

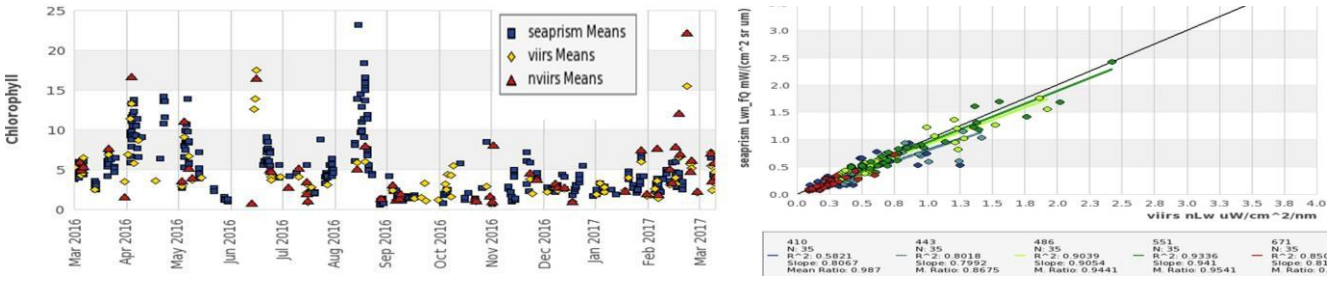


Figure 25. A) WavCis data used for validation of the VIIRS satellite from Mar 2016 to Mar 2017. The product is derived chlorophyll from WavCIS (blue) and the processing from NOAA MSL12 (Red) +--and the Navy APS (Yellow) processing. B) Matchup of the 5 spectral channels from the VIIRS satellite with the Navy APS and the WavCis. The correlation was good for all the data collected.

Milestone completed: The WavCis platform provided a continuous supply of daily data to NOAA, NASA AERONET and the Cal Val team. The SeaPrism on WavCis was removed in September and sent to the NASA for calibration and a replacement loaner SeaPrism from NOAA was on WavCIS until the calibrated sensor was reinstalled in March 2017. WavCIS SeaPrism sensor 610 was calibrated on yearly bases and the data remained a consistent data set. The WavCIS platform provided a continuous data set that is being used to determine the accuracy of the VIIRS satellite so that the sensor can be validated and calibrated.

B. Ocean Color Cal Val Cruise in Cal – Val in Gulf Stream: The project participated in the NOAA SNPP cal val cruise for ocean color. A major focus of the VIIRS cal val effort is to determine the uncertainty and differences in in situ measurements of the nLw and RRS-(Remote sensing Reflectance) which are used for VIIRS calibration and validation. Our goal was to determine the variability in between several in situ sensors measurements and how to improve the methods used in data collection so that the VIIRS products can be better validated. There were several groups from different agencies, and universities aboard the Nancy Foster research vessel with different sensors. The cal val cruise was reported at the International Ocean Color Coordinating group and NOAA news (http://ioccg.org/2017/05/may-2017/). The VIIRS CalVal cruise on Oct 13- 18, 2016 (figure 26A) out of Charleston SC was influenced by the passage of hurricane Mathew (Figure 26B) prior to the cruise causing a 9 day delay in departure. The hurricane impacted the ocean color properties and position of the Gulf Stream. The Foster Cruise track consisted of 13 stations following the storm which were adaptively selected in cloud free regions so that the matchups of the in situ ocean color and the VIIRS satellite were possible and valuable.

Stennis participation on the VIIRS CalVal cruise included: coordination with NOAA for adaptive daily planning of the cruise track and sampling locations in coastal waters west of the Gulf Stream which included optimizing stations based on cloud cover and sea state. Selected stations were in Gulf Stream shingle eddies and in coastal plumes and upwelling waters. Selection of the stations were from near real-time satellite data being used to identify ocean features for adaptive sampling. The Stennis team provided the real-time satellite data which was used for the sampling. The Stennis team measurements included: 1) water leaving radiance (nLw) with two (NRL, USM) floating Satlantic's Hyperpros; 2) above water Analytical Spectral Devices (ASDs) to determine RRS at optimal station locations 3) The ASD were also measured with the NIST Blue tile with the other members on board 4) flowthrough underway Inherent Optical Properties (IOPs) instruments include the ac9 for spectral water absorption and backscattering sensor. Goals included testing methods to develop collection and

processing protocols for consistent in situ optical ocean measurements from multiple (identical/different) instruments collecting simultaneous and coincident water properties, which can be used for consistent satellite calval with improved uncertainty in measurements. Activities were delayed and limited due to the passage of hurricane Mathew which occurred (October 7th) prior to the planned cruise departure (October 4th).

(A) **(B)**

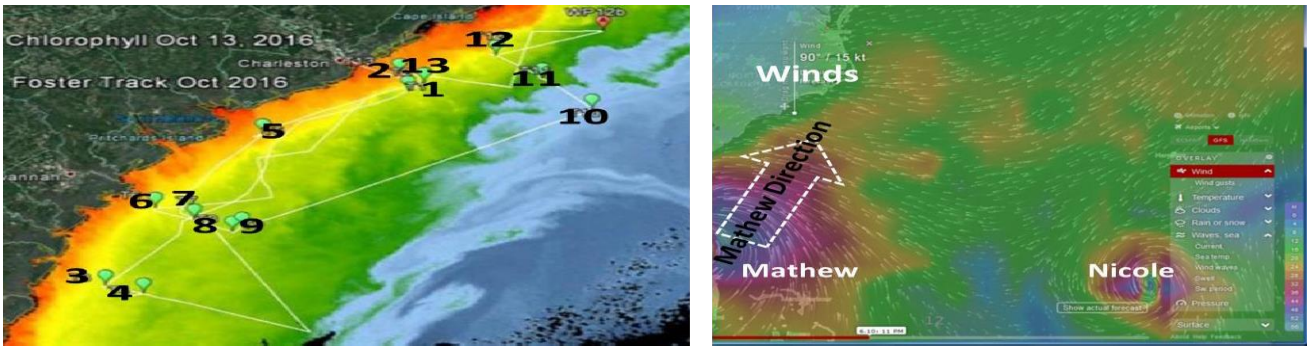


Figure 26. A) The Foster Cruise track and 13 Stations on October 13 – 18, 2016.
Figure 26. B) The passage of Hurricane Mathew prior to the Cruise on October 7, 2016.

Prior to the cruise, telecons were conducted to test data collection protocols which were agreed upon by all ship participants (USM, NRL, NOAA, USF, and UMASS). These protocols where to be used to test for consistency and improved uncertainty between multiple in-water and above-water in situ optical ocean measurements from different (ASD, Spectral Evolution, GER, etc.) instruments from different groups to improved quality data that is used for satellite cal val. By using similar data collection protocols, the observed uncertainty between instruments was determined to possibly result from instrument differences and characteristics, changing environment, etc. These measurement protocols used for collection and processing the data are documented below.

<u>Foster cruise Oct 2016: Influence of Hurricane Mathew.</u> VIIRS chlorophyll products clearly showed that the hurricane passage extended chlorophyll concentrations offshore of the east coast. The position of the Gulf Stream was moved closer to the coast by Mathew's East winds. Following the passage the NE winds direction were opposing the Gulf Stream currents and resulted in strong vertical mixing. The passage of the storm changed the water color and composition significantly. We observed trichodesmium blooms located along the coastal water of South Carolina which came from offshore waters and impacted the ocean color. We worked with NOAA in identifying the impact of hurricane Mathew on coastal waters.

Sensors participation:

1. <u>Floating HyperPro Measurements:</u>
   The floating HyperPro is a hyperspectral profiling radiometer that simultaneously measures above-water downwelling irradiance (*Es, Ed*) and in-water upwelling radiance (*Lu*) on a tethered floating buoy platform and downwelling *Es* onboard the ship fixed to an elevated pole. The Hyperpro is used to measure the normalized water leaving radiance (*nLw*), from which spectral remote sensing reflectance (RRS) is calculated, and used for validation and calibration of the VIIRS *nLw*. Both floating Hyperpros were calibrated at the NOAA facility which also calibrated the other team's instruments. The Stennis team utilized 2 floating Hyperpros (USM and NRL) on the cruise and collected measurements at 13 stations. These

instruments were used with a molded floatation collar, allowing the observation of temporal variability of in-water surface measurements, at a fixed depth, just beneath the sea surface. The downwelling *Ed* sensor uses a cosine collector and is approximately 30 cm above the water surface. The upwelling (*Lu*) radiance sensor is mounted approximately 30 cm below the water surface. The ship mounted *Es* sensor also uses a cosine collector and was mounted on the 01 deck affixed to a pole which was elevated above the ships superstructure while on station. *Es* from the ship mounted sensor was combined with *Lu* from floating Hyperpro for computation of *Rrs*.

The Floating HyperPro, equipped with a floatation collar, was deployed near the starboard and port quarters). The instrument was allowed to float out a sufficient distance from the boat (20 to 30 m). This ensured there was no contamination from vessel-generated bubbles and ship shadowing or any other potential disturbances. Once the instrument was a sufficient distance from the vessel, data were recorded for 10 minutes. Post processing of this dataset from level 1 to level 4 was done using Satlantic's Prosoft v8.1.4 with set protocols.

The RRS data from the two floating Hyperpro were compared with the RRS from the 3 profiling Hyperpro data set at the different stations. The profiling hyperpros have a different set of protocols for extracting the RRS at the surface. The comparison of the *Rrs* at the coincident stations (figure 27) represents the similarities in the 2 Stennis floating Hyperpro sensors and the profiling NOAA hype. Both sensors are in agreement at all 13 stations.

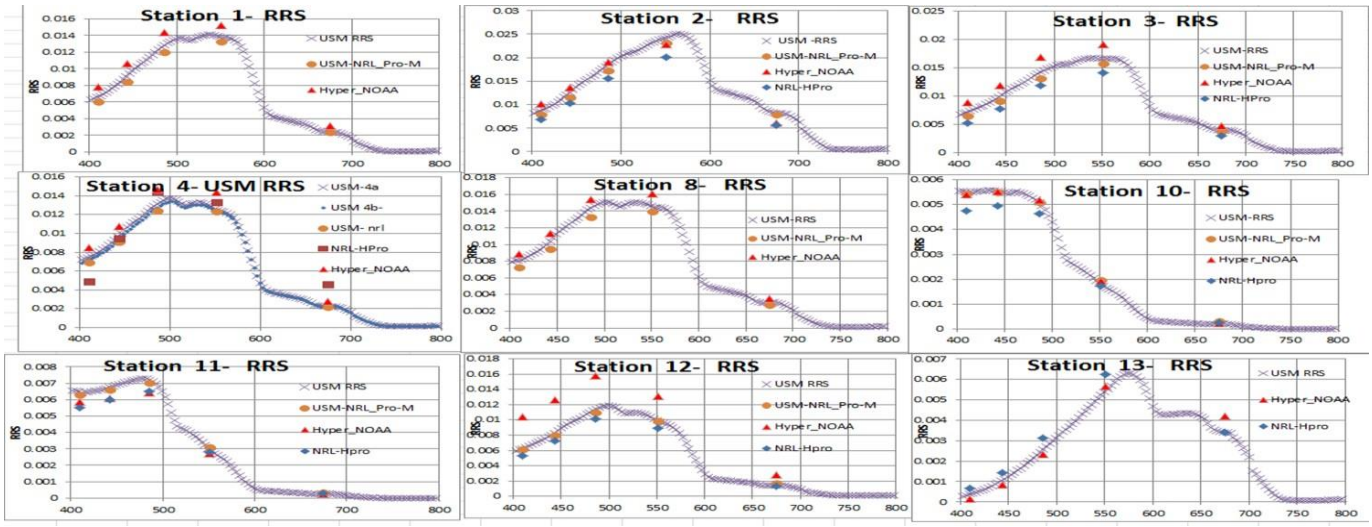


Figure 27.The Rrs for the USM and NRL floating Hyperpros with the NOAA profiling Hyperpro for the 9 coincident stations. Note that there is an issue with the NOAA profiling Hyperpro for station 12 and it is currently being investigated.

The protocols for processing the Floating hyperpro were determined and have been submitted to the NOAA Foster cruise report. The protocols use the data processing using the ProSoft 8.1.4 with set parameters including omitting data where the sensor angles exceed a threshold and averaging the Lu and ES with a time period. The ES (Down welling) radiance was compared and shown to be stable between several sensors mounted on the ship antenna.

2. Inherent Optical Properties Collected Using Underway Flow-Through System on the Nancy Foster

The flow-through system provides an extensive Inherent Optical Properties (IOP) data set demonstrating the large variety of the water masses and ocean processes that were identified along the cruise track (figure 26a). The flow-through IOP products of total spectral absorption and beam attenuation for the spectral VIIRS channels will be used to validate the VIIRS IOP products derived using the Quasi-Analytical Algorithm (QAA) for spectral absorption and backscattering. Matchups between ship collected and VIIRS derived IOPs will provide validation and uncertainty in different water masses including US coastal and shelf waters. Additionally, the high spatial resolution of the flow-through can be used to validate the spatial variability within the VIIRS 750 m pixel by defining the mean and variability of IOP measurements within the VIIRS pixel.

Flowthrough Set up: IOPs were measured continuously on the cruise using two WetLabs absorption and beam attenuation (*ac*) instruments connected to the ship's flow-through system. One hyperspectral instrument (*acs*) measured the non-filtered water and the other instrument (*ac9*) measured filtered water (Color Dissolved Organic Material – CDOM). These measurements address cruise objectives to: (A) Characterize the spatial variability of water's optical properties (a,b->bb,c) along the cruise track and how the variability impacts the uncertainty of in situ measurements at each station. (B) Determine the water total and dissolved absorption (*at*, *ag*) properties at specific wavelengths and validate the IOP measurements derived from the VIIRS ocean color satellite. (C) Define coastal/shelf frontal boundaries using thermal, biological and optical properties.and (D) Develop PROTOCALS for processing IOP data

The IOP instruments were interfaced with the Fosters ship's flow-through system which pumped water from a depth of ~2.5 m. Concurrent flow-through measurements of position, temperature, and salinity will be used for correction of the ac-9 and ac-s a(λ). This is important in order to correctly address the thermal, salinity and scattering corrections that must be applied. The WetLabs ac protocols for data collection and processing were used and are considered standard throughout the ocean community. The *acs* (*non-filtered*) was used to measure the "total" IOPs, which includes both the particulate and the dissolved properties of the waters sampled. The *ac9* (*filtered*) used water passed through a Cole Palmer 0.2-micron filter to remove the particles so that the IOPs from the dissolved fraction were determined. The filtered *ac9* is used to determine the spectral absorption and scattering associated with the colored dissolved organic matter (CDOM; i.e., gelbstoff). The difference between the unfiltered (acs) and filtered (*ac9*) instruments provides the spectral absorption and scattering directly associated to particles. Note that hyperspectral ag is produced from the 9-ac9 channels using a spectral ag model so that the ag can be subtracted off the at before the scatter correction is applied. The ag is then added back after correction. To insure stability and reliability, both the ac9 and acs instruments were placed in a controlled temperature water bath to dissipate the instruments' heat and maintain a constant temperature. This is critical because instrument electronic temperature instabilities can impact the scattering and absorption measurements.

The acs and ac9 were interfaced with a WET Labs DH4 data logger with additional inputs from 1) the ship's flow- through system (position, temp, salinity 2) the backscattering sensor (bb550) . The ship's flow-through system inputs included position, time, date, heading, water temperature, salinity, and fluorescence (voltage). These inputs were required for the standard protocol corrections during the post processing of the acs and ac9 data.

The acs and ac9 instruments were calibrated 3 times: once prior to the cruise and twice during the cruise Post-processing of the acs and ac9 data followed the “WET Labs, 2011” protocols. The ac9 data were processed using a scattering correction [*Rottgers et al.*, 2013], removing of the absorption of gelbstuff (*ag*) and adding back the pure water absorption [*Pope and Fry*, 1997]. The ac9 and acs flow-through data was used to identify the spatial coherence of the IOPs and to identify water mass changes while on stations and underway. These data will be merged with the ship flow-through data based on time using the WET Labs WAP software to combine datasets. This merged dataset will be used to characterize the spatial variability of water optical properties.

<u>IOP Post Processing and PROTOCOLS – Absorption and beam attenuation:</u> The Rotter scatter correction method was selected at the best method for processing IOP (acs). The Flowthrough total absorption 443 nm was matched up with the VIIRS data with the MSL12 Science level and the NRL processing. Day 291 – was an excellent cloud free day for matchup of the flowthrough acs and the VIIRS products. The matchup of the total 24 hours (Figure 28A) and the 30 minute before and after the satellite overpass were compared (Figure 28C). The Time of the overpass was at location C which is Station 11.

Results show that on day 291 Oct 17, 2016 when the satellite overpassed at location C (Figure 28B), the region was spatial homogenous at the ship location (C). The matchup at the ship location, plus/ minus 30 minute period of the VIIRS overpass (Figure 28D), all 5 pixels showed similar values in the flowthrough and matched up with the MSL2 and APS processing of the VIIRS data. The results of the absorption matchup at different channels were also very good. All 5 pixels showed similar values in the flowthrough and the VIIRS data (Figure 28C). The results of the total absorption matchup at different channels (Figure 29) show the R^2 for all the channels for the NOAA <SL12 and the Navy APS processing. Results show VIIRS spectral total water absorption products are valid for day 291 at Station 11, Location C.

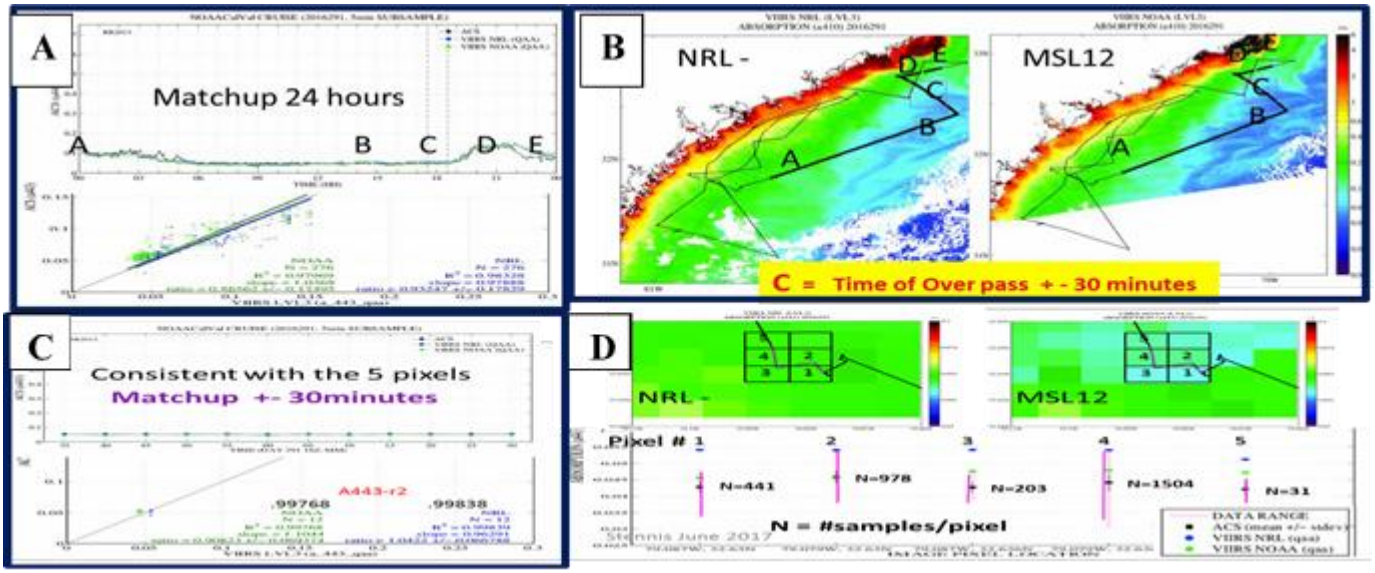


Figure 28. Day 291 –Matchup Flowthrough IOP and VIIRS A) the 24 hour flowthrough absorption 443 for day 291 with the VIIRS matchups from NOAA (MSL12 (green) and Navy APS (blue) B) Cruise track location of the 24 hour Flowthough for APS and MSL12.note C is location of the Overpass. C) 30 minute matchup of the IOP and VIIRS NOAA and Navy processing. D) Zoom in at Location C during the 30 minute matchup with VIIRS MSL12, NRL 5 pixels (750m). The Subpixel Variability at the VIIRS matchup for day 291.

VIIRS- Total Absorption R2		
	MSL12	NRL
410	.99724	.99744
443	.99768	.99839
486	.99869	.99915
551	.99969	.99973
671	.99992	1.0

Figure 29. Matchup statistics (R2) for day 291 of the total absorption from the flowthrough and the VIIRS processing for MSL12 and NRL processing for the + - 30 minutes from the satellite over pass.

Backscattering Matchup: The Flowthrough IOP backscattering data (bb462) which were collected at 462nm, was converted to bb486nm so can matchup with the VIIRS bb products. The matchup for the 24 hours and +- 30 minute of the overpass are shown as a scatter diagram for the MSL12 and the APS processing. Improved protocols for backscattering are required to validate satellite bb. We discussed using matchup of the IOP with other participants in preparation for the next Cal Val Cruise. The processing for the flowthrough has been established and the entire Foster 2016 cruise and will be used for matchups at all the cruise locations. The flowthrough data provide a capability to define the spatial variability of the pixels which are used for validation of the VIIRS 750 meter pixels. More details are available.

3. Above water measurement of the RRS – The ASD (Analytical FieldSpec™ Spectro radiometers) instrument determined the ocean color without being in the water. The ocean, sky and grey card are all assumed to estimate the RRS. Methods have been discussed with several groups to establish a protocol of how above water instruments can be used to determine the RRS.

A group of above water spectrometer instruments from different institutions collected data jointly at 13 stations during the cruise. The Above Water Group (AWG) was made up of 5 ASD instruments (USM, NRL, NOAA, USF, and CUNY), 1 GER (CUNY) and 2 spectral evolutions (OSU, UMB). At each station the AWG met on the 01 deck and made coincident measurements of the water reflectance. They used a similar grey card (NRL) and similar procedures, which were documented, at each station. The field collection protocols are described as follows:

All above water instruments were configured with similar settings for number of spectra to average, dark currents and saved spectra. Integration time was optimized for each target prior to collection (i.e., integration time of sensor was changed based on relative brightness of the target and new dark counts were taken to correct for instrument noise). Integration times ranged from 68ms to 4352ms. Using a fore-optic attachment (degree based on groups fore optic – NRLs was 10 degrees), five consecutive radiometric spectrum (S) measurements were taken of each of the following targets: Gray card (S_g), water (S_{sfc}), and sky (S_{sky}).

These instruments enable the derivation of above-water *Rrs* using un-calibrated spectro radiometers in radiance mode and a diffuse reflectance standard (gray plaque). The reflectance plaque is a 10% gray card with a known bi-directional reflectance function (BRDF), and is assumed to be a semi-Lambertian surface. For all stations the AWG used the NRL grey/reference plaque. The ASD RRS measurements following the same protocols are shown in Figure 30 for the stations.

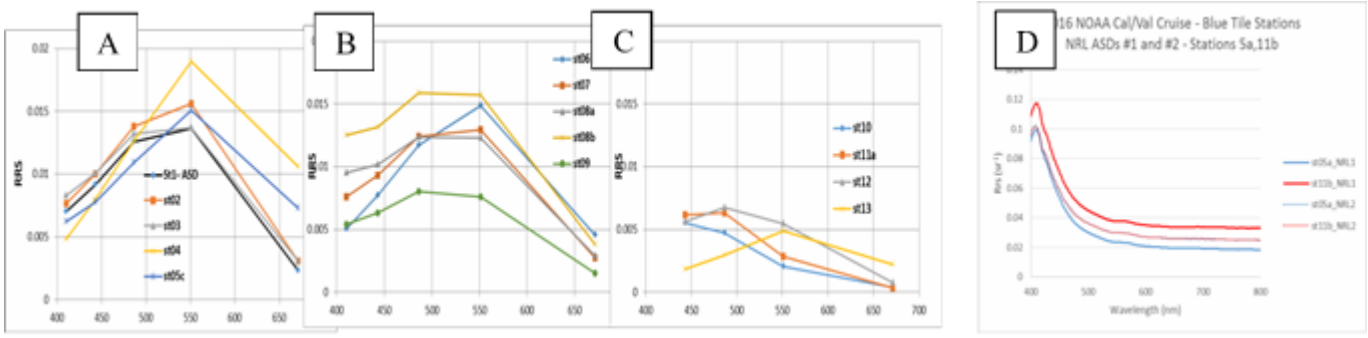


Figure 30. Remote Sensing Reflectance from NRL ASD A) Stations 1,2,3,4,5 B) Stations 6,7,8,9 C) Stations 10,11,12,13 D) Plot of 2 blue tile stations for 2 NRL ASDs (1,2) for 2 stations (5,11). Solid lines are NRL ASD #1 and dashed lines are NRL ASD #2. Both stations for each ASD should match. Note for NRL #2 (dashed lines) they are very close and NRL #1 (solid lines) are variable. Also, the coincident stations for both ASDs (same color) should match and are variable.

NIST Blue Tile: AWG- Above Water Group: To assess the differences among instruments at determining *Rrs*, the relative reflectance of a standard 16.5 cm square blue glass tile developed by NIST was measured by the five ASDs, GER and two spectral evolution. The groups all used the same protocols (number of files collected, number of dark currents, angles, etc.) to measure the relative reflectance of the target, using the tile in place of the surface measurement. The blue tile measurements for the different instruments used the same gray plaque (NRL) and were processed using the NRL processing. Details of the protocols and NIST comparisons are available.

Cruise reports: The Stennis team provided input the NOAA cruise report for the 2015 and 2016 Cruise. The results of 2015 cruise report are published: https://repository.library.noaa.gov/view/noaa/1304. The 2016 cruise report is underway. The Cruise report provides the sensors and the protocols used for data collection and processing.

C. Participation in NOAA's VIIRS Calibraiton and Validation telecons and annual meeting

The NGI ocean color cal val team at Stennis participated in bi-monthly – NOAA- JPSS – cal val team telecons which are hosted by NOAA -STAR. Every 2 weeks, we collaboratively reviewed and discussed collective results of work with other team members. The NOAA JPSS STAR calibration and validation ocean color team represent approximately 28 scientists from 10 universities, agencies and organization throughout the nation and are major leaders in satellite ocean color. Every 2 months, the NGI- (Stennis team) presented our accomplishments and specific status and results to the cal val team. The six presentations per year consisting of a 30 – 40 minute PowerPoint presentation to the entire team of approximately 15- 30 slides of progress and accomplishments. This was followed by a write up summary to the JPSS program office of the ocean color cal val status. These 6 presentations and write-ups are available per year if rerequired.

D. Summary

The WavCis platform has been updated to sensor SN610 and is operating fine. The sensor has been recalibrated and the WavCis data are planned to be updated by NASA in level 2. The Foster 2016 cruise for the flowthrough data is being processed using several scattering corrections. The RR scatter correction was used and total absorption data for day 291 – 2016 was matched up with VIIRS data and shown to be very good. The subpixel variability at

Station 11 was low and the flowthrough show similar homogenous area. The matchup of the VIIRS and flowthrough absorption was good. Flow though IOP and backscattering data will be provided to NOAA.

The major milestones that we achieved this year are listed below and are detailed in the publications.

1. WavCIS data were maintained for daily deliverable data to NASA and NOAA for VIIRS calibration
2. Coordinated and Participated in the Cal Val cruise 2016 and the collection of in situ data
3. Developed protocols for processing the IOP and ASD sensors for cal val.
4. Delivered the processed in situ data from the cruises in 2015 and 2016 to the STAR Cal Val group.
5. Completed delivering 6 telecons to the cal val team and providing 6 detailed progress reports per year to NOAA on work accomplished.
6. Attended the annual JPSS cal val meeting in 2015- 2016 and presented 2 presentation and 9 posters of Stennis accomplishments of cal val
7. Publications (SPIE and JGR) of the Diurnal variability of ocean color - New VIIRS products for ocean color
8. The VIIRS processing from NOAA MSL2 is being produced as a real time and science data quality product. These products are being evaluated with NASA products to determine the accuracy of the ocean color

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

1. Diurnal Changes in ocean color: Publication in JGR -
   Research was performed on how rapidly ocean color can change in coastal waters and has been documented. Coastal processes can change on hourly time scales in response to tides, winds and biological activity, which can influence the color of surface waters. Measurements of diurnal changes in ocean color in turbid coastal regions in the Gulf of Mexico were characterized using above water spectral radiometry from a NASA (AERONET - WaveCIS CSI-06) site that can provide 8-10 observations per day. Satellite capability to detect diurnal changes in ocean color was characterized by using hourly overlapping afternoon orbits of the VIIRS Suomi–NPP ocean color sensor and validated with in situ observations. The monthly cycle of diurnal changes was investigated for different water masses using VIIRS overlaps. Results showed the capability of VIIRS satellite observations to monitor hourly color changes in coastal regions that can be impacted by vertical movement of optical layers, in response to tides, re-suspension, and river plume dispersion. The spatial variability of VIIRS diurnal changes showed the occurrence and displacement of phytoplankton blooming and decaying processes. The diurnal change in ocean color was above 20%, which represents a 30% change in chlorophyll-a. Seasonal changes in diurnal ocean color for different water masses suggest differences in summer and winter response to surface processes. The diurnal changes observed using satellite ocean color can be used to define: surface processes associated with biological activity, vertical changes in optical depth, and advection of water masses.

   New ocean products have been developed from the VIIRS orbital overlap (Figure 31) and are valid. The VIIRS cal val provides a capability to identify the changing color in ocean waters. The paper also indicates that satellite senor matchup used for cal val must include

the diurnal changes that occur in ocean color as a protocol. New products include how change in the satellite penetration depth can be used to identify upwelling and down welling regions. Additional products include the ability to identify chlorophyll blooms and vertical movement of phytoplankton layers. Results conclude that VIIRS orbital overlaps data can be used for tracking diurnal changes in diurnal processes. New Geostationary Satellites can provide an enhanced capability.

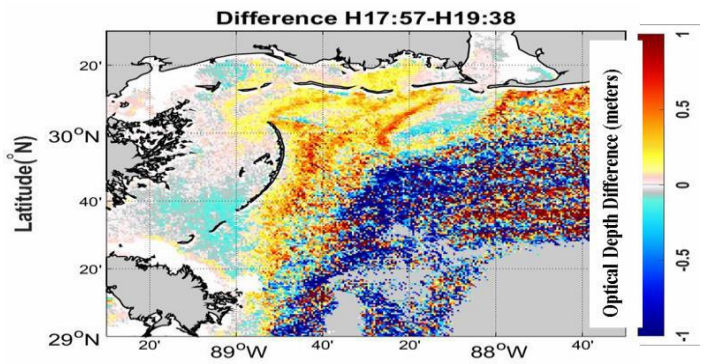


Figure 31: Difference in Optical depth of VIIRS imagery for April 3, 2016. (17:56 and 19:38 GMT). Negative values (blue) indicate the depth of diurnal vertical deepening and positive values (red) is rising subsurface layers (change in meters).

2. Protocols were developed for collection and processing of in situ optical data used for ocean color cal val. These included the IOP floating hyperpro and above water ASD instruments.
3. Cal val cruise results of protocols and all data from the ocean color cruises were transitioned to NOAA and put into cruise reports with a doi.
4. The NOAA MSL12VIIRS ocean color products were shown to be similar and an improvement to NASA's products.
5. Methods for establishing an advanced cal val cruise for ocean color were established and additional cruises are required to improve and advance the methods for data collection for satellite calibration. This is an interagency coordination (NOAA, NASA, NAVY) being coordinated with the 6 universities.
6. The variability of in situ data used for calibration of VIIRS products was shown to be variable and not consistent between all instruments for all stations. This inconsistency required methods to improve the cal val protocols for processing to improvement in calibration for satellite VIIRS products.
7. The WavCIS platform is transitioning daily data to NASA and NOAA for calibration and validation of the Ocean Color on VIIRS satellite. These data are being used for maintaining high quality VIIRS products.

Information on collaborators/partners:

a. Name of collaborating organization: There were many collaborators and projects with USM on this project. These include: NOAA-STAR Center for Satellite Applications and Research, NASA, Goddard, Navy NRL, CCNY (City College, New York), NIST, USF University of Southern Fl, UMB- Univ of Mass Boston, Univ of Miami, Oregon State University, Columbian University (LAMONT), Joint Research Council (Italy). Also collaborating with the GOMRI – Concorde project and the NASA GEOCAPE program Additional collaborations include the NOAA National Marine Fishers Service with collaboration in the NOAA restore program.
b. Date collaborating established: a. Collaboration with the NOAA cal val team was part of the bi-weekly weekly telecons b. Collaborating with NOAA cal val team on joint cruises Dec 2015 and Oct 2016.
c. Does partner provide monetary support to project? Amount of support? Partners in GOMRI - CONCORD- and Restore provide some salary and post doc salary. Navy partners on the Stennis team receive support from the Navy.
d. Does partner provide non-monetary (in-kind) support? Ship opportunity for data collection in Gulf of Mexico. And coordination with Navy satellite processing group.
e. Short description of collaboration/partnership relationship: There are many collaborators that are involved in the NOAA VIIRS cal val effort. By working together, we are developing the US national standards for the satellite ocean color calibration. These include protocols in instrumentation and validation methods. Collaboration with GOMRI is through using the VIIRS ocean color products in the Ocean Weather Laboratory (OWX) in the Gulf of Mexico. The OWX products are used for adaptive sampling for gliders, ships, and sample collection. Collaboration was performed with the NOAA RESTORE Act Science Program for identifying Ocean Hotspots. The project includes using the VIIRS products to define a data base and anomalies of ocean conditions in the Gulf of Mexico. There will be used to identify the potential hotspots for fisheries. Collaboration with Navy includes NRL's cal val projects for the Automated processing system (APS) for the VIIRS and cruises of opportunity.

Information on any outreach activities

VIIRS ocean color data is used in the Ocean Weather Laboratory (OWX) at USM https://www.usm.edu/marine/research-owx. Daily ocean satellite and circulation model products are visually displayed and animated with in situ observations from ships, glider and mooring etc. The VIIRS ocean color products provide a daily validation for the circulation models and better understanding the ship and glider observations. The products from the ocean weather lab are used for adaptive sampling and are presented to students and teachers to show the daily changing ocean conditions in the Gulf of Mexico. The OWX is collaborating with NOAA ships in the Gulf of Mexico. The OWX is coordinating with the NOAA restore program with identifying dynamic anomalies in the Gulf of Mexico. The OWX Lab hosts webinars, and classes and visitors of conditions in the Gulf of Mexico. We have been visited by the Coast Guard, Navy, State Department of Marine Research, and periodic visitors.

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

Related NOAA Enterprise Objectives: Science and Technology

NGI File #: 16-NGI3-17

Project Title: Continuation of Secure Archival Storage for NOAA/NMFS Preserved Specimens at USM's Plankton Archival Facilities

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

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

Award Amount: $20,392

Description of research conducted during the reporting period and milestones accomplished and/or completed
This project was awarded at the end of the reporting period so there is no activity to report on.

Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Organization and Administration

Appendix A. Publication Documentation

Publications completed during the reporting period:

	Institute Lead Author	NOAA Lead Author	Other Lead Author
Peer-Reviewed	2	1	1
Non Peer-Reviewed	24	2	11

Appendix B. Employee Support

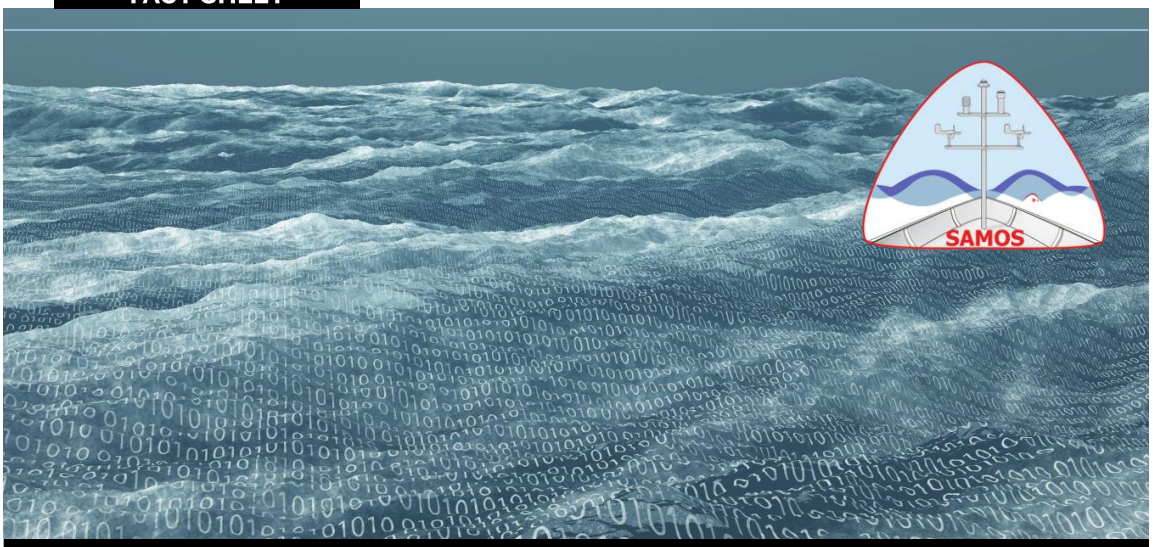
Personnel				
Total # of employees by job title & terminal degree that receive at least 50% support from the NGI NOAA CI funds, postdocs & visiting scientists				
Northern Gulf Institute Employee Support **October 1, 2016 - June 30, 2017** Personnel (all schools combined)				
Category	**Number**	**B.S.**	**M.S.**	**Ph.D.**
>= 50% Support				
Research Scientist	3	1	1	1
Visiting Scientist	0	0	0	0
Postdoctoral Fellow	2	0	0	2
Research Support Staff	1	1	0	0
Administrative	0	0	0	0
Total (>= 50% support)	**6**	**2**	**1**	**3**
Category	**Number**	**B.S.**	**M.S.**	**Ph.D.**
Employees w/ <50% support	20	5	8	7
Category	**Number**	**B.S.**	**M.S.**	**Ph.D.**
Undergraduate Students	1	1	0	0
Graduate Students	10	0	8	2
Category	**Number**	**Name of Lab**		
# of employees / students that are located at the Lab (include name of lab)	3	AOML		
# of employees / students that were hired by NOAA within the last year	0			

Appendix C. Other Agency Awards

Principal Investigator	Prime Sponsor	Project Title	Funding Amount
Moorhead, Robert	Mississippi Department of Marine Resources (MDMR)	GBNERR Data Collection	$3,602.85
Brown, Michael	National Oceanic and Atmospheric Administration (NOAA)	Understanding the Variability of Southeastern Severe Storm Environments Using Mobile Soundings During VORTEX-SE	$82,712.00
Fitzpatrick, Patrick	Gulf of Mexico Alliance	CONsortium for oil spill exposure pathways in COastal River-Dominated Ecosystems (CONCORDE)	$102,715.00
Ritchie, Jarryl B	BP America	GOMA BP Gulf of Mexico Research Initiative Web Support Project	$2,312,953.00
		Total	**$2,501,982.85**

Appendix D. Fact Sheet

FACT SHEET



Making use of a sea of data

While weather satellites orbit the earth monitoring the cloud systems, winds, ocean currents, and ocean-atmospheric energy flows, research vessels are at sea observing our oceans — measuring wind speed, ocean salinity, air and sea temperature, pressure, moisture, and rainfall. But what in the world do scientists do with all of these data? And how do they find what they need in the sea of information that has been collected over the years?

An important part of what researchers who study the Earth's ocean and atmosphere do is observe and measure factors such as temperature, wind speed-direction, and air pressure. The data they collect help answer questions about how earth systems work, including how and why weather events occur. Scientific data also reveal what areas require more study. **The work marine meteorologists and weather data curators do impacts everyone... even you!**

For instance, if you plan to go outside today, chances are you want to know what kind of weather to expect. Should you bring an umbrella, wear a light or heavy jacket, or maybe even consider staying in? Of course you'd want to know if there was any potential dangerous weather such as a hurricane or tornado to watch out for.

Weather prediction is an example of how ocean and atmopsheric science impacts our daily lives. Certainly agricultural decision-making depends upon accurate weather forecasts, not just to help farmers schedule their crop planting and harvesting, but also to forecast the spread of diseases that threaten their crops and can be carried on the wind. But those of us readying ourselves for school, work, or just running errands also rely on weather prediction in our day-to-day lives.

The science behind weather forecasting

Did you ever wonder what makes it possible to accurately predict the weather? Weather forecasting begins by observing phenomena that create weather events such as rainfall, storms, and temperatures. It requires an understanding of patterns observed because they offer some explanation for common phenomena and can therefore be used to predict future occurrences.

The Marine Data Center at the FSU Center for Ocean-Atmospheric Prediction Studies (COAPS) | www.coaps.fsu.edu

Early weather forecasters based their predictions on what they could see and measure themselves — rainfall, winds, temperature, and storm patterns — observing how these changed over time. Today, scientists also use satellites, marine towers, buoys, and ships equipped with sophisticated instruments to monitor and record these kinds of observations, making modern weather forecasting possible. In fact, accurate forecasting depends upon observations made both within the atmosphere and remotely from space-based satellites.

As a result of all these data collection techniques, there is an incredible amount of historical and current information available for scientists to analyze. However, scientists need to be able sort through this sea of information to address the questions they want to answer. Thanks to the Internet, that is now possible... no matter where the data comes from and who wants access.

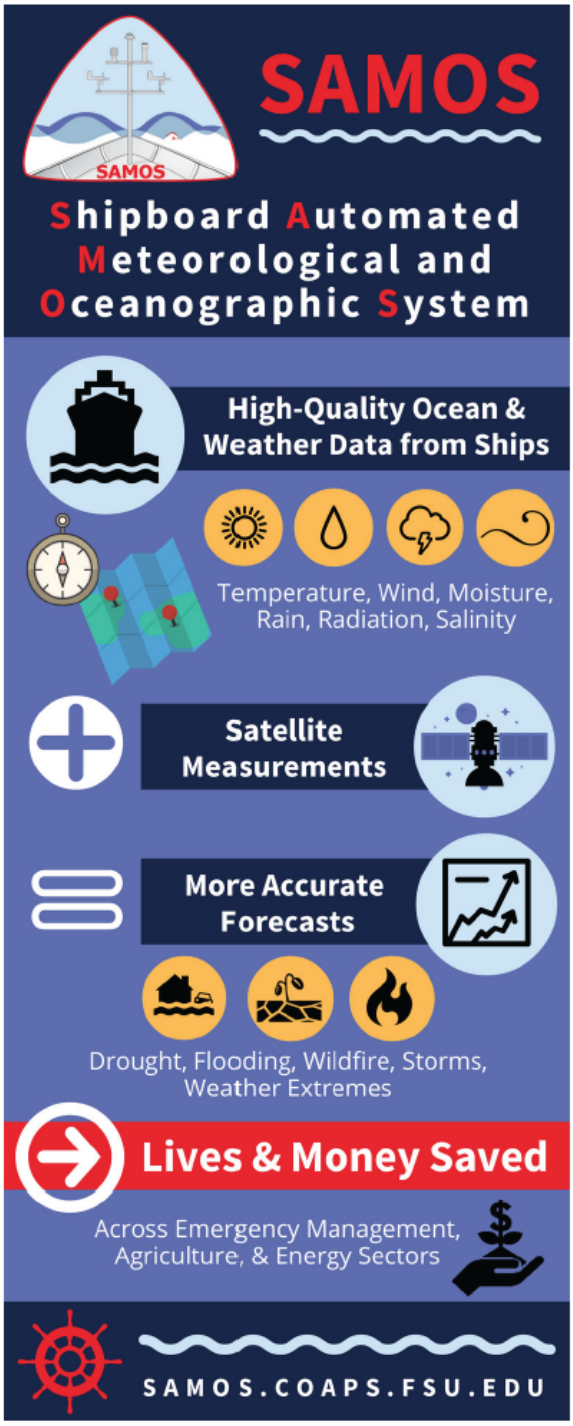
Gathering and sharing ship data

The Marine Data Center at FSU COAPS is home to a project that captures and shares the extensive and nearly continuous meteorological data collected by research vessels. This **Shipboard Automated Meteorological and Oceanographic System** (known as **SAMOS**) gets the meteorological data and other measurements collected by research vessels while they are at sea. But more importantly, SAMOS makes these data available to individual researchers, organizations, and weather forecast agencies that, in turn, use them to validate weather satellite data from the National Aeronautics and Space Administration (NASA). Validated data can be used to create and improve computer models and other tools employed in weather forecasting.

Data validation is critical

It is important to remember that scientists don't just want access to **a lot** of data... they need to know that data they are using in their research has been validated, meaning it has been checked for accuracy and inconsistencies. This is particularly true for observations made by satellites in space. That is done is by comparing the satellite data to the observational data collected by research vessels at sea.

The SAMOS system is an important part of our nation's weather forecasting capabilities — **allowing scientists to validate satellite observations with what ships at sea observe.**



The SAMOS initiative at Florida State University is base-funded by NOAA's Ocean Observing and Monitoring Program via the Northern Gulf Institute (Cooperative Agreement #NA11OAR4320199) and the National Science Foundation's Oceanographic Instrumentation and Technical Services Program (Grant #OCE-1447797). Since 2013, the Schmidt Ocean Institute has provided funding to complete SAMOS data processing for observations from the RV Falkor.

The Florida State University (FSU) Center for Ocean-Atmospheric Prediction Studies (COAPS) is internationally known for providing high quality, innovative data products. Our goal is to provide data products that are useful for both operational and research activities and climate applications. The COAPS Marine Data Center dispenses a wide range of these products focusing on the atmosphere-ocean interface. For more information visit www.coaps.fsu.edu