ANNUAL PROGRESS REPORT

Northern Gulf Institute

Reporting Period covering
July 1, 2016 - September 30, 2017

This report was prepared under award NA11OAR4320199 to the Northern Gulf Institute by NOAA's Office of Oceanic and Atmospheric Research, U.S. Department of Commerce.

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The University of Southern Mississippi
NGI Northern Gulf Institute a NOAA cooperative institute

NGI Annual Report

Award NA110AR4320199

Reporting Period: July 1, 2016 to September 30, 2017

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PROJECT REPORTING (Note that the last 2 digits of the NGI File # correspond with the amendment # to NA110AR4320199)

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 July 1, 2016 to September 30, 2017. The items in this report cover the research conducted under NOAA award NA11OAR4320199. The report consists of two (2) sections and appendices. The first section provides the General Description of NGI, the NGI Direction, Organization and Operations, 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 sponsor and strategic goal. Appendix A provides the total count of publications for this reporting period, and Appendix B summarizes the total number of employees and students supported by NOAA funding at NGI. Appendix C lists other agency awards NGI received during this reporting period.

NGI General Description and Core Activities

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

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

The Institute contributes to NOAA's priority interests in the four NGI research themes of Ecosystem Management, Geospatial Data Integration and Visualization, Coastal Hazards, and Climate Effects on Regional Ecosystems. Important recent research accomplishments by NGI researchers, in collaboration with multiple NOAA researchers, focus on the issues and resources of the Gulf with many of the tools and protocols transferrable to other coastal 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 the Stennis Space Center, MS, facilitates close interactions with multiple NOAA activities and key stakeholder groups including the NOAA Gulf of Mexico Regional Collaboration Team, regional Sea Grant programs, and the Gulf of Mexico Alliance. The Mississippi State University Science and Technology Center at Stennis Space Center, which houses NGI and NOAA activities, provides NGI with the foundation and the building blocks to maintain and grow its role in northern Gulf of Mexico environmental research and education. NGI continued its international engagement in the Gulf of Mexico by continued interactions with the Consorcio de Instituciones de Investigación Marina del Golfo de México (CiiMar-GoM).

Since its initial award on October 1, 2006, the NGI's leadership has worked diligently to build collaborations between the five academic institutions and NOAA research and education programs. NOAA's support for NGI's active projects totals over $20 million. NGI continues to use NOAA's investment to contribute to the recovery and future health, safety, resilience and productivity of the Northern Gulf of Mexico region, through sustained research and applications in a geospatial and ecosystem context. NOAA cooperative institute metrics summarizing published research and staffing support are provided in the appendices.

In 2006, the NGI Council of Fellows, consisting of a senior investigator from each of the member institutions, established an Executive Office at MSU in Starkville, Mississippi, and a Program

Office at Stennis Space Center, Mississippi. Funding for the NOAA led research began in the spring of 2006 and research initiatives at the NGI partner institutions began in February 2007. Significant efforts are being made to address important questions related to NOAA's long-term goals of Climate Adaptation and Mitigation, Weather-Ready Nation, Healthy Oceans, Resilient Coastal Communities and Economics, and NOAA enterprise-wide capabilities. The second five-year cooperative agreement began in October 2011.

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

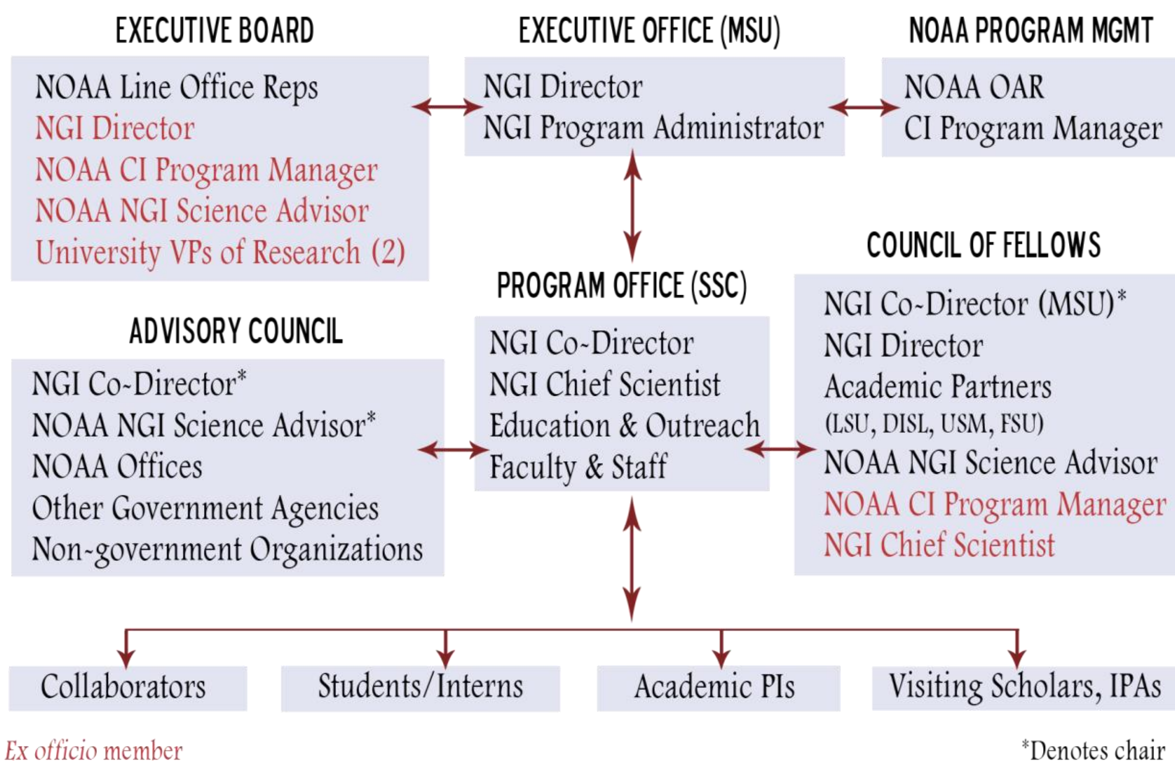


Figure 1. NGI organization diagram

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

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

NGI has 3 councils that make management and advisory contributions to the Institute. The Council of Fellows is composed of senior scientific/ technical representatives from each NGI member academic institution, as well as the NOAA NGI Science Coordinator, and the NOAA OAR CI Program Manager. The Council is chaired by the NGI Co-Director or designee. The Council of Fellows is the principal vehicle for NGI concept development, program strategy, annual research plans, peer review, resource allocation, research and technology coordination, and achieving the overarching goal of regional and disciplinary integration.

The Council of Fellows

For period of July 1, 2016 through September 30, 2017, the NGI Council of Fellows consisted of:

Robert Moorhead, Ph.D., Mississippi State University
Steve Ashby, Ph.D., Mississippi State University (chair)
Monty Graham, Ph.D., University of Southern Mississippi
Eric Chassignet, Ph.D., Florida State University
Robert Twilley, Ph.D., Louisiana State University
John Valentine, Ph.D., Dauphin Island Sea Lab
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 vice presidents of two 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
Bonnie Ponwith, Ph.D., Director, NOAA SE Fisheries Science Center (Chair)
Margaret Davidson, Senior Leader Coastal Inundation and Resilience Science and Services
Louisa Koch, Director, NOAA Office of EducationAlan Leonardi, Ph.D., OAR OER Director; Chair

David Shaw, Ph.D., MSU VP for Research and Economic Development
Gordon Cannon, Ph.D., USM VP for Research
Candice Jongsma, Ph.D., OAR CI Program Manager (Ex-officio)
Robert Moorhead, Ph.D., NGI Director (Ex-officio)

The NGI Advisory Council

The NGI Advisory Council serves as the principal interface to the regional stakeholder community of the NGI. It has broad representation from the entities listed in the organizational chart, and meets regularly to identify and prioritize research and educational needs in the Northern Gulf region. The Advisory Council provides input on the current research and education/outreach programs of the NGI. NGI supports the formation and efforts of workgroups around each of the major themes of the NGI and accepts direction from the Advisory Council when they identify the need. The NGI Advisory Council members are:

Steven Ashby, Ph.D., MSU, NGI Co-Director (Chair)
Duane Armstrong, NASA Stennis Space Center
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

Executive Summary of Important Research Activities

Research activities focused on completing projects with an emphasis on healthy oceans and habitats, data analysis for weather and climate assessments, product development to transition research to operations, and increased education and outreach. Some examples are highlighted in the following.

Research in support of healthy oceans and habitats included several projects

- Increasing our understanding of the interaction between physical and ecological processes in the Gulf of Mexico and Caribbean continued. The final student project supported under this grant is the development of a biophysical modeling system for the Gulf of Mexico for simulating and understanding causes of variability of prey for fish larvae and consequences for larval mortality and recruitment. Under this funding, a biogeochemical model that simulates zooplankton (a proxy for fish larvae prey) concentration was developed and coupled to the HYCOM circulation model. Through collaboration with NOAA scientists at AOML and SEFSC, an experimental design for this Ph.D. work of a recently enrolled graduate student was developed.

- A localized ADCIRC and Hydro-MEM model was developed for the region from Chesapeake Bay to Ocean City. The Hydro-MEM modeling results will provide site specific information on the loss of marsh for the study region and its effect on storm surge inundation in Hampton Roads will be evaluated.

- Research on the Gulf sturgeon population continued. After quality control/quality assurance, we currently have a total of 1267 individuals genotyped for the range-wide analysis of population structure. These individuals provide strong representation of the populations from the major river systems across the range of Gulf sturgeon.

- Research to determine habitat use and movement patterns for adult smalltooth sawfish continued and included numerous invited presentations to public schools, the general public, and university groups. Examples include:

    - July 20, 2016 - SeaCamp, Big Pine Key, FL. Presentation to 120 SeaCamp students. *Ecology of coastal and deepwater sharks and bony fishes*.
    - September 2016 - President's Club College – Florida State University – Class for FSU Donors that are members of the President's Club on Research to Promote Recovery of Endangered Smalltooth Sawfish.
    - September 30, 2016 - EEE Honors Society at FSU. Research presentation to ~100 honors students on deep sea shark and endangered sawfish research at FSU.
    - October 31, 2016 - Plymouth Marine Laboratory – Seminar Series, Plymouth, United Kingdom. *Using state of the art telemetry to study very large elasmobranch fishes: endangered sawfish and deep sea sharks*.

    An article highlighting this research was prepared for the IUCN supported Sawfish Conservation Society. The documentary, "Alien Sharks: Return to the Abyss" will be highlighted again during Shark Week 2017.

- Impacts of pollutants in marine environments were further documented with two projects.

    - Examining microplastic occurrence in gut contents of Sargassum-associated juvenile fishes reinforced just how significant the issue of microplastics and their impacts on marine life can be. Of the microdebris particles observed, over 88% were classified as fibers. Overall, observations suggest that some fishes associated with Sargassum may have a greater probability of consuming microdebris, but data from non-Sargassum habitats are generally lacking. A growing recognition of the issue resulted in a request for a written set of our protocols and telephone conference by researchers working on a UNEP-CEP funded project examining marine debris ingestion by fishes in the Caribbean (Dr. Clare Morrall, Department of Biology, Ecology and Conservation, St. George's University, Grenada, West Indies). These investigators were directed to us by Dr. Amy Uhrin (Chief Scientist, Marine Debris Division NOAA Office of Response and Restoration) and we were happy to share our experiences, protocols and offer advice to this group.

  - A second project on the occurrence and accumulation of marine debris on barrier islands in the Northern Gulf of Mexico produced results that show that more litter is consistently washing up on the ocean side than the sound side of the barrier islands and that there is a large jump (> 2x) in the number of pieces of plastic debris collected in April/May with the start of tourist season, this increasing trend continues through October. Approximately 88% of the marine debris collected across all locations (combining ocean and sound sides) was made of plastic.

- The increased utility of using Unmanned Aerial Systems for ecological studies was demonstrated in a UAS Program Office funded NOS project that effectively builds on habitat analysis work at the Grand Bay NERR. Additionally, a small UAS was used to create a digital surface model (DSM) of a marsh reconstruction project in Bayou Dupont, located approximately 15 miles south of New Orleans and approximately 3 miles west of the main stem of the Mississippi River. This project demonstrated that a 1000 acre marsh can be overflown by a small UAS and imagery obtained at 2 inch resolution in one day. Using about 5 GCPs, the resulting mosaic can be geo-referenced to sub-inch accuracy in hours.

Data analysis focused on satellite data, weather forecasting, and climate

- Research for improving ATMS SDR data quality for weather and climate studies continued. This project involved assessing impacts of satellite orbital drift and inter-satellite biases on AMSU-A derived climate trend from NOAA-15, -18, -19 and MetOp-A using diurnal correction and double differencing methods and developing ATMS de-striping optimal filters for ATMS surface-sensitive channels. The modified de-striping method performs well for reducing the striping noise at ATMS window channels without introducing the artefacts to the de-striped brightness temperature fields.

- Several advancements have been made to understand how measurements from the Stepped-Frequency Microwave Radiometer (SFMR) vary with incidence angle. For the cases with similar wind and wave directions, it was not possible to determine whether the peaks in the asymmetry that occur around +/- 90° wind/wave relative SFMR look angle were associated with the wind direction or the wave direction. However, for the case where the wind and wave directions differed by about 90°, a shift in the peaks was observed for the wave relative SFMR look angle, but not for the wind relative SFMR look angle. This result determined that the peaks in the asymmetry were robust to wind direction and not wave direction with respect to the SFMR look angle.

- 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 NOAA's Climate Observation Division. Additionally, archiving all quality-evaluated SAMOS data at NCEI along with evaluation of post-cruise underway Scientific Computer Systems 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.

- The data management program at DISL, consisting of a formal Data Management Center, Senior Data Manager, Data Management Specialist, and Data Management Advisory Committee, has been extremely successful at incorporating metadata creation, data archiving, and overall data management into the regular process of research at DISL. Transition from FGDC CSDGM to ISO 19115-2 metadata standard has been completed. All metadata written with Data Management Center involvement, and all training workshops going forward, will be in ISO. DISL's customized ISO metadata writing tools continue to be available at http://cf.disl.org/datamanagement/ISO/ISO_index.html.

- Advancing the Use of Airborne Lidar Bathymetry (ALB) for Navigational Charting Coos Bay Lidar to Chart Effort. A full report on the data package was compiled with descriptions of how the data differed to the current chart and recommendations for updates to the chart.

- A comprehensive damage survey was conducted on the Falkville-Priceville tornado, which occurred on 31 March 2016. Ground surveys were completed by NWS/HUN office personnel, and this was supplemented with several follow-up surveys by UAH personnel. The secondary surveys disclosed that tornado formation occurred sooner and the tornado dissipated later. Some of these ambiguities were clarified by our SPoRT partners, a helicopter overflight, and several UAS overflights conducted by NOAA/ARL and ENRGIES, a private company in Huntsville. This collaborative activity will be documented in a poster or oral presentation at the upcoming Conference of Severe Local Storms.

Product development to transition research to operations, examples

- 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, mooring, etc.

- A unified user-friendly GUI, known as TaoGUI, has been developed for the Windows 7 operating system as the gateway to the existing TAO delayed-mode data processing programs. This unified user-friendly software package will significantly reduce data processing time and operator errors.

Education and outreach

- Guided tours of the SWIRLL building continued on a regular basis. 17 formal tours were provided since January 2016, and this rate continues to increase. Groups include senior citizens, social clubs, K-12, foreign groups, and other visitors. We also accept invitations to special conferences and "Weatherfests" when possible. For these events, several graduate students will drive 1-2 mobile facilities to the location of the event. Other "mobile" tours have been conducted at K-12 schools.

- 25 GIS workshops were conducted with a total of 241 participants.

- A data and information sharing infrastructure was utilized for the storage of over 6.3 Terabytes of web-accessible data that is referenced from the NCEI catalog. This web-accessible data consists of 80 Okeanos mission data sets. The infrastructure served data to 4,695 unique IP addresses during the reporting period. The support and operation of the Exploration Command Center has broadened the research opportunities associated with the ocean exploration activities of NOAA by allowing participation from a larger and dynamic group of scientists. The continuing deployment of the publicly accessible data repository will also enable broader usage of the ocean exploration data. Mississippi State University is utilizing the ECC and high definition video streams to promote ocean exploration as well as science, technology, engineering and mathematics (STEM) in general. Visitors are able to “experience” the live dives in the ECC or via a receive-only video setup in the lobby of the MSU High Performance Computing Building in Starkville, MS. Additionally, the high definition highlight video streams of the dives are frequently replayed in both the ECC and in the Starkville facilities for visitors. The Starkville facility is a regular tour stop for visiting and prospective students to MSU, and consequently provides for unique outreach opportunities.

- A certificate program curriculum was developed for social science applications for meteorologists. The goal of this project is to develop curriculum for a training program in social science applications to meteorologists and meteorology professionals. Course content for five courses containing multiple modules of instruction was developed.

- Collaboration 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 States Marine Fisheries Commission, the Gulf of Mexico Fishery Management Council, 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.

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).

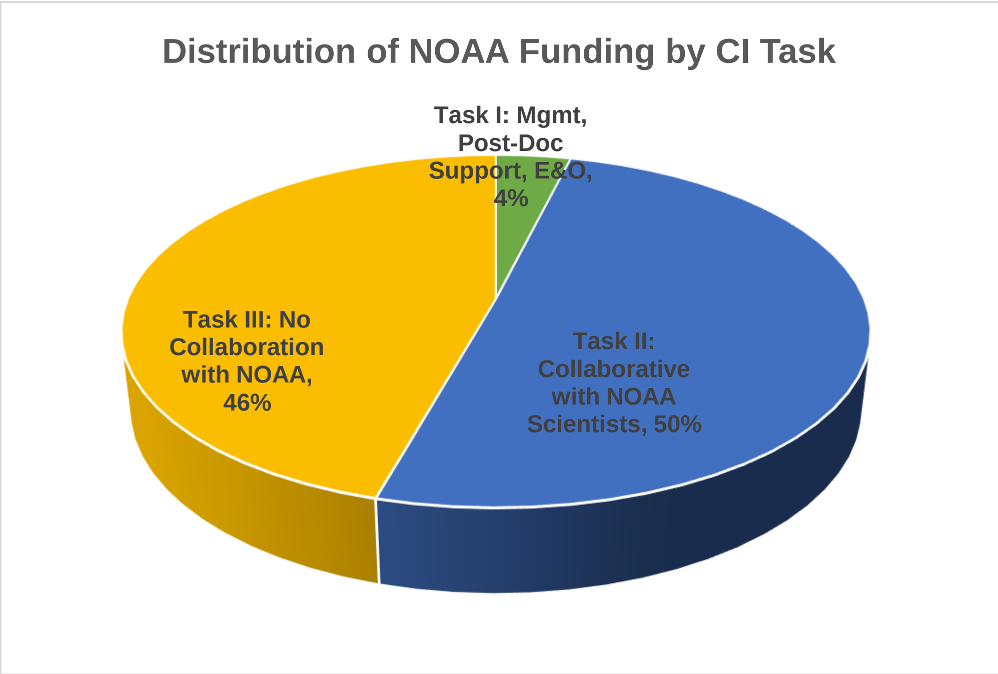


Figure 2. Distribution of NOAA funding by the three cooperative institute task categories.

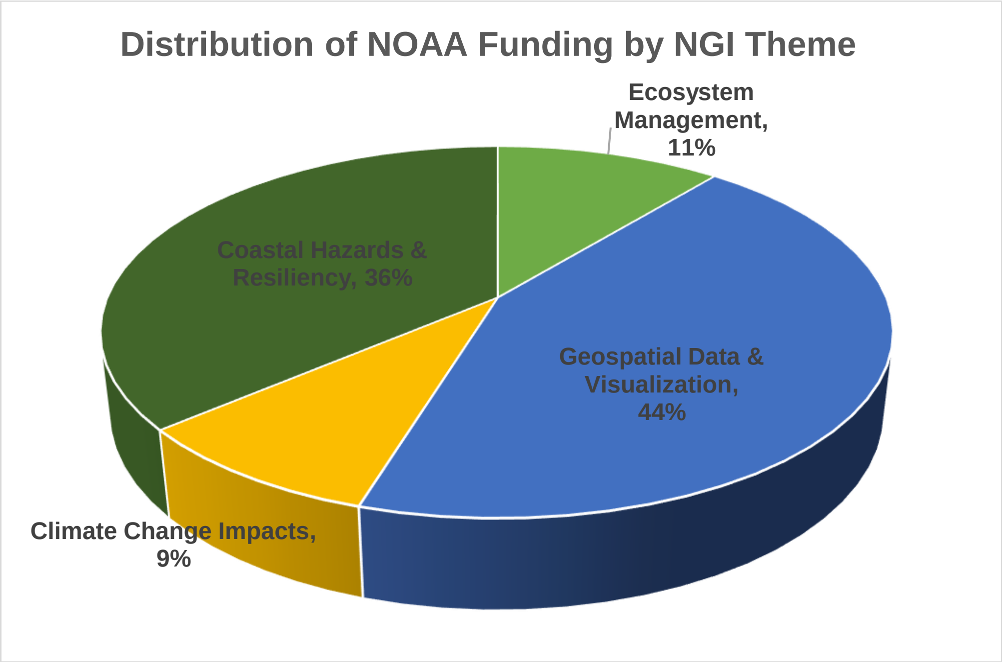


Figure 3 Distribution of NOAA funding by the four NGI themes.

Task I Activities

Task I funding supports the central management and coordination of the five complementary academic partners working together with NOAA. Task I funding was used to support the administration of NGI, student activities, education and outreach, other research activities (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.

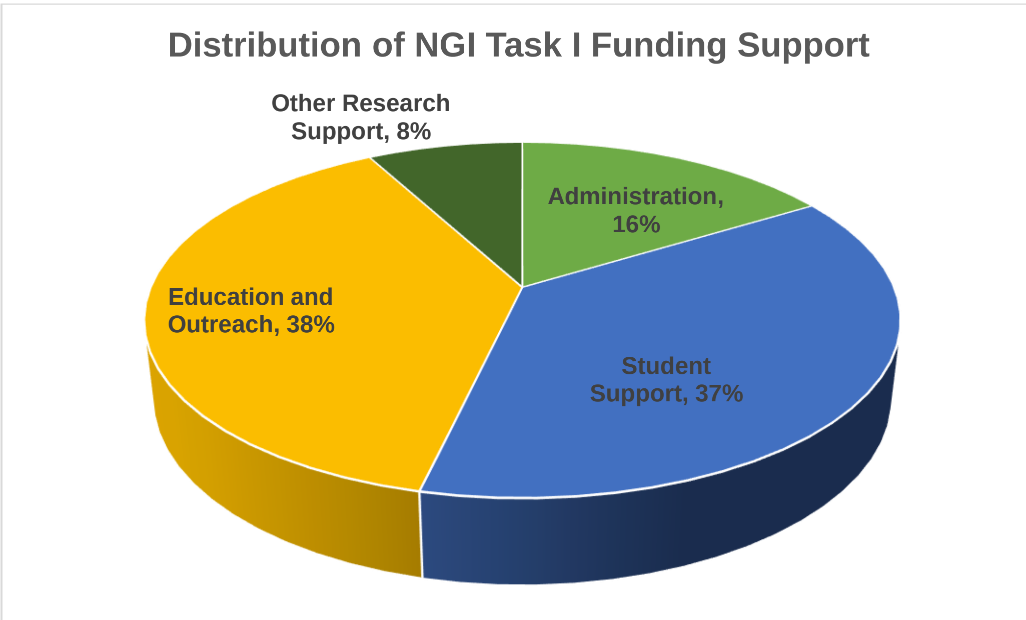


Figure 4. Distribution of NGI Task I funding.

NGI File # 14-NGI2-70

Project Title: Examining Microplastic Occurrence in Gut Contents of *Sargassum*-Associate Juvenile Fishes

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: Alison Hammer, NOS

Award Amount: $68,243

Project objectives and goals

1. Quantify and characterize juvenile fish assemblages and co-occurring debris collected in *Sargassum* mats and/or weedlines
2. Determine the microplastic frequency of occurrence in the guts of *Sargassum*-associated fishes

Description of research conducted

Our sponsor (NOAA Marine Debris Program) supported a pilot project to examine possible ingestion of microplastics by *Sargassum*-associated fishes. *Sargassum* is a near-surface habitat, and as such, it is subject to oceanographic processes (e.g., Langmuir cells, frontal zones) that aggregate floating objects, including marine debris. Samples of *Sargassum*-associated fishes were available from three projects awarded to lead PI Hernandez: 1) a NSF RAPID project (2010) to examine Deepwater Horizon (DWH) impacts on *Sargassum* habitats; 2) a GoMRI RFP-III project (2011) to collect data on *Sargassum* recovery the year after DWH; and 3) collections made during the course of this project (2014, 2015). Fishes were collected during these surveys using a neuston net (505 micron mesh) and a plankton purse seine (1000 micron mesh) and then preserved in ethanol. In the lab, fish were measured, enumerated, and identified the lowest possible taxonomic level. In general, the entire alimentary canal was removed, but for conservative estimates of microdebris ingestion, only the stomach was dissected and examined for evidence of microdebris ingestion. The number and general type of microdebris found in stomachs was recorded. Microdebris types were classified as fiber, sphere, flake or fragment, following the descriptions of Li et al. (2010, Environ Poll 214:177-184). In general, only specimens larger than 10 mm were dissected, and in cases where over 50 individuals of the same species were in a single sample, a random subsample of 50 individuals was selected for examination. Observations were entered into a database, and the frequency of occurrence of microplastic ingestion was determined for each taxon.

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

A total of 860 fishes were dissected and examined for evidence of microplastic ingestion from samples collected in 2010 (n=420), 2011 (n=19), 2014 (n=286), and 2015 (n=45). In total, fishes from 18 families were represented in the collections (Table 1). Dominant taxa included Planehead Filefish (*Stephanolepis hispidus*, ~25%), Pipefishes (*Syngnathus* spp., ~14%), Sargassumfish (*Histrio histrio*, ~12%), Blue Runner (*Caranx crysos*, ~12%), and Bermuda Chub (*Kyphosus sectatrix*, ~8%), among others. In total, approximately 10% of the fishes dissected for analysis contained microdebris in their stomachs. Microdebris frequency of occurrence varied by taxon, with some of the highest frequencies observed in Pygmy Filefish

(*Stephanolepis setifer*, 22%), Sergeant Major (*Abudefduf saxatilis*, 18%), and Bermuda Chub (K. *sectatrix*, 16%). Of the microdebris particles observed, over 88% were classified as fibers. Examples of microdebris removed from juvenile fish stomachs are provided in Figure 1. Overall, our observations suggest that some fishes associated with *Sargassum* may have a greater probability of consuming microdebris, but data from non-*Sargassum* habitats are generally lacking.

No novel protocols or methods were developed during the course of this work; gut dissections were performed as previously described in the literature (e.g., Hyslop, 1980, *J Fish Biol* 17:411-429). However, in May 2016 a written set of our protocols and telephone conference was requested by researchers working on a UNEP-CEP funded project examining marine debris ingestion by fishes in the Caribbean (Dr. Clare Morrall, Department of Biology, Ecology and Conservation, St. George's University, Grenada, West Indies). These investigators were directed to us by Dr. Amy Uhrin (Chief Scientist, Marine Debris Division NOAA Office of Response and Restoration) and we were happy to share our experiences, protocols and offer advice to this group.

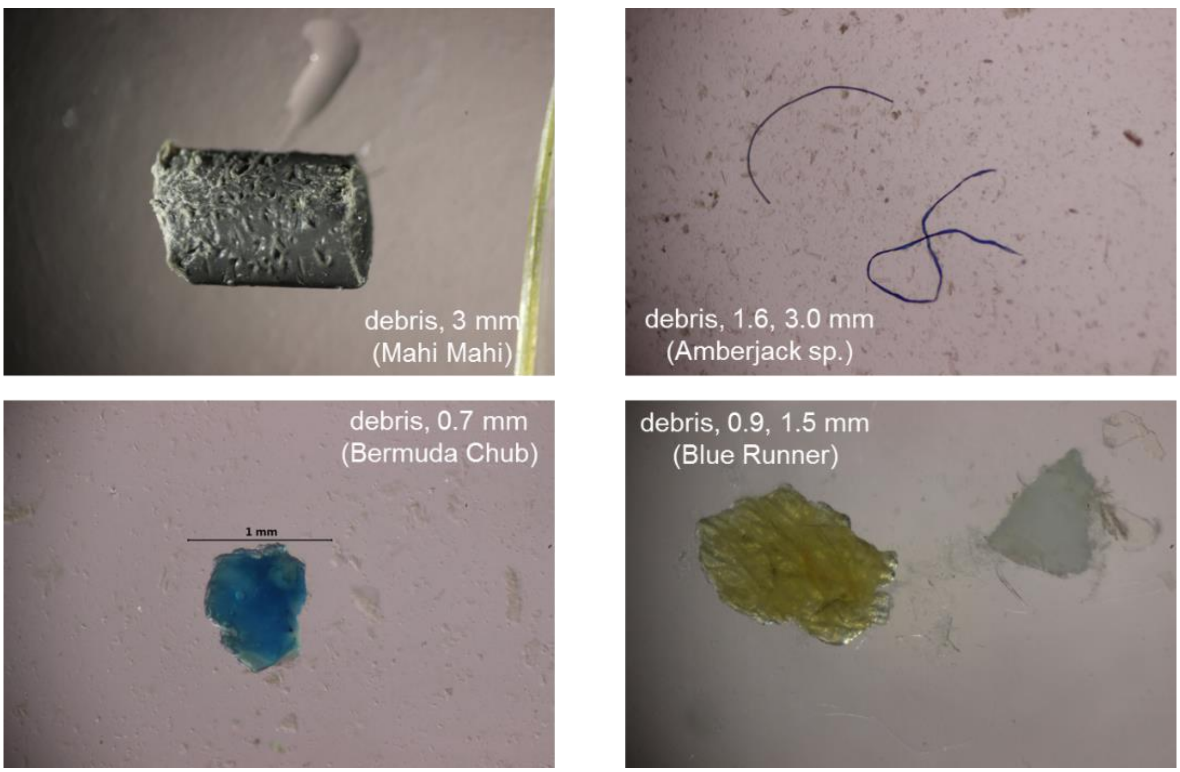


Figure 1. Examples of microdebris removed from the stomachs of fishes dissected in this study.

Table 1. *Sargassum*-associated fishes collected during 2010 (n=420), 2011 (n=19), 2014 (n=286), and 2015 (n=45) in the northern Gulf of Mexico and dissected for microdebris stomach analysis.

Taxon	No. Dissected	No. with debris in stomach	Mean SL (mm)	Range SL (mm)
Antennariidae				
Histrio histrio	102	2	29.6	10.0 - 67.3
Mugilidae				
Mugil sp.	1	0	24.0	24.0
Belonidae				
Unidentified	1	0	54.5	54.5
Exocoetidae				
Unidentified	1	0	14.6	14.6
Syngnathidae				
Syngnathus sp.	116	13	102.0	30.0 - 167.0
Carangidae				
Caranx crysos	100	9	45.5	12.4 - 403.0
Caranx latus	2	0	23.0	18.8 - 27.2
Caranx sp.	36	0	29.3	14.0 - 52.5
Chloroscombrus chrysurus	24	0	18.4	11.1 - 38.0
Decapterus punctatus	3	0	27.7	16.3 - 39.6
Elagatis bipinnulata	6	0	36.7	28.5 - 44.2
Seriola rivoliana	4	1	38.8	27.0 - 58.0
Seriola zonata	1	0	45.9	45.9
Seriola sp.	2	1	84.9	17.7 - 152.0
Unidentified	2	0	25.9	23.8 - 28.0
Coryphaenidae				
Coryphaena hippurus	11	1	297.7	33.6 - 590.0
Kyphosidae				
Kyphosus sectatrix	70	11	27.6	13.2 - 52.9
Kyphosus sp.	2	0	15.5	13.0 - 18.0
Lobotidae				
Lobotes surinamensis	21	3	75.4	12.0 - 330.0
Lutjanidae				
Unidentified	2	0	13.1	13.0-13.1
Pomacentridae				
Abudefduf saxatilis	45	8	19.9	13.0 - 31.0
Blenniidae				
Unidentified	2	1	17.0	17.0
Ephippidae				
Chaetodipterus faber	1	0	13.4	13.4
Sphyraenidae				
Sphyraena guachancho	1	0	24.5	24.5
Trichiuridae				
Trichiurus lepturus	1	0	54.0	54.0
Balistidae				
Balistes capriscus	22	2	31.1	20.6 - 52.0
Cantherhines pullus	1	1	46.5	46.5
Monacanthidae				
Aluterus monoceros	1	0	180.0	180.0
Aluterus scriptus	2	0	211.0	204.0 - 218.0
Canthidermis sufflamen	1	0	78.5	78.5
Stephanolepis hispidus	211	20	23.4	8.0 - 64.9
Stephanolepis setifer	9	2	14.4	9.4 - 26.3
Stephanolepis sp.	55	8	15.5	5.3 - 51.2
Tetraodontidae				
Sphoeroides sp.	1	0	12.0	12.0
Totals	**860**	**83**		

Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology

PROJECT REPORTING (Note that the last 2 digits of the NGI File # correspond with the amendment # to NA110AR4320199)

NGI File # 14-NGI2-71

Project Title: Diagnosing Atlantic Basin Tropical Cyclone Rapid Intensification with Artificial Intelligence and Compositing Techniques

Project Lead (PI) name, affiliation, email address: Andrew Mercer, Northern Gulf Institute, Mississippi State University, Mississippi State, MS, mercer@gri.msstate.edu

NOAA sponsor and NOAA office of primary technical contact: Molly Baringer, NOAA Office of Atmospheric Research.

Award Amount: $148,748.00

Project objectives and goals
The ultimate goal of this work is the improvement of forecasting of tropical cyclone rapid intensification (RI). Currently, operational forecasts are completed using the SHIPS-RII system, which predicts RI onset using a mixture of large-scale and local-scale predictors in a purely statistical framework. Input predictors used in the SHIPS-RII are based on numerical guidance for the next several forecast hours, so the system is entirely prognostic. The predictors currently utilized were statistically significantly different between RI storms and non-RI storms at various lead times (based on a variance independent *t*-test). Such a predictor suite likely smoothed out spatial details within the storm and as such may be missing key ingredients in the RI process, possibly leading to lower forecast skill. Additionally, several studies specifically called for the application of more advanced statistical and artificial intelligence techniques (they noted neural networks, though others are available). This project seeks to address both of these issues with the development of a complementary system to the SHIPS-RII that can be integrated into the consensus modeling approach outlined in Kaplan et al. (2013). We proposed to complete this work through two major research phases:

1. Phase 1, Formulation of composite fields – composite fields of relevant diagnostic variables for RI processes from numerical model guidance output to identify not only which variables are important but also which levels and spatial points in proximity to the cyclone are important for the prediction of RI.
2. Phase 2, Formulation of artificial-intelligence based modeling framework for RI – through the use of numerical model output, artificial intelligence based models for RI using numerous techniques, including artificial neural networks, support vector machines, and random forests, will be developed based on the results from the compositing work.

Ultimately, the primary goal of this research is the improvement of RI forecast skill within the SHIPS-RII framework by providing a new member to the system that incorporates both spatially distinct predictors and artificial intelligence methods. In this third year, both phases were completed through finishing the 6 tasks provided in section V outlining the research conducted during the project and the project timeline.

Description of Research Conducted during reporting period and milestones

The timeline below shows the expected timeline and an outline of tasks to be completed. It was updated owing to a 1-year no-cost extension. *Tasks 1-4 were completed in year 1 (though task 4 was revisited in year 2 to get improved feature selection), and tasks 5 and 6 were completed in this calendar year (year 3 of the no-cost extended year). The project timeline finished July 31, 2017.*

Project Timeline - Sep. 1 2014 - Aug. 31, 2016	Year 1				Year 2			
	Sep-Nov	Dec-Feb	Mar-May	Jun-Aug	Sep-Nov	Dec-Feb	Mar-May	Jun-Aug
Obtain GFS reforecast data for composites at all desired lead times (12-h to 48 h)	■							
Conduct *T*-mode RPCA to obtain clusters in line with Grimes (2014) results		■	■					
Formulate *S*-mode RPCA to look into specific structures within each type and identify patterns useful for forecasting			■	■				
Formulate permutation tests on all relevant variables to denote specific spatial regions of interest				■				
Cross-validation experiments for tunable AI parameters					■	■		
Test blended AI product and do final verification steps of all AI methods							■	
Publish results				■	■			■
Visit NHC/AOML for initial and finalized project discussion	■							■
Present preliminary results at AMS annual meeting		■				■		

1. GEFS reforecast fields were obtained for individual TC timesteps to use as input into the machine learning-based forecast system. In total, 949 timesteps were retained for Atlantic TCs from 1985 to present, noting that many other steps were not able to be included due to the lack of available intensification information. RI forecasts were obtained on the 949 timesteps after significant feature selection was implemented. Feature selection was completed by analyzing a total of 59 forecast layers on 9° x 9° latitude/longitude TC-centric domains, many of which were directly from GEFS fields and a few of which were derived from those fields. Table 1 below lists the fields tested in this updated feature selection implementation.

   The initial feature selection procedure involved using a rotated PCA to do data reduction where 65% of the resulting variance explained was retained. RPCA was also done layer by layer to identify which RPCs were most highly significantly different between RI and non-RI events in a forward feature selection procedure. The results were quite poor with regards to classification, as Brier Skill scores did not exceed 0.1 for any of these methods, suggesting there was too much overlap in using all fields (even after they were reduced by RPCA). To improve on these results, a more detailed point-by-point implementation was implemented.

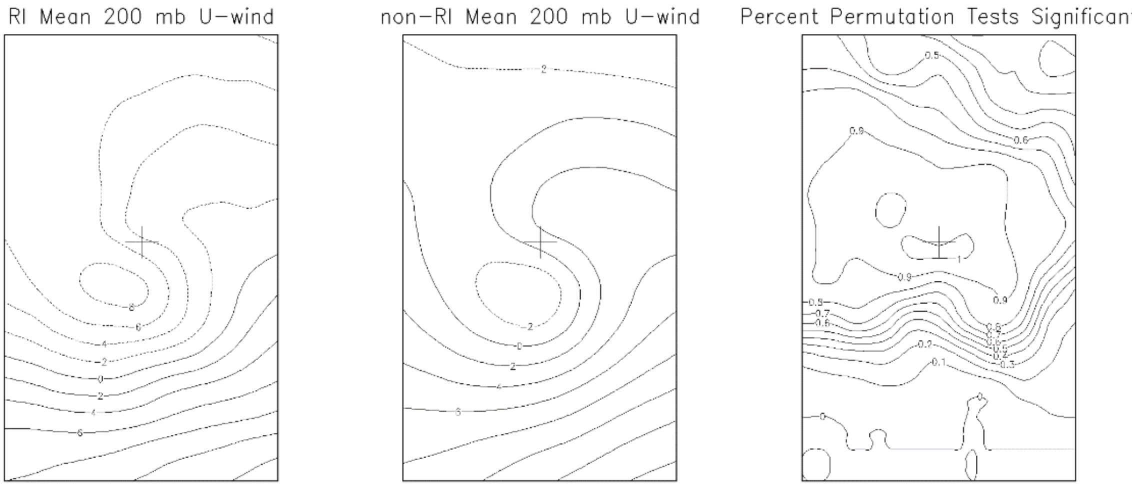
   The first phase of this new feature selection process involved full-layer (all points in the 9° x 9° grid TC centric grid) permutation testing on the mean RI and non-RI TC centric fields for each of the 59 layers. Layers which had *p*-values smaller than 0.01 were retained as highly significantly different and used for further testing. The results showed that several fields were highly significant, including 100 mb temperature, 1000 mb, 850 mb, 700 mb, and 500 mb equivalent potential temperature, 1000 mb and 925 mb specific humidity, sea surface temperature, and the zonal wind component at 500 mb, 300 mb, and 200 mb. Once retained, an additional point-by-point feature selection process was implemented to identify specific gridpoints in these significant layers that were significantly different between RI and non-RI events. This approach resulted in 6 highly significantly different gridpoints, all of which were in the 200 mb and 300 mb layer. These 6 features were retained as the main GEFS features for RI/non-RI classification.

Table 1. GFSR extracted fields (165 gridpoints for each field, 59 total fields). Derived fields are italicized.

Variable name	Vertical levels (mb)
Geopotential height (m)	1000, 925, 850, 700, 500, 300, 200, 100
Temperature (K)	1000, 925, 850, 700, 500, 300, 200, 100
Zonal (*u*) wind speed (m s^{-1})	1000, 925, 850, 700, 500, 300, 200, 100
Meridional (*v*) wind speed (m s^{-1})	1000, 925, 850, 700, 500, 300, 200, 100
Specific Humidity (kg kg^{-1})	1000, 925, 850, 700, 500, 300
Mean Sea Level Pressure (Pa)	Surface
Sea Surface Temperature (K)	Surface
Latent Heat Flux (K m s^{-1})	Surface
Sensible Heat Flux (K m s^{-1})	Surface
Convective Available Potential Energy (J kg^{-1})	Surface
Convective Inhibition (J kg^{-1})	Surface
Pressure Vertical Velocity (Pa s^{-1})	850
Static Stability (m^4 s^2 kg^{-2})	925, 850, 700, 500
Equivalent Potential Temperature (K)	1000, 850, 700, 500, 300
Divergence (s^{-1})	200
Vorticity (s^{-1})	700, 500, 200
Vertical Shear (m/s)	850-200 mb layer

The importance of the upper level wind field has been documented in the literature and is included indirectly in the SHIPS-RII implementation with the use of 200 mb divergence. However, the raw *u* component winds have not been included in this manner, and their use increased BSS values to roughly 0.12. Some further exploration into the *u*-wind differences was conducted, showing that in the mean RI and non-RI storm domain, the upper level anticyclone is considerably more pronounced in the RI event than in the non-RI event (Fig. 1), suggesting a stronger system. Further exploration into this issue will be conducted in future work.

Fig. 1. Mean *u*-wind component for all RI timesteps (left panel), all non-RI timesteps (middle panel), and the percentages of permutation tests that were significantly different ($p < 0.01$) between the two. The cross in the center indicates the TC center for each panel.



2. Once the final features were identified, the next phase was to develop the machine learning ensemble for RI/non-RI classification. As there are many different AI methods and different tuning parameters for each method, considerable parameter tuning was required for this phase of the work. Initially, three machine learning methods (support vector machines – SVMs, multilayer perceptrons – MPs, and random forests – RFs) were employed, each with a series of tuning parameters, including:

- For SVMs – cost functions of 1,10,100, and 1000; radial basis functions with γ = 0.01, 0.1, and 0.05 as well as polynomial kernel functions with degrees 2 to 5; a total of 28 permutations
- For MPs – stopping criteria of 30000, 50000 and 100000; hidden node counts of 10 to 13; hidden layer counts of 1 to 3; a total of 24 permutations
- For RFs – number of trees to grow of 100, 200, 300, 400, and 500; cutoff criteria of 0.1, 0.2, 0.3, 0.4, and 0.5; and predictors used at each leaf split between 4 and 8; a total of 125 permutations

There were several challenges with this approach. First, the datasets were highly unbalanced, such that roughly 8% were RI events. As such, each AI was tested using weighted (for the unbalanced dataset) and unweighted predictands (though the unweighted results were much poorer and are not provided here). Each individual AI method (SVMs, RFs, and MPs), was tuned against other AI configurations for the same method. In total, 60 SVM configurations, 125 RF configurations, and 60 MP configurations were considered. Robust pairwise cross-validation with 300 training/testing sets (80% training, 20% testing for each of the 300 resamples) was conducted, and those methods which performed best (highest Heidke skill score) in at least 10 of the 300 resamples were retained as part of the ensemble. This methodology resulted in 5 SVM ensemble members, 18 RF members, and 18 MP members. Individual member performance is provided in Tables 2 and 3 below.

Overall, the individual members performed on-part with the current SHIPS-RII implementation, as HSS values were around and in excess of 0.3 (these are base values, not confidence interval values). Interestingly, of the 18 MP members, all performed very similarly, but the individual predictive errors were very different between the 18 configurations (each MP member's predictive correlation was between 0.51 and 0.6 with all of the different members). Another interesting finding was that the random forests were largely insensitive to weighting with the unbalanced datasets, and that at least 200 trees grown seemed to give optimal performance. SVM predictions were best, with the RBF kernel the best performer (most of the low cost and low gamma configurations performed best). These results were generally in line with the current state of the science with the SHIPS-RII system.

While individual member performance was informative, the objective of the project was to develop the blended AI ensemble to complement the SHIPS-RII. This blending was completed using two similar methodologies. First, each of the members was weighted equally in its decision, with the sum of the RI forecasts divided by the total forecasts as an estimate of RI probability. This approach was repeated 500 times through random resampling of training and testing, yielding BSS values around 0.15, with values as high as 0.36 observed in some of the 500 iterations (Fig. 2a). Similarly, a second weighted RI prediction was done, where the weights were based on individual AI performance (the HSS values in Tables 2 and 3). The weighted approach yielded little improvement (Fig. 2b).

Formal AI decisions were obtained as well by a majority vote for each of the 500 iterations. These yielded performance statistics on HSS, false alarm ratio (FAR), and probability of detection (POD). Initial assessment revealed the AI ensemble had a low RI predictive bias, such that the cutoff for what was deemed "majority" was a 35% RI vote. After bias correction, POD values ranged from 0.111 to 0.714, while FARs spanned 0.3 to 0.9 (still quite high). Ultimately, these performance statistics, in combination with the BSS statistics, are in line with current SHIPS-RII verification statistics, though they do not exceed them appreciably.

Table 2. SVM ensemble member configurations and performance statistics. Larger HSS values mean better performance.

Member	Kernel	Cost	γ-value	HSS
SVM1	Poly-2	1	0.05	0.183
SVM2	RBF	1	0.05	0.270
SVM3	RBF	10	0.05	0.306
SVM4	RBF	1	0.1	0.319
SVM5	RBF	10	0.1	0.277

Table 3. Same as Table 2, but for RFs (left side) and MPs (right side)

Member	Trees	Predictors	Cutoff	HSS	Member	Layers	Nodes	Epochs	HSS
RF1	100	4	0.2	0.258	MP1	4	10	100000	0.308
RF2	100	4	0.3	0.248	MP2	2	11	100000	0.309
RF3	100	5	0.2	0.263	MP3	2	12	100000	0.310
RF4	100	5	0.3	0.263	MP4	1	8	100000	0.308
RF5	100	6	0.2	0.265	MP5	4	8	100000	0.310
RF6	100	6	0.3	0.264	MP6	4	10	30000	0.309
RF7	100	6	0.4	0.265	MP7	1	11	30000	0.310
RF8	100	6	0.5	0.214	MP8	1	12	30000	0.309
RF9	100	6	0.6	0.131	MP9	3	8	30000	0.309
RF10	100	7	0.3	0.267	MP10	4	8	30000	0.306
RF11	100	7	0.4	0.274	MP11	2	9	30000	0.314

RF12	100	5	0.2	0.265	MP12	4	9	30000	0.309
RF13	200	5	0.4	0.259	MP13	1	10	50000	0.310
RF14	200	6	0.2	0.267	MP14	3	11	50000	0.307
RF15	200	6	0.3	0.264	MP15	4	12	50000	0.306
RF16	200	7	0.2	0.267	MP16	1	8	50000	0.313
RF17	200	7	0.3	0.267	MP17	1	9	50000	0.309
RF18	200	7	0.4	0.277	MP18	2	9	50000	0.313

Fig. 2. Ensemble performance bootstrap replicates for BSS values for the weighted ensemble (left panel), the unweighted ensemble (center panel), and the bias-corrected HSS (right panel). The red line shows the operational baseline BSS value for the SHIPS-RII of 0.13.

While the AI ensemble was initially developed using a 30-kt definition for RI, many RI studies (including those involved with SHIPS-RII) utilize multiple definitions of RI to ascertain performance sensitivity to RI definition. As such, the AI ensemble was also developed using a 25-kt and 35-kt wind speed increase in 24 hours as an RI definition.

For the 25-kt RI definition AI ensemble (Tables 4 and 5), results were slightly improved over the 30-kt results (not with the retraining of the ensemble that new AI members were selected). Interestingly, SVMs performed worst with this definition (SVM ensemble member average HSS of 0.199), while RFs were superior (HSS of 0.328). The mean MP HSS performance was 0.257. This improvement is likely a result of a larger RI sample size due to the weaker definition and has been seen in previous studies.

In line with the results for 25-kt and 30-kt, the 35-kt definition (Tables 6 and 7) showed generally poorer performance than the other two. As was the case with the other definitions, a new selection of AI members was formulated that included more SVMs than the previous two RI definition AI models, and many fewer MP configurations. As was the case with the 25-kt definition, the SVM members performed poorest (mean HSS of 0.063 among its AI ensemble members), while the RFs were considerably better than all other methods (mean HSS of 0.215). MP results fell between the two (HSS of 0.17). The degraded HSS values for all ensemble members resulted in poor (negative) BSS performance, which is below SHIPS-RII performance.

Despite the limited improvement obtained from these approaches, a mature AI ensemble for RI prediction is now fully developed. Task 3 in this year's body of work implemented the AI ensemble on two Atlantic TCs in the 2017 hurricane season, with results provided below.

Table 4. SVM ensemble member configurations and performance statistics for the 25-kt definition.

Member	Kernel	Cost	γ-value	HSS
SVM1	RBF	1	0.01	0.225
SVM2	Poly-1	1	0.05	0.192
SVM3	Poly-1	10	0.05	0.191
SVM4	RBF	10	0.01	0.226
SVM5	Poly-1	100	0.05	0.192
SVM6	RBF	100	0.01	0.199
SVM7	Poly-2	10	0.05	0.197
SVM8	Poly-2	100	0.05	0.170

Table 5. Same as Table 4, but for RFs (left side) and MPs (right side)

Member	Trees	Predictors	Cutoff	HSS	Member	Layers	Nodes	Epochs	HSS
RF1	100	2	0.2	0.318	MP1	4	10	100000	0.308
RF2	300	2	0.2	0.370	MP2	2	11	100000	0.309
RF3	200	2	0.2	0.300	MP3	2	12	100000	0.310
RF4	100	2	0.3	0.276	MP4	1	8	100000	0.308
RF5	100	3	0.2	0.305	MP5	4	8	100000	0.310
RF6	100	4	0.3	0.383	MP6	4	10	30000	0.309
RF7	100	3	0.3	0.362	MP7	1	11	30000	0.310
RF8	300	3	0.2	0.324	MP8	1	12	30000	0.309
RF9	100	8	0.3	0.349	MP9	3	8	30000	0.309
RF10	100	6	0.2	0.305	MP10	4	8	30000	0.306
RF11	100	7	0.3	0.310	MP11	2	9	30000	0.314
RF12	400	3	0.2	0.327	MP12	4	9	30000	0.309

Table 6. SVM ensemble member configurations and performance statistics for the 35-kt definition.

Member	Kernel	Cost	γ-value	HSS
SVM1	Poly-1	1	0.05	0.067
SVM2	RBF	100	0.01	0.104
SVM3	RBF	10	0.01	0.077
SVM4	RBF	1	0.01	0.062
SVM5	Poly-1	10	0.05	0.067
SVM6	Poly-2	100	0.05	0.036
SVM7	Poly-2	1	0.05	0.034
SVM8	Poly-2	10	0.05	0.052
SVM9	Poly-1	100	0.05	0.068

Table 7. Same as Table 6, but for RFs (left side) and MPs (right side)

Member	Trees	Predictors	Cutoff	HSS	Member	Layers	Nodes	Epochs	HSS
RF1	100	2	0.1	0.118	MP1	3	11	100000	0.197

RF2	100	2	0.2	0.239	MP2	3	10	100000	0.159
RF3	100	2	0.3	0.237	MP3	3	13	100000	0.171
RF4	100	3	0.1	0.125	MP4	2	10	100000	0.156
RF5	100	3	0.2	0.228	MP5	3	12	100000	0.152
RF6	100	3	0.3	0.341	MP6	2	13	30000	0.197
RF7	100	4	0.3	0.262	MP7	2	11	30000	0.174
RF8	100	4	0.4	0.237	MP8	2	12	30000	0.152
RF9	100	7	0.1	0.178					
RF10	100	5	0.3	0.268					
RF11	400	2	0.1	0.107					
RF12	200	2	0.3	0.235					

3. To demonstrate the maturity of the method, the AI ensemble was used to predict RI within the recent Hurricane Harvey, specifically for the storm beginning 20 August 2017 at 0000 UTC to 29 August 2017 at 0600 UTC. Fig. 3 shows an RI forecast time series using the 41 member AI ensemble trained on the original GEFS fields with the SHIPS-RII predictors and NHC predictors mentioned previously. Note that RI occurred within Harvey (following the 30-kt in 24-hour definition) beginning at 0000 UTC 24 August 2017 through 0600 UTC 25 August 2017, and the RI ensemble picked up on it well, with an elevated probability as high as 50% during the RI window. One timestep had a notable drop-off in probability, which could likely be improved with further investigation into the issue. Brier skill score values for the Harvey forecast were roughly 0.11, which is in line with the performance being seen by the training database for the AI. It is possible that further feature selection work may improve the AI ensemble as well.

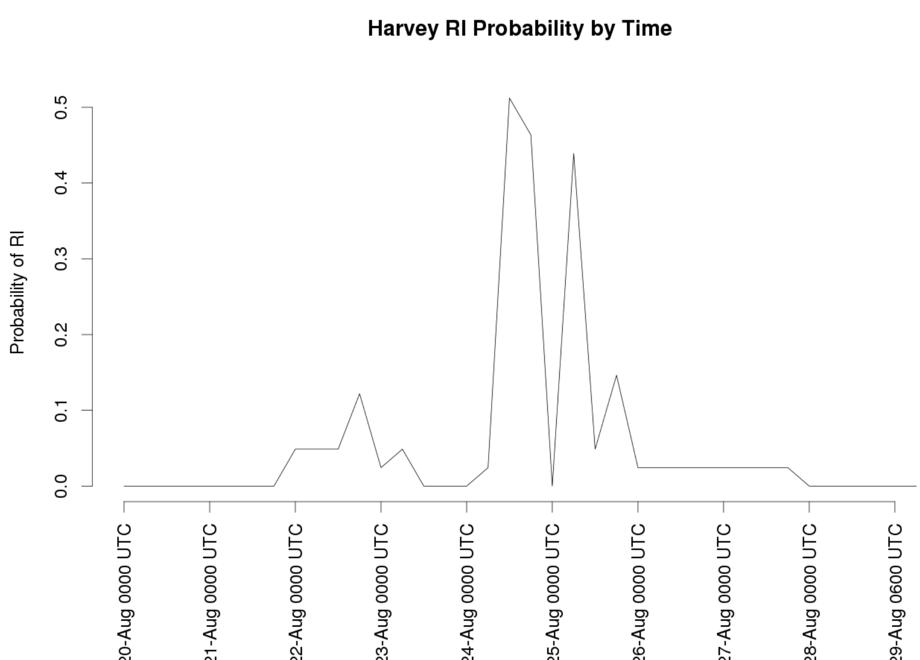


Fig. 3. RI probability for Hurricane Harvey (2017) over the storm's life cycle.

Description of significant research results, protocols developed, and research transitions
As stated above, the last two tasks of the research have been completed, with a thorough, robust cross-validation finalized on a 43-member AI ensemble (for the 30-kt definition) and a test on current 2017 events. Some of the major findings include:

1. Most RI systems seem to be tied to an increase in 300-200 mb zonal wind speeds near the center of the cyclone, particularly in proximity to the TC center.
2. A machine learning ensemble has been developed for RI/non-RI prediction. The ensemble consists of 43 different AI methods/configurations, each of which were assessed for individual performance. Of those performance measures,
    a. Multilayer perceptrons provided very consistent RI skill, though the exact cases which were forecast RI/non-RI were unique between the different members, such that they each contribute unique skill to the model.
    b. SVMs seemed to do the best job overall in terms of HSS, though their performance is in line with the MP performance and generally exceeded the RF performance.
    c. RFs had lower performance than the other two methods, and that 200 or higher trees grown seemed to do the best job in distinguishing RI/non-RI events (among the RI members).
3. A blended ensemble forecast was produced that used two primary methods:
    a. Unweighted predictions from each member were summed and that sum was divided by all members to yield a probability estimate
    b. Weighted predictions (based on individual member HSS performance) were obtained as well, though the performance improvements offered were not enough to warrant further exploration of this method.
4. Overall, RI/non-RI predictive skill from the AI ensemble remained in-line with current SHIPS-RII implementations, though some resampled training/testing sets provided boosted BSS values in excess of 0.35.
5. As seen in previous work, improvements in forecast skill were seen with weaker definitions of RI, while the strongest tested definition (35-kt) showed considerably poorer skill than the current operational 30-kt definition.
6. Implementation of the method on Hurricane Harvey demonstrates the methods readiness to begin transitioning into an operational forecast product, and also reveals areas where additional improvement will likely aid in predictive performance.

Collaborator information
This proposal was developed under the general advisement of AOML. Roughly quarterly progress reports were submitted to AOML personnel, including the director and John Kaplan.

Outreach information:
None

NGI File # 14-NGI2-74

Project Title: Occurrence and Accumulation of Marine Debris on Barrier Islands in the Northern Gulf of Mexico

Project Lead (PI) name, affiliation, email address: Caitlin Wessel, Dauphin Island Sea Lab, University of South Alabama, cwessel@disl.org

Co-PI(s) name, affiliation, email address: Just Cebrian, Dauphin Island Sea Lab, University of South Alabama, jcebrian@disl.org

NOAA sponsor and NOAA office of primary technical contact: Kim Albins, NOS

Award Amount: $44,082

Project objectives and goals

The overall goal of this research was to expand on current NOAA Marine Debris Shoreline Monitoring Programs by exploring seasonal and spatial trends in the occurrence, type, and accumulation rates of marine debris on barrier islands in the Northern Gulf of Mexico.

Specifically, the following questions were investigated:

1.) What are the major types and possible sources (land or ocean based) of shoreline debris?

2.) Does the rate of deposition of debris onto the shoreline show seasonal oscillations?

3.) How does debris deposition change from the west (Chandeleur Islands) to the east (Santa Rosa Island) of the Northern Gulf of Mexico?

4.) What are the possible causes of the temporal and spatial trends found (e.g. rainfall and runoff, human population, boat traffic)?

5.) What are potential, mitigation measures based on monitoring results (i.e. source reduction, clean-ups)?

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

Shoreline marine debris monitoring occurred for 9 monthly periods during this reporting period for a total over the 3 reporting periods of 24 months of continuous sampling and 26, 28 day sampling periods over that time period.

Month 1- June 24-July 1
Month 2- July 23-28
Month 3- Aug 19-24
Month 4- Sept 18-23
Month 5- Oct 14-18
Month 6- Nov 13-17
Month 7- Dec 11-15
Month 8- Jan 7-13
Month 9- Feb 5-10

Milestones

January 2015	Study site selection and preliminary analysis (i.e. power analysis to determine sample size, methods training, equipment construction)	Completed
February 2015 – January 2017	Monthly Debris Accumulation Surveys (weather dependent), Data Processing, Analysis	Completed
February 2017	Manuscript(s), Report(s)	In progress*

*****we anticipate 2 manuscripts which we hope will be submitted for publication by Dec 2017

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

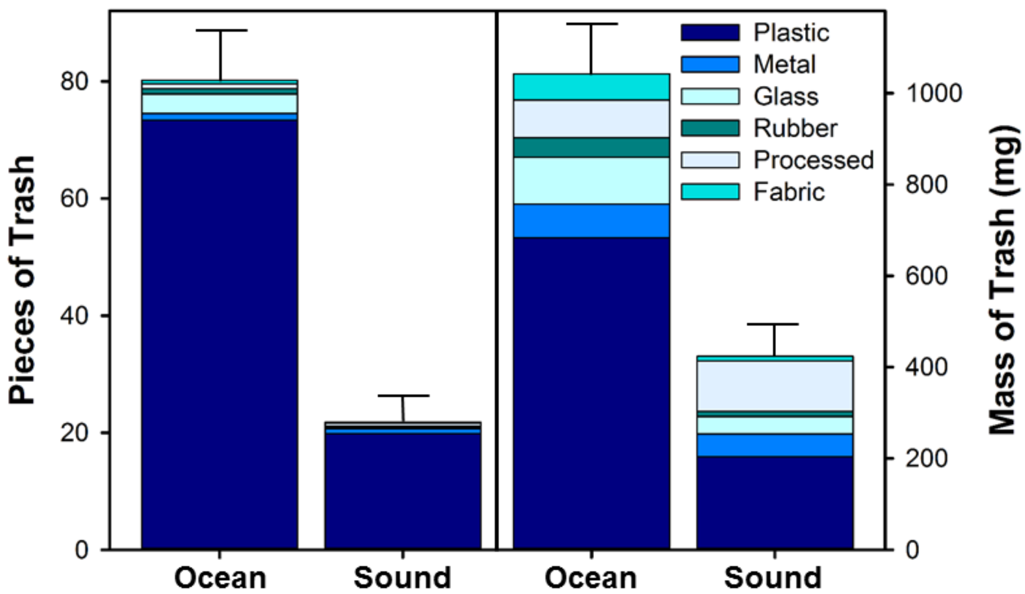
Protocols-

Once every 28 days (+/- 3) we went out to each of six barrier islands which have three 100 meter transects on the ocean side and three on the sound side and collected all man-made debris from the waterline to the dunes. All collected debris was identified and photographed, then the mass was recorded by category and disposed of properly.

Results-

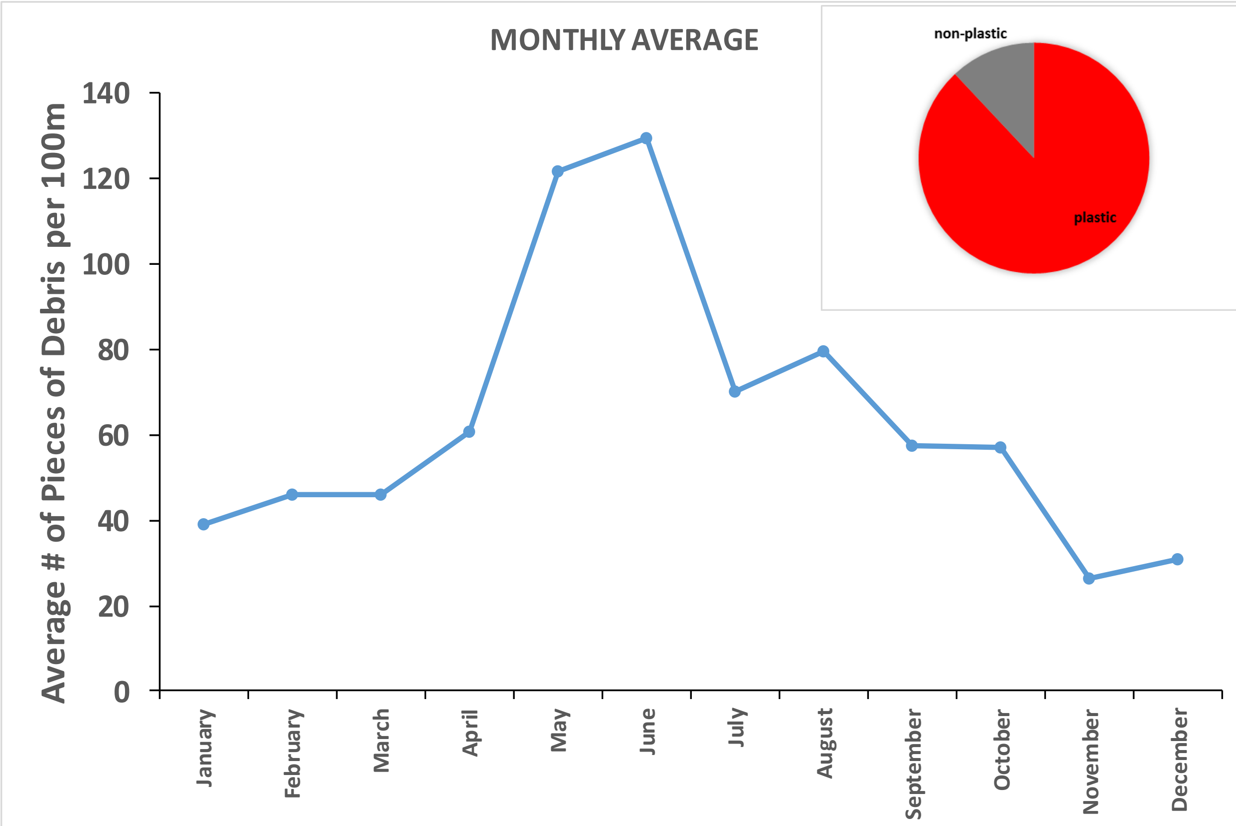
We completed two years of sampling for this two-year project, which included an initial cleanup in Feb. 2015 followed by 26 monitoring cleanups, which occurred every 28 days (+/- 3). Results show that more litter is consistently washing up on the ocean side than the sound side of the barrier islands and that there is a large jump (> 2x) in the number of pieces of plastic debris collected in April/May with the start of tourist season, this increasing trend continues through October. Approximately 88% of the marine debris collected across all locations (combining ocean and sound sides) was made of plastic.

Average of Single use plastics %	28.89
Average of fishing items %	5.98
Average of personal care products %	0.80
Average of plastic other %	1.14
Average of All fragments %	56.92
Average of Everything Else %	5.47



Average ocean side pieces collected:	86.74
Average ocean side weight collected (mg):	1115.80
Average sound side pieces collected:	23.34

North-central Gulf



Related NOAA Strategic Goals: Resilient Coastal Communities and Economies

Related NOAA Enterprise Objectives: Science and Technology

NGI File # 14-NGI2-79

Project Title: Increasing Our Understanding of the Interaction Between Physical and Ecological Processes in the Gulf of Mexico and Caribbean

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

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

Award Amount: $223,662

Project objectives and goals
The goal of this project is to understand physical mechanisms impacting for larval transport and other ecological processes important to fisheries in the northeastern Gulf of Mexico. Further, this project has the goal of training students in using physical and biophysical modeling to conduct research of ecological importance. Specific objectives include: development and application of circulation models of the Gulf of Mexico and the northeastern Gulf of Mexico, application of individual-based models (IBMs, or larval transport models) to simulate potential larval dispersal pathways for regionally important fish, and analysis of circulation processes relevant to regional ecosystems.

Description of research conducted during the reporting period and milestones accomplished and/or completed
During this reporting time period, doctoral student Taylor Shropshire worked with Dr. Steve Morey (FSU) and NOAA researchers Dr. Mandy Karnauskas (SEFSC) and Dr. Sang-Ki Lee (AOML) developing a biophysical modeling system for the Gulf of Mexico to be applied for simulating and understanding causes of variability of prey for fish larvae, and consequences for larval mortality and recruitment. A biogeochemical model that simulates zooplankton (a proxy for fish larvae prey) concentration was developed and coupled to the HYCOM circulation model using the MITgcm offline tracer advection module. During the summer of 2016, Mr. Shropshire was in residence at the NOAA laboratories in Miami working on the experimental design and synthesizing the data necessary to conduct the biophysical modeling. The result of this summer's work is a foundation for the student's Ph.D. research.

Description of significant research results, protocols developed, and research transitions
Over the duration of the entire project, three graduate students have been supported. Austin Todd completed his Ph.D. in 2013, with a thesis entitled "Circulation Dynamics and Larval Transport Mechanisms in the Florida Big Bend". Thanh Tam Nguyen completed her M.S. in 2014 with a thesis entitled "Variability of Cross-Slope Flow in the DeSoto Canyon Region". Finally, this project supported Ph.D. student Taylor Shropshire, who is continuing his research on the impacts of oceanographic variability on prey availability and larval mortality of Gulf of Mexico fishes in collaboration with AOML and SEFSC researchers.

Circulation and Larval Transport in the Florida Big Bend Region

The Big Bend region (BBR) of Florida in the northeastern Gulf of Mexico (NEGOM) exists at the juncture of the Florida Peninsula and the Florida Panhandle, and where the coastline orientation changes by roughly 90° (*Weatherly and Thistle*, 1997). The BBR contains both spawning sites and nursery habitats for many key species of the region, and has thus been studied as a source habitat for fisheries production. The physical oceanographic state can largely impact the egg and larval stages of reef fish development by setting dispersion patterns of their egg and early-stage (pre-settlement) larvae. This study uses the gag grouper (*Mycteroperca microlepis*) as a representative for the plethora of reef fish species in the BBR. Adult gag spawn on offshore reefs along the continental shelf break each spring (February - April), with pelagic larvae settling as juveniles in seagrass habitats along the coast 30-60 days later. The physical mechanisms responsible for this onshore larval transport remain unknown. This work investigated the contribution of physical transport mechanisms to variations in population size of gag larvae, using a high-resolution numerical ocean model, and explained the dynamics relevant to the onshore circulation processes.

A high-resolution (800-900m) simulation of the northern West Florida Shelf was developed based on ROMS (Regional Ocean Modeling System). The model was run as a hindcast over the period 2004-2010. The model simulation demonstrates that the mean springtime shelf circulation patterns are set primarily by flow during periods of southeastward or northwestward wind stress, and that significant cross-shelf flow is generated during southeastward winds. Lagrangian particle tracking experiments demonstrate that a primary pathway exists south of Apalachicola Bay by which simulated larvae are able to reach inshore nursery habitat. Significantly more particles arrive inshore when they originate from an area adjacent to a known gag spawning aggregation site (Figure 1). The results provide a description of the pathways by which onshore transport is possible from gag spawning sites at the shelf break to seagrass nurseries at the coast in the Florida Big Bend, and the interannual variability of onshore transport. The analysis also yields clues to possible reasons for preferred spawning sites by regional gag populations.

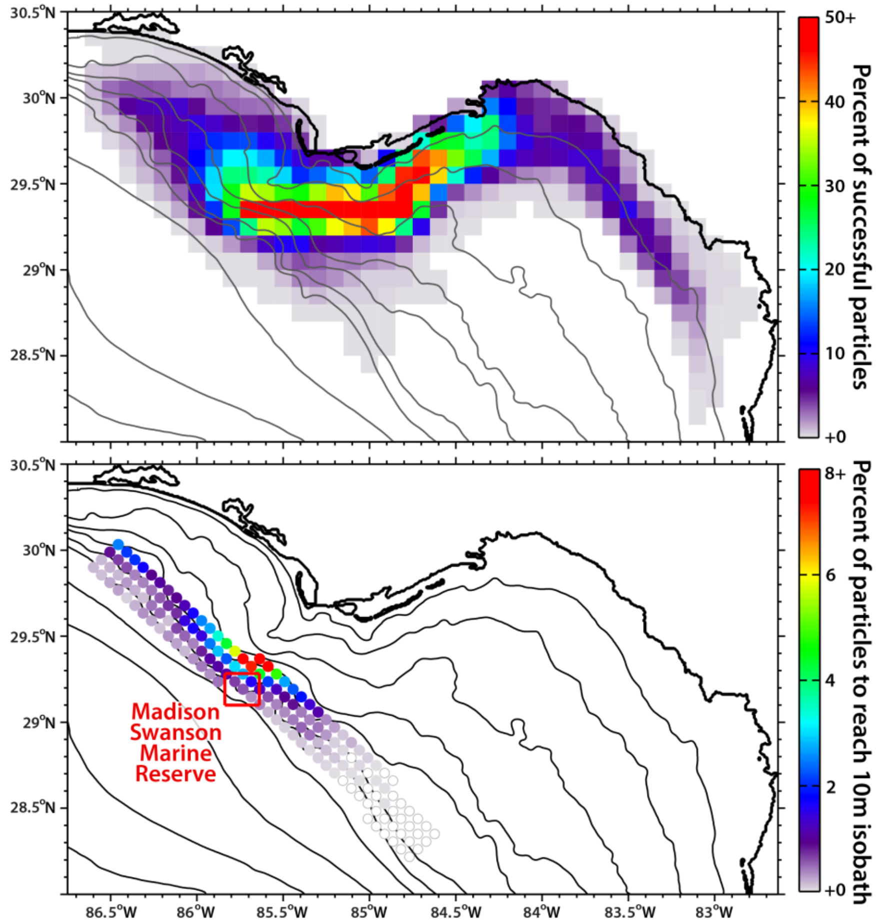


Figure 1: (top) Density of all simulated larvae that reach the 10m isobath during their advection period and (bottom) the origins of those that successfully reached the 10m isobath during their pelagic duration. Colors represent the percentage of successful larvae originating from that location.

Cross-Slope Near-Bottom Flow in the DeSoto Canyon Region

The De Soto Canyon in the northeastern Gulf of Mexico is an important area for oil and gas exploration, commercial and recreational fisheries, and maritime services. The proximity of deep water to the coast at De Soto Canyon suggests that the bathymetry here may be favorable for exchange of waters between the deep ocean and shelf. Cross-slope benthic flow and associated upwelling and downwelling in this region are of critical importance for governing the shelf water properties that can dramatically impact local marine ecosystems. A study of the variability and mechanisms for this cross-slope flow was conducted using a multi-decadal (54-year) free-running 1/25° Gulf of Mexico HYCOM (HYbrid Coordinate Ocean Model) simulation. Results of the analysis show that across the continental slope, a positive sea surface height (SSH) anomaly and corresponding large-scale depression and offshore movement of isopycnals (downwelling) occur more frequently when the Loop Current impinges upon the West Florida Shelf slope further south. Upwelling and onshore movement of isopycnals occurs with roughly the same likelihood regardless of Loop Current impingement on the slope. The remote influence of Loop Current on the De Soto Canyon region downwelling is a consequence of a high pressure anomaly that extends along the continental slope emanating from the location of Loop Current impact (Figure 2).

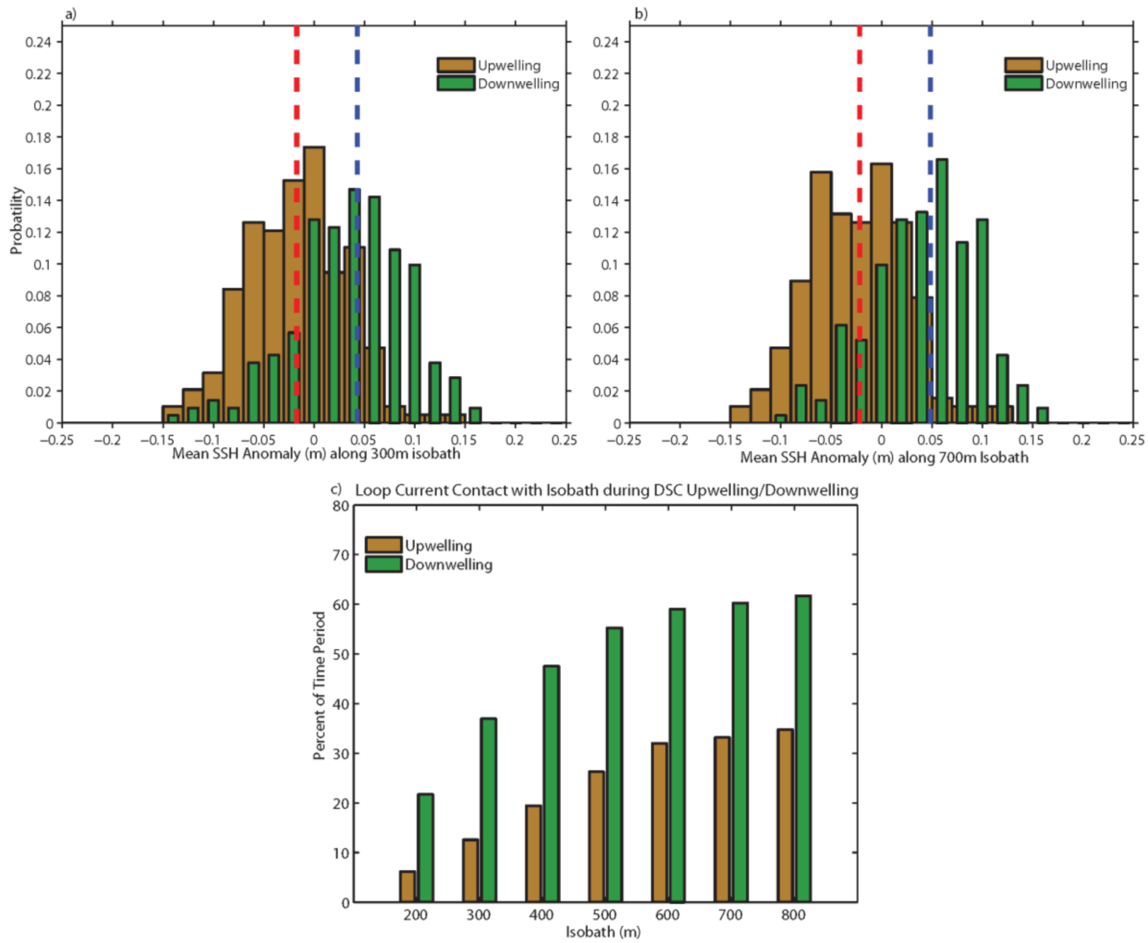


Figure 2. (a-b) Normalized histograms of SSH anomaly along the (a) 300m and (b) 700m isobaths between latitudes 24.5°N and 27.7°N during time periods of large-scale De Soto Canyon upwelling (green) and downwelling (orange). The median SSH anomalies along these isobaths segments during upwelling and downwelling events are shown with the red and blue lines, respectively. (c) Percent of time period of Loop Current contact with isobaths (indicated along the abscissa) along the West Florida Shelf slope south 27.7°N during which large-scale De Soto Canyon upwelling (green) and downwelling (orange) events occurs. Green and orange horizontal lines indicate the percent of the total 54-year model time period during which upwelling and downwelling occurs.

Biophysical Modeling of Food Availability and Impact to Fish Larvae Mortality in the Gulf of Mexico

The final student project supported under this grant is the development of a biophysical modeling system for the Gulf of Mexico to be applied for simulating and understanding causes of variability of prey for fish larvae, and consequences for larval mortality and recruitment. Under this funding, a biogeochemical model that simulates zooplankton (a proxy for fish larvae prey) concentration was developed and coupled to the HYCOM circulation model. Through collaboration with NOAA scientists at AOML and SEFSC, an experimental design for this Ph.D. work of a recently enrolled graduate student was developed. This work will continue as the student's Ph.D. dissertation research.

Information on collaborators/partners

Dr. Sang-Ki Lee (NOAA-AOML) and Dr. Mandy Karnauskas (NOAA-SEFSC) collaborated with a graduate student supported on this project, Taylor Shropshire. They provided guidance on refinement of the research project objectives, including selection of key study species, development of hypotheses, and design of numerical experiments to test the hypotheses. Mr. Shropshire spent two months during the summer of 2016 in residence at the NOAA labs in Miami collaborating with these and other scientists.

Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology

NGI File # 14-NGI2-83

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

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

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

Award Amount: $188,042

Project objectives and goals
Pursuant to NOAA's strategic goal of maintaining critical support for NOAA's mission (e.g. science and technology enterprise), this project serves primarily in the continued development of geospatial data visualization and access capabilities for the large and diverse collection of scientific data and information resulting from NOAA-sponsored ocean exploration expeditions. Currently, exploration data from the Ocean Exploration and Research (OER) program is passed from ship to shore through the National Centers for Environmental Information (NCEI) Stennis office (formerly the NODC/NCDDC), where documentation and meta/data archive preparations are completed. NCEI provides a GIS infrastructure, but continual upgrades to ESRI ArcServer technology require efforts to maintain capacity for state-of-the-art integrated data visualization and access to OER data through the Federal Enterprise Architecture. Of course, geospatial database design, geospatial visualization tools, and meta/data products must be operational on NOAA systems.

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

Description of research conducted during the reporting period and milestones accomplished and/or completed
Goal 1: Assess the exploration geospatial data collection and plan a new strategic approach to managing these data collections.

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

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

Progress: COMPLETED; no new tasks assigned beyond 30 Jun 2016 of the previous reporting year (details provided in 2016 NGI/NOAA Annual Report #14-NGI2-83).

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

Progress: COMPLETED; no new tasks assigned beyond 30 Jun 2016 of the previous reporting year (details provided in 2016 NGI/NOAA Annual Report #14-NGI2-83).

Milestones: Goals 1-3 were accomplished in previous reporting years (Goal 1 in 2013; Goals 2-3 were on-going until 2016). For the current reporting period (01 Jul 2016 – 30 Sep 2016), no new tasks for Goals 2-3 of NOAA GIS workflow were assigned beyond 30 Jun 2016 of the previous reporting year (details provided in 2016 NGI/NOAA Annual Report #14-NGI2-83).

Progress: ALL MILESTONES MET by project termination.

Description of significant results, protocols developed, and research transitions

Expanded GIS-based Storymap Functionality and Product Availability

Developed in-house ESRI ArcGIS Story Map protocols for NOAA, using existing and future data products, to streamline the development of new, user-based multimedia data exploration tools to broaden the availability, appeal, and engagement of GIS-based data in visual communication of information. Created and currently maintain a live Hurricane Katrina Storymap, featured by ESRI in the Living Atlas of the World (http://doc.arcgis.com/en/livingatlas/#s=0&subCat=0&type=All&area=All&q=katrina).

Shiptrack and ROVtrack Thinning

Protocols include working within the Integrated Products Team (IPT) to continually update NOAA's Okeanos Atlas, an interactive, geospatial application that provides access to data information corresponding to exploration missions conducted aboard the R/V Okeanos Explorer (OKEX). Typically, these protocols involve Google map overlays which are created from a geotif using bathymetric (multibeam) and CTD data products collected from OKEX missions (accomplished using ArcMap to create a .png product). It is a cumulative product, where the geotif being overlaid is updated manually every day during a cruise and added to the map (i.e. Okeanos Atlas). Standard protocols also include working with the chief programmer to write a Standard Operating Procedure (SOP) for thinning raw SCS ship track navigation data. This procedure produces a thinned ship track using Keyhole Markup Language (.kml) for visualization in Google Earth™., as well as shapefiles (.shp) for visualization on ESRI®-supported *Digital Atlas*.

This process requires a python script to reduce data points along a ship or ROV cruise track, which greatly reduces the .kml and .shp file sizes. The algorithm creates two sets of thinned shiptrack products (.kml and .shp) and a text file (.txt) from the Scientific Computer System (SCS) aboard the *Okeanos Explorer*, which includes the Dynamic Digital Global Navigation System precise-point positioning system by C&C Technologies (CNAV) and the Position and Orientation System for Marine Vessels (POS/MV), a set of high resolution, 6-second thinned shiptrack (or ROV) products and a set of Ramer-Douglas-Peucker thinned products. These products are then written to GIS folders assigned to the respective expedition using a Python script and then integrated into a map layer in the *Digital Atlas.*

CTD Data Processing + ROV Product QA/QC

Performed comprehensive QA/QC for data products associated with ROV operations. Additionally, provided regular CYD data processing support for manned NOAA vessels. Routine conductivity, temperature, and depth (CTD) data, collected from *Okeanos Explorer* missions (vessel and submersible) require daily processing for meta/data product delivery and archival. After processing these data, map products (*i.e.* shapefiles and CTD plot graphics) are generated for display on the *Okeanos Explorer Atlas* in near real-time. This task requires routine download and processing of available raw CTD files using Sea-Bird Electronics SBE Data Processing software, and the user must then initiate a Python script to thin the CTD data and to generate the map products. Once the processing is complete, vessel and submersible CTD data are pushed to a server to provide daily updates while *the Okeanos Explorer* conducts its mission. After mission completion, associated data are made accessible for download through the *Digital Atlas*. These tasks are required for every *Okeanus Explorer* deployment.

<u>Digital Atlas Reachback</u>
In support of on-going NCEI data management and accessibility issues, regular participation in data management meetings is necessary for the development of protocols that identify data gaps in the ever-evolving *Digital Atlas*. This “Reachback Campaign” requires regular re-examination of metadata records dating back to 2001, mining online data portals for information to fill in these data gaps, and reaching out to expedition principal investigators and participants for meta/data and publications relevant to the respective projects. Once the meta/data products and publication information are received, they are stored in an in-house server made accessible through the *Digital Atlas*. Significant accomplishments in Reachback campaign include:

- Collection and archival of 148 cruise-related publications
- Collection and archival of 84.89 GB mission-related data products
- Collection and digital conversion of 38 miniDV’s of mission data, dive logs, and imagery
- Collection and archival of documents, metadata, and virtual 3D model from 7 major cruises

Information on outreach activities
Public engagement in the *Okeanos Explorer* (and larger NOAA) missions is augmented through the use of mission-related storymaps, created using ArcGIS Online®, a free online mapping interface offered by ESRI. This proof-of-concept project was initiated in the current evaluation year and utilized a poster produced by a previous *Okeanos Explorer* intern who highlighted the technical aspects of locating and mapping gaseous seeps in the Gulf of Mexico. Using a template provided by ArcGIS Online, this storymap, entitled *Seep Mapping: Using NOAA Ship Okeanos Explorer Data to Visualize the Physical Environments of Seeps in the Gulf of Mexico,* provides an overview of how the *Okeanos Explorer* conducts seafloor exploration and mapping, the importance of gaseous seeps, and how these seeps are detected remotely from the ship. The storymap integrates ESRI’s online interactive mapping tools with the ability to embed high-definition videos and images, which can be geographically referenced. While this project focused primarily on the capacity for using online storymaps as a vehicle for education and scientific outreach, the project also utilized various aspects of geospatial data visualization that included generating maps and converting raw geospatial data for visualization, video editing, image enhancement, and working closely with GIS experts and education specialists to generate a compelling story for public engagement. Moreover, the storymap project was the center’s first experience using this technology and demonstrated its capability to serve as an effective tool for education and outreach for NOAA’s OER-supported missions. See above for more information specific to Storymapping products.

Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology

NGI File # 15-NGI2-105

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: $417,876

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 Fig. 2). Three years ago we improved the physics and can produce the winds poleward of 15°; however, that general approach was found to be 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

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

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 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.

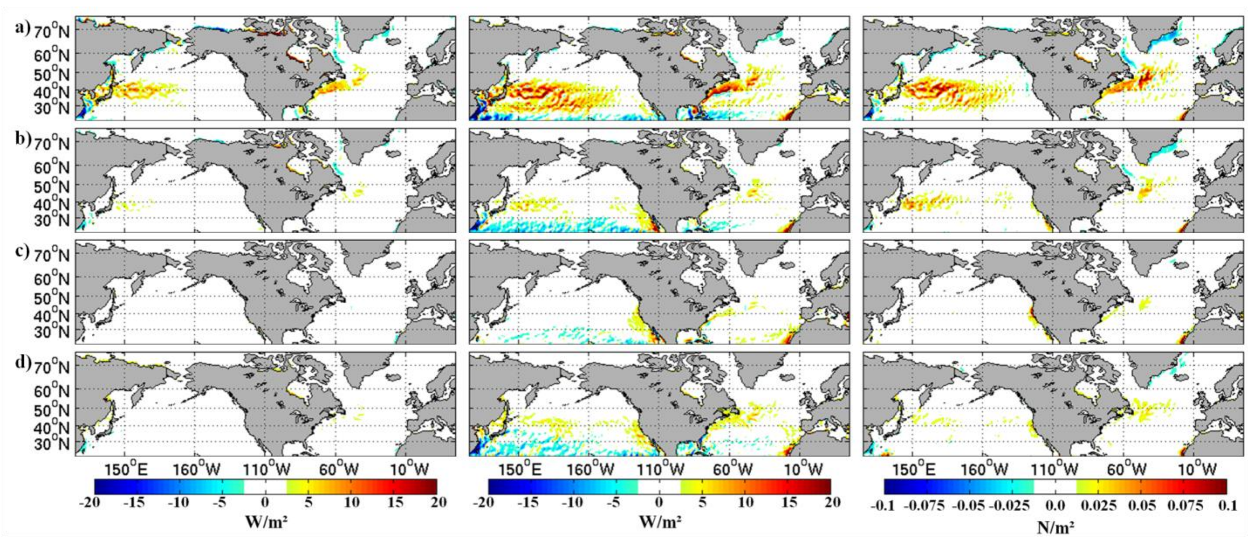


Figure 2. Seasonal biases in sensible heat flux (left), latent heat flux (center) and stress (right). From top to bottom seasons are winter, spring, summer and fall. On daily or six-hourly time scales the changes can by roughly a factor of ten greater.

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 3. 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 $18ms^{-1}$ 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 $3ms^{-1}$) 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 $2.51ms^{-1}$, $2.42ms^{-1}$ and $2.46ms^{-1}$, 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.”

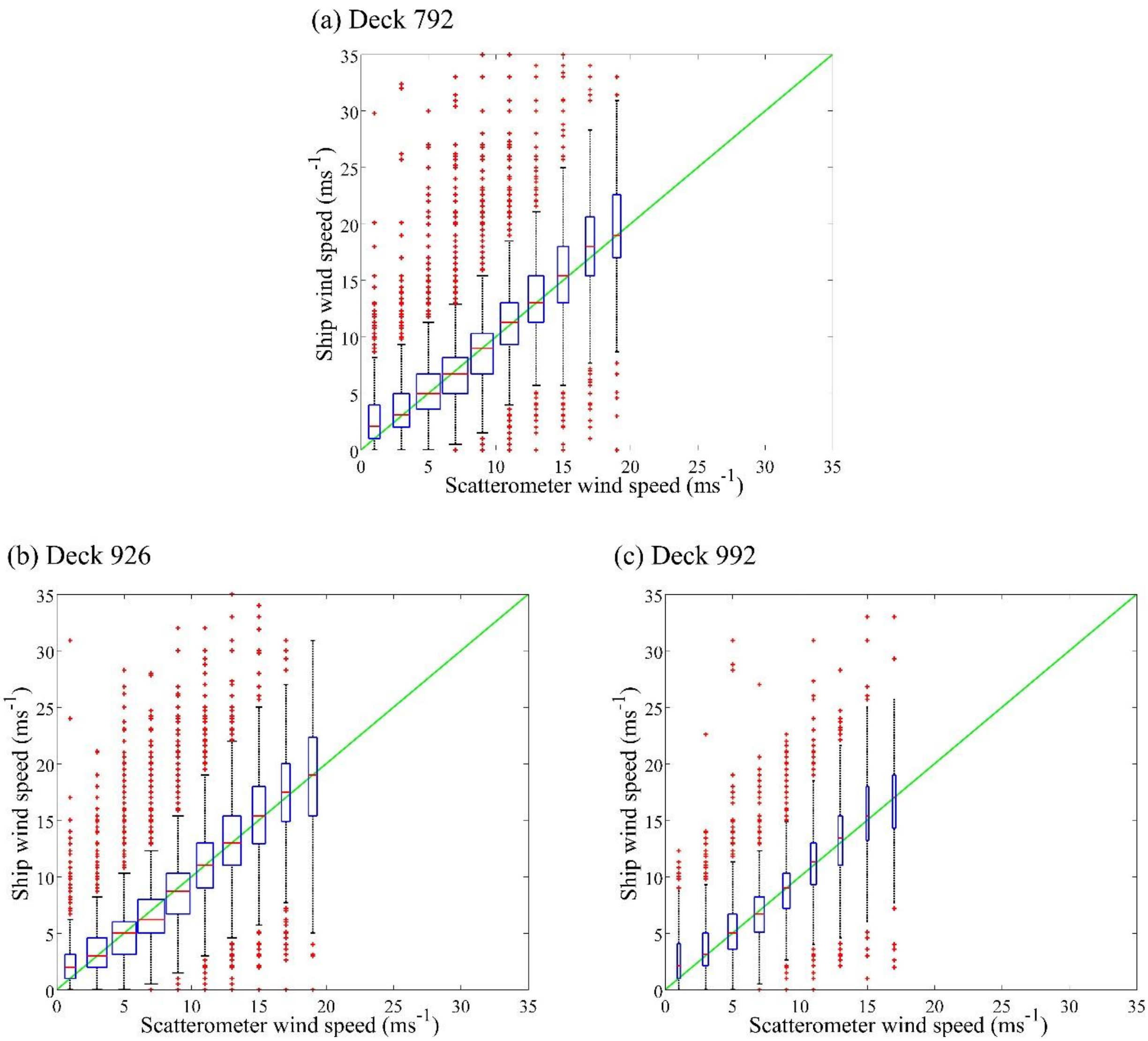


Figure 3. The boxplots for the three different decks (a) 792, (b) 926 and (c) 992. Each one of the whisker boxes is associated with the number of data points in a range of $2ms^{-1}$ of scatterometer wind speed (only for those bins contain 100 more collocated pairs). The width of each whisker box is 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:

<u>Visual ship wind calibration collaboration</u>

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 # 15-NGI2-108

Project Title: Analysis of Fisheries Acoustic Data

Project Lead (PI): Steve Ashby, NGI, sashby@ngi.msstate.edu

Co-PI: Valerie Samedy, NGI, valerie@ngi.msstate.edu

NOAA sponsor and NOAA office of primary technical contact: Chris Gledhill, NMFS (Pascagoula Laboratory) christopher.t.gledhill@noaa.gov

Award Amount: $253,094.00

Project objectives and goals

The National Marine Fisheries Service (NMFS), Pascagoula Laboratory, collect fisheries acoustics data throughout the water column at numerous sites in the Gulf of Mexico. Data are collected with a Simrad EK60 split-beam echosounder and analyzed using Myraix Echoview software. The objectives of the work include:

1. Determine scattering strength summaries (as layer strengths (sv/m^2)) for the planned GOM ATLANTIS model regions and layers with data segregated by sounder frequency, and day/night. Ensure that all non-biological echoes such as surface clutter, false bottoms, and CTD profiles, as well as acoustic interference, are marked for non-inclusion.

2. Explore relationships between the available acoustic data (scattering layers, schools, and single targets), species and biomass caught (deep bottom trawl survey data), bathymetry, and location in the Gulf (shelf-slope, deep abyssal, TX to FL).

3. Explore frequency relationships on a ping-by- ping-by-layer basis, searching for regions with good potential for frequency dependent classification of species-biomass categories.

4. Explore the utility of the EK60 single target TS determinations for fish echoes in regions of good single target resolution, for example, in regions of dispersed schools at night or echoes from deep pelagic single echoes.

5. Provide preliminary biomass estimates and recommendations on specific target species and regions that may be amenable to further analysis as single stocks or multispecies aggregations. For example, a determination of Gulf-wide and regional biomass of the shelf-slope edge mesopelagic boundary community from TX to FL. Or the notable schools occurring on the TX shelf and likewise on the West FL shelf.

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

Data processing continued until December of 2016 when Dr. Samedy accepted another position. A draft report describing the data processing methodology was prepared.

Information on collaborators/partners

N/A

Information on any outreach activities

Dr. Samedy prepared a draft technical report to explain the processing and the inventory of fisheries acoustics data from NMFS surveys in the Gulf of Mexico (2010-2015). This report is being finalized by NOAA NMFS personnel.

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

Related NOAA Enterprise Objectives: Science and Technology

NGI File # 15-NGI2-110

Project title: Improving ATMS SDR Data Quality for Weather and Climate Studies

Project Lead (PI) name, affiliation, email address: Xiaolei Zou, University of Maryland, xzou1@umd.edu

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

Award Amount: $478,875

Project objectives and goals

In order to accurately achieve quality weather forecasts and to extract climate signals and climate change from satellite data, which remains to be an extremely challenging task, this project focuses on works related to an in-orbit monitoring of satellite-measured radiances, such as characterization of ATMS SDR data quality, cross-calibration of MSU, AMSU-A and ATMS SDR, and satellite-derived global and regional climate trends in physical space. This is a key component to the success of satellite mission. It requires a series of comparisons between satellites operated by different operating agencies such as NOAA and EUMETSAT.

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

- Assessing impacts of satellite orbital drift and inter-satellite biases on AMSU-A derived climate trend from NOAA-15, -18, -19 and MetOp-A using diurnal correction and double differencing methods
- Developing ATMS de-striping optimal filters for ATMS surface-sensitive channels

Description of significant results, protocols developed, and research transitions

- Assessing impacts of satellite orbital drift and inter-satellite biases on AMSU-A derived climate trend from NOAA-15, -18, -19 and MetOp-A using diurnal correction and double differencing methods

Measurements of brightness temperatures from Advanced Microwave Sounding Unit-A (AMSU-A) temperature sounding instruments onboard NOAA polar-orbiting Operational Satellites (POES) have been extensively used for studying atmospheric temperature trends over the past several decades. Inter-sensor biases, orbital drifts and diurnal variations of atmospheric and surface temperatures must be considered before using the merged long-term time series of AMSU-A measurements from NOAA-15, -18, -19 and MetOp-A. We study the impacts of the orbital drift and orbital differences of local equator crossing times (LECTs) on temperature trends derivable from AMSU-A using near-nadir observations from NOAA-15, NOAA-18, NOAA-19, and MetOp-A during 1998 - 2014 over the Amazon rainforest. The double difference method is firstly applied to estimation of inter-sensor biases between any two satellites during their overlapping time period. The inter-calibrated observations are then used to generate a monthly mean diurnal cycle of brightness temperature for each AMSU-A channel. A diurnal correction is finally applied each channel to obtain AMSU-A data valid at the same local time. Impacts of the inter-sensor bias correction and diurnal correction on the AMSU-A derived long-term atmospheric temperature trends are separately quantified and compared with those derived from original data.

A journal publication is completed:

Chen, H., X. Zou and Z. Qin, 2017: Effects of diurnal adjustment on biases and trends derived from inter-sensor calibrated AMSU-A data. *Frontier of Earth Sci*., (revised)

- ATMS striping noise mitigation for surface-sensitive channels

The S-NPP ATMS upper air temperature sounding channels display a clear across-track striping noise in the NWP O-B fields. The striping magnitude variation is much more significant in ATMS along-track directions. Such a striping feature is also visible at brightness temperature fields at all 22 channels during an ATMS on-orbit pitch maneuver period. An algorithm was developed earlier by combining a principal component analysis (PCA) and ensemble empirical mode Decomposition (EEMD) and worked well for reducing the striping noise at ATMS upper air temperature sounding channels. However, at ATMS window channels (channels 1 and 2), artefacts were generated in the destriped observations at places where ATMS scanlines are aligned with either coastlines curves or the edges of deep clouds. They are caused by the along-track sharp gradients of brightness temperatures at window channels when ATMS earth scenes change from ocean to land or clear-sky to deep clouds and vice versa. Thus, an additional step is added to the PCA/EEMD method to eliminate such impacts. The modified de-striping method performs well for reducing the striping noise at ATMS window channels without introducing the artefacts to the de-striped brightness temperature fields.

A journal publication is completed:

Zou, X., H. Dong and Z. Qin, 2017: Striping noise reduction at ATMS window channels using a modified destriping algorithm. *Quart. J. Roy. Meteor. Soc*., (accepted)

Information on outreach activities

a. Type: Speaker
b. Name of event: The 2016 STAR JPSS Annual Science Team Meeting
c. Date: August 8 – 12, 2016
d. Location: NOAA Center for Weather and Climate Predictions, College Park, Maryland
e. Description: An oral presentation entitled, “Re-evaluation of Suomi NPP ATMS Destriping Algorithm for Surface-Sensitive Channels”
f. Approximate number of participants: Approximately 150

Related NOAA Strategic Goals: Weather-Ready Nation

Related NOAA Enterprise Objectives: Science and Technology

NGI File # 15-NGI2-111

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

Project Lead (PI) name, affiliation, email address: Robert Arnone, 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: $1,028,695

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 which is to be launched in 2018 and 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's 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.

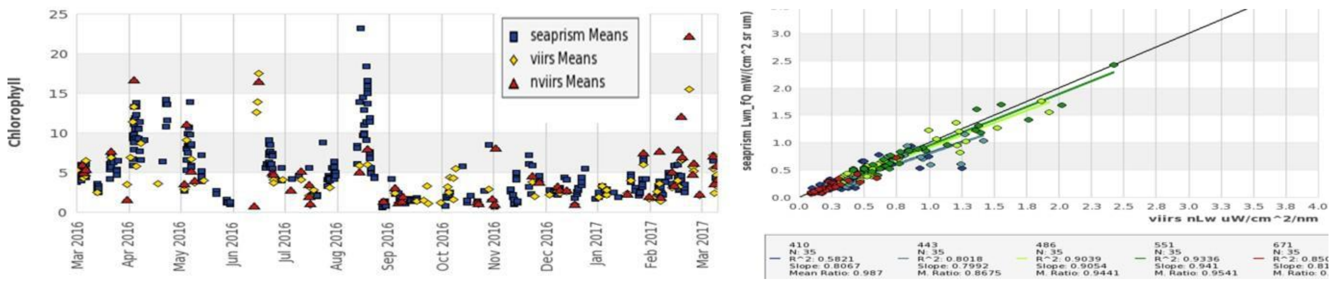
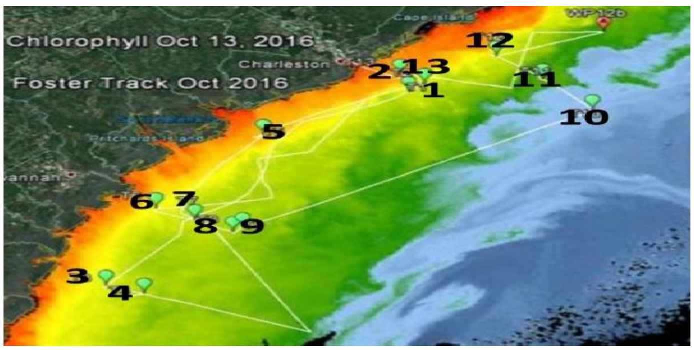


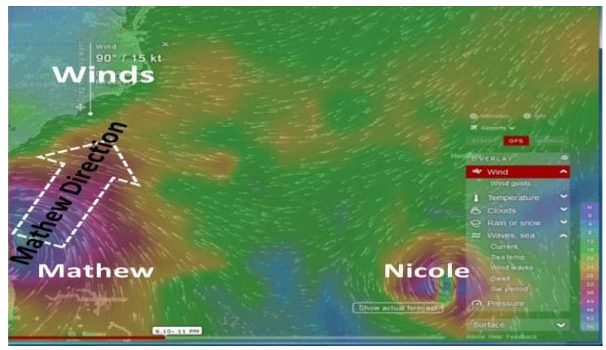
Figure 25 – A) WavCis data used for validation of the VIIRS satellite from Mar 2016 to Mar 2017. The product is derived chlorophyll from WavCIS (blue) and the processing from NOAA MSL12 (Red) +--and the Navy APS (Yellow) processing. B) Matchup of the 5 spectral channels from the VIIRS satellite with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

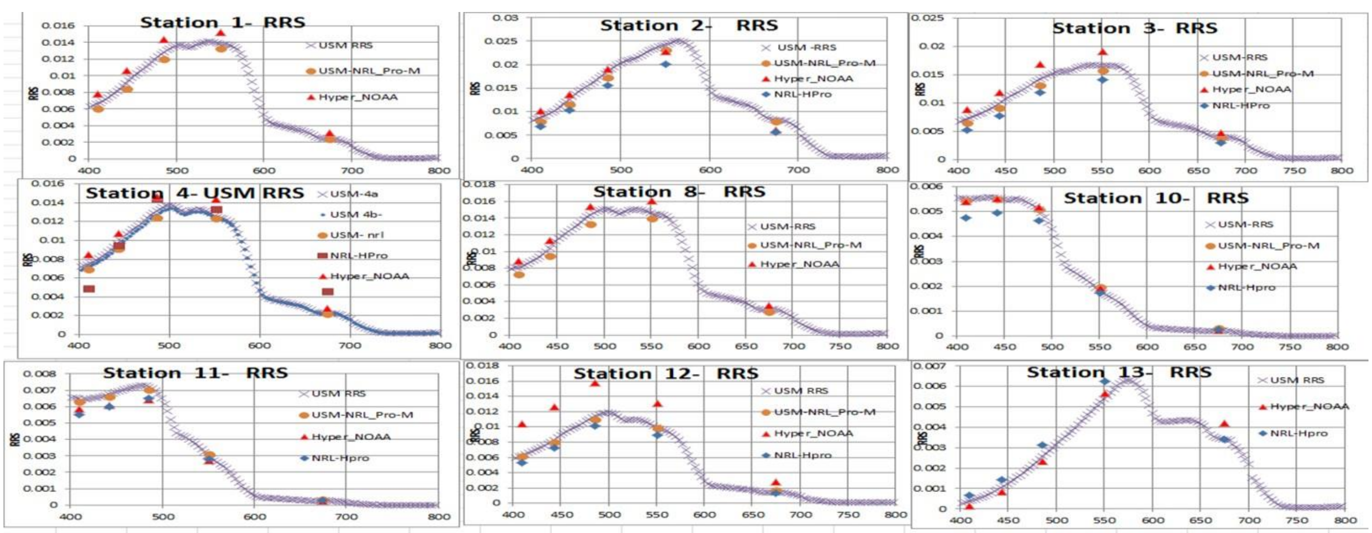


Figure 27.The *Rrs* for the USM and NRL floating Hyperpros with the NOAA profiling Hyperpro for the 9 coincident stations. Note that there is an issue with the NOAA profiling Hyperpro for station 12 and it

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.

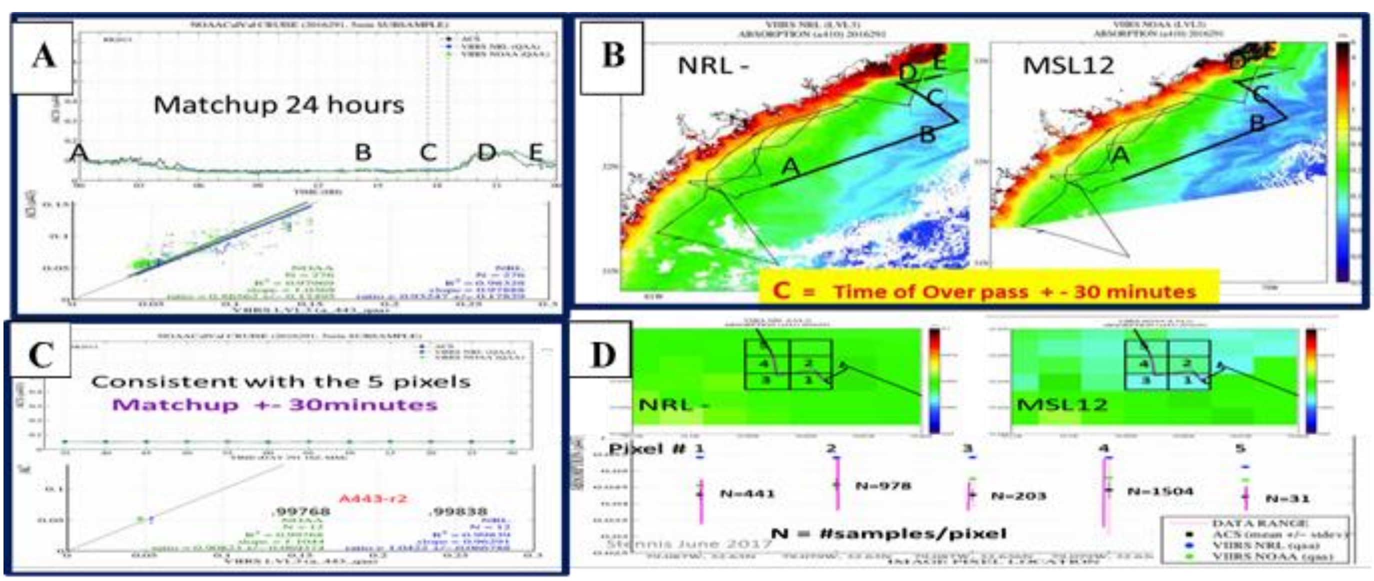
Figure 28- Day 291 –Matchup Flowthrough IOP and VIIRS A) the 24 hour flowthrough absorption 443 for day 291 with the VIIRS matchups from NOAA (MSL12 (green) and Navy APS (blue) B) Cruise track location of the 24 hour Flowthough for APS and MSL12.note C is location of the Overpass. C) 30 minute matchup 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^{TM} 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 (Sg), water (Ssfc), and sky (Ssky).

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.

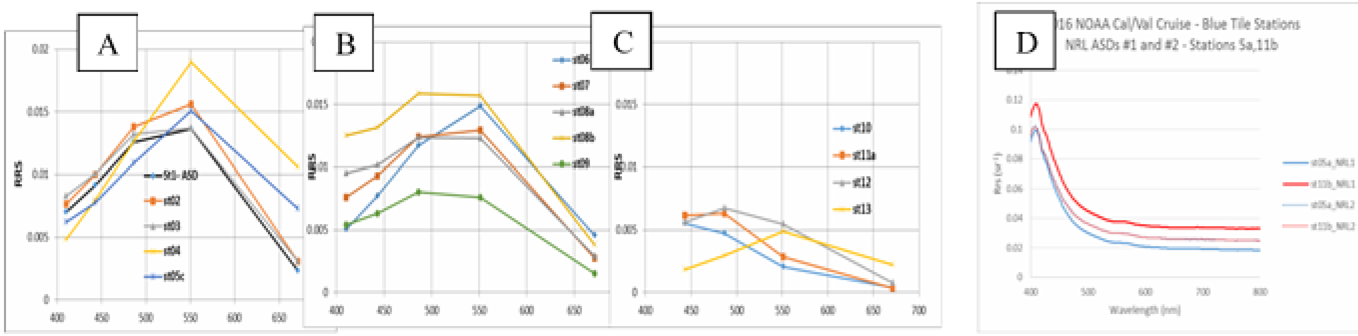


Figure 30: Remote Sensing Reflectance from NRL ASD A) Stations 1,2,3,4,5 B) Stations 6,7,8,9 C) Stations 10,11,12,13 D) Plot of 2 blue tile stations for 2 NRL ASDs (1,2) for 2 stations (5,11). Solid lines are NRL ASD #1 and dashed lines are NRL ASD #2. Both stations for each ASD should match. Note for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

<u>NIST Blue Tile: AWG- Above Water Group:</u> 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 evolutions. 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 required.

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 presentations 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.

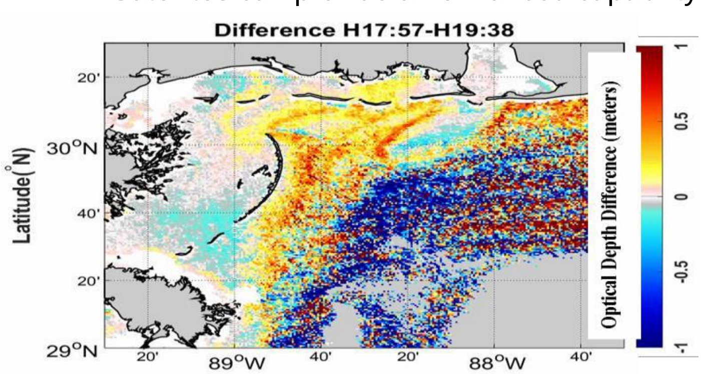


Figure 31: Difference in Optical depth of VIIRS imagery for April 3, 2016. (17:56 and 19:38 GMT). Negative values (blue) indicate the depth of diurnal vertical deepening and positive values (red) is rising subsurface layers (change in meters).

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 maintain 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 - CONCORDE- 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 # 15-NGI2-112

Project Title: Exploring the use of coupled camera and acoustic systems for estimation of fish densities and catchability in a test-bed using stationary camera arrays, AUVs, and ROVs and towed sleds

Project Lead (PI): Steve Ashby, Northern Gulf Institute, Mississippi State University, sashby@ngi.msstate.edu

NOAA sponsor and NOAA office of primary technical contact: Matthew Campbell, NMFS (Pascagoula Laboratory) matthew.d.campbell@noaa.gov

Award Amount: $174,596.00

Project objectives and goals
NOAA has a long term goal to have healthy oceans. One of the challenges in determining the health of the oceans is to have an accurate assessment of biodiversity and fish stocks. This is particularly challenging in critical habitats where traditional measurement methods are not easily or effectively deployed (e.g., untrawlable habitats such as coral reefs). This research will provide a comparison of measurement methods that can be correlated to standard techniques and used in areas where traditional methods are not possible.

Description of research conducted during the reporting period and milestones accomplished and/or completed
Equipment and supplies were organized for the Untrawlable Habitat Strategic Initiative (UHSI) research cruise. The Module Optical Underwater Sampling System (MOUSS) cameras were deployed and retrieved. Metadata was recorded and updated for the cruise and video files from the ROV were downloaded. Raw video data is being converted into abundance estimates before, during and after transit of the ROV and AUV vehicles in front of the MOUSS cameras. Five other biologists performed the video reads for the project. SeaGIS was used to measure vehicle distances from the MOUSS cameras.

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

Processing of the video data continued with two undergraduate students. These students also participated in data collection cruises.

Information on collaborators/partners
Name of collaborating organization – The Alaskan Fisheries Science Center, Northwest Fisheries Science Center, Pacific Islands Fisheries Science Center, Woods Hole Oceanographic Institute, Florida International University, and the University of South Florida.
Date collaborating established – May 2014
Does partner provide monetary support to project? No Amount of support? None reported
Does partner provide non-monetary (in-kind) support? Yes, technical input/review
Short description of collaboration/partnership relationship - Assisted with calibration methods for the MOUSS cameras and data analysis for developing improved methods for the estimation of fish densities and catchability.

Information on any outreach activities: Results were presented by the two students at a seminar held at the Mississippi State University Science and Technology Center at the Stennis Space Center.

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

Related NOAA Enterprise Objectives: Science and Technology

NGI File # 15-NGI2-113

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

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

NOAA sponsor and NOAA office of primary technical contact: Adam Brame, NMFS

Award Amount: $168,980

Project objectives and goals

The primary goals of this project are to 1) investigate movements and migration of subadult 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. Each year of this project we sought 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 research surveys. The shelf edge at water depths of 40-55 meters from offshore of Key West the Marquesas Keys is a known area of sawfish interactions with commercial longline and shrimp trial fisheries. Our data suggest this is also an aggregation site for adult smalltooth sawfish, at least during summer. In addition, Florida Bay is a known area of high interaction with charter fisheries. These are the two primary areas of sampling.

<u>Methods:</u> 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. A pop-off archiving satellite transmitter (PSAT) is attached to the first dorsal fin using a harness technique developed by the principal investigator. On most adult and large juvenile sawfish capture, we either deploy one of the following: Mini-PAT tags manufactured by Wildlife Computers®. These tags record pressure (depth), temperature, light, and light-based location estimates at intervals predetermined by the. PAT tags are programmed to release after 2 to 5 months. Light-based geolocation data are notoriously noisy; therefore, a form of the Kalman filter (Sibert et al. 2003) incorporating sea-surface temperature (Nielson et al. 2006) will be applied to the location data. We are currently analyzing the data using Kernal analyses on

location data to define areas of concentrated use, potential adult aggregation sites, and activity space as a function of temporal cycles (e.g., diel, lunar, seasonal). Site fidelity and indices of reuse will be applied as appropriate. We will examine temperature and depth data for patterns and preferences and will compare the data as functions of diel and seasonal patterns as well as sex and size of sawfish. Beginning in 2016, we have been permitted to surgically implant coded acoustic transmitters in sawfish. These transmitters will be 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.

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

During the reporting period (01 July – 31 December 2016), two research trips (17 total days, 13 days at sea) were completed and 55 total fishery independent longline sets were made (Figure 1), all aboard an FSU research vessel (a 26' Calcutta). Four sawfish (two adults, one large juvenile and one small juvenile) were captured and tagged (Figure 1). The first trip to the Florida Keys was conducted in July 2016. Most of the sampling during this trip took place inshore between Cudjoe Key and Key West, however, we did sample offshore areas where we captured adult male and female sawfish in July 2011 and May 2016. During the July 2016 trip we captured one large juvenile (292 cm TL) male sawfish in a creek near Sugarloaf Key at a depth of 8 meters and successfully implanted 10-years transmitter.

The second trip was completed in September 2016. Data from adult male sawfish tagged with passive acoustic receivers in Florida Bay (See Papastamatiou et al. 2015), as well as fisher knowledge, suggested adult sawfish leave specific aggregation sites in Florida Bay in July and it was hypothesized that they leave the bay entirely. However, in August 2013 we caught two adult males in Florida Bay, therefore we conducted trips in September 2014, 2015 and 2016 to test these limits and also search for sawfish in other areas, including the on the edge of the continental shelf offshore of the Middle Keys. During the September 2014 trip, we caught one adult female at 50 meters depth on the edge of the continental shelf. We conducted an ultrasound on the adult female and review of the resulting video indicated she was pregnant (Jim Gelsleichter and Brenda Anderson, pers. comm.). This was the first documented pregnancy of a smalltooth sawfish. During the September 2015 trip, we caught another adult female in this region at a depth of 70 meters and blood was collected for reproductive hormone analyses. However, during the September 2016 trip, we caught one adult male and one adult female in the same location in the far northern part of Florida Bay near Flamingo. We implanted 10-year acoustic transmitters in both of these. This is the first time we have captured adult male and female sawfish together in Florida Bay. We also visited a potential pupping site in northern Florida Bay during the September trip and successfully captured and tagged one young-of-year sawfish.

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

During the reporting period we captured and tagged two adults and one juvenile of the endangered smalltooth sawfish. Using NGI funds and previous funds from the NOAA Section 6 Program, we have completed 387 demersal longline sets during the last five 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 2). We captured 45 adult or large juvenile smalltooth sawfish on longlines and an additional 9 sawfish on rod and reel. Of the 45 captured on longline, 21 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 23 were caught in the shallow waters of Florida Bay. One was caught in shallow water on the Atlantic side of the Florida Keys. We received multiple detections of the first sawfish we implanted with an acoustic transmitter in 2016. This adult female was tagged off Key West May 2016, then was detected of West Palm Beach in mid-June, then off Cape Canaveral in late June and again in late July. During late July, she was detected more than 400 times on a single receiver off Cape Canaveral. Data to date suggest adult smalltooth sawfish do not leave U.S. waters and primarily remain in Florida waters (Figure 4). Males use very shallow flats and channels in Florida Bay from January through August, but also occur in deeper water along the edge of the continental shelf during this same period. To date, 71% of adult males were caught in Florida Bay and 29% in deeper shelf edge waters. Large juvenile females were only caught in Florida Bay and occur there at least from March through August. Adult females occur in Florida Bay at least between January and March, but to date, 12 of the 16 adult females captured (80%) were in deep water on the edge of the continental shelf in summer or winter. Additional sampling during winter months is needed to examine potential use of Florida Bay waters by adult females. Depth data obtained from satellite tags suggest only ephemeral use of shelf-edge habitats where most interactions with commercial fisheries occur. Adult sawfish spent the great majority of their time in waters less than 10 meters deep.

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 5). 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 6). 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.

I co-organized a symposium on the biology of sawfish for the American Elasmobranch Society's annual meeting held in New Orleans July 2016 as part of the Joint Meeting of Ichthyologists and Herpetologists. This NGI-supported research was highlighted in 5 different oral presentations as well as in my plenary talk before the whole JMIH congregation.

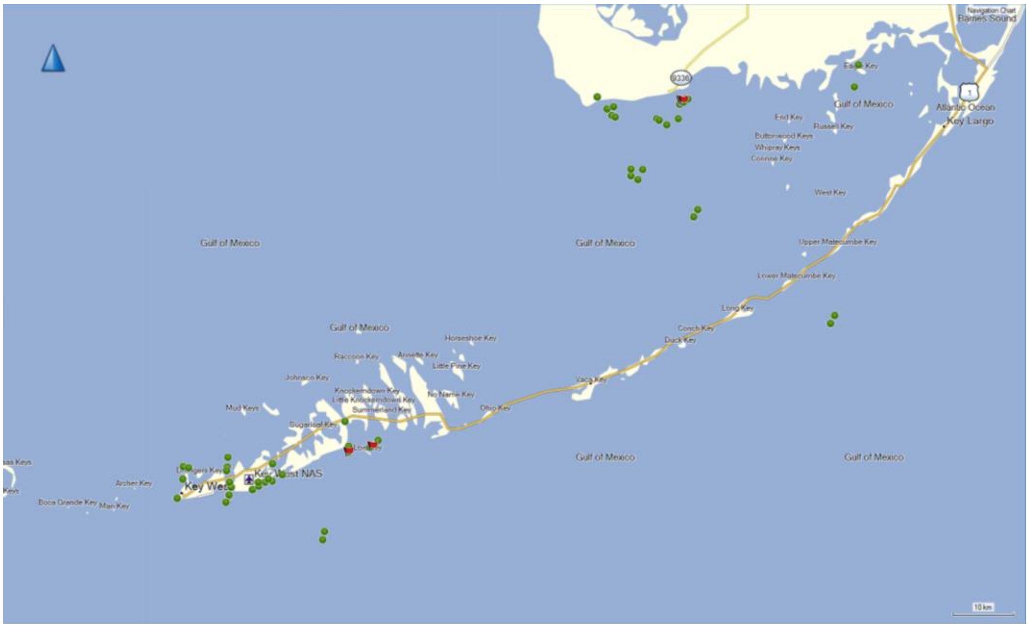


***Figure 1*: Distribution of fishery-independent longline stations (N=55) sampled during the July-December 2016 reporting period to capture and tag endangered smalltooth sawfish. Red flags = sawfish capture locations.**

***Figure 2*: Distribution of fishery-independent longline stations (N=387) sampled during the 2011-2016 period to capture and tag endangered smalltooth sawfish. Red flags = sawfish capture locations (N=45).**

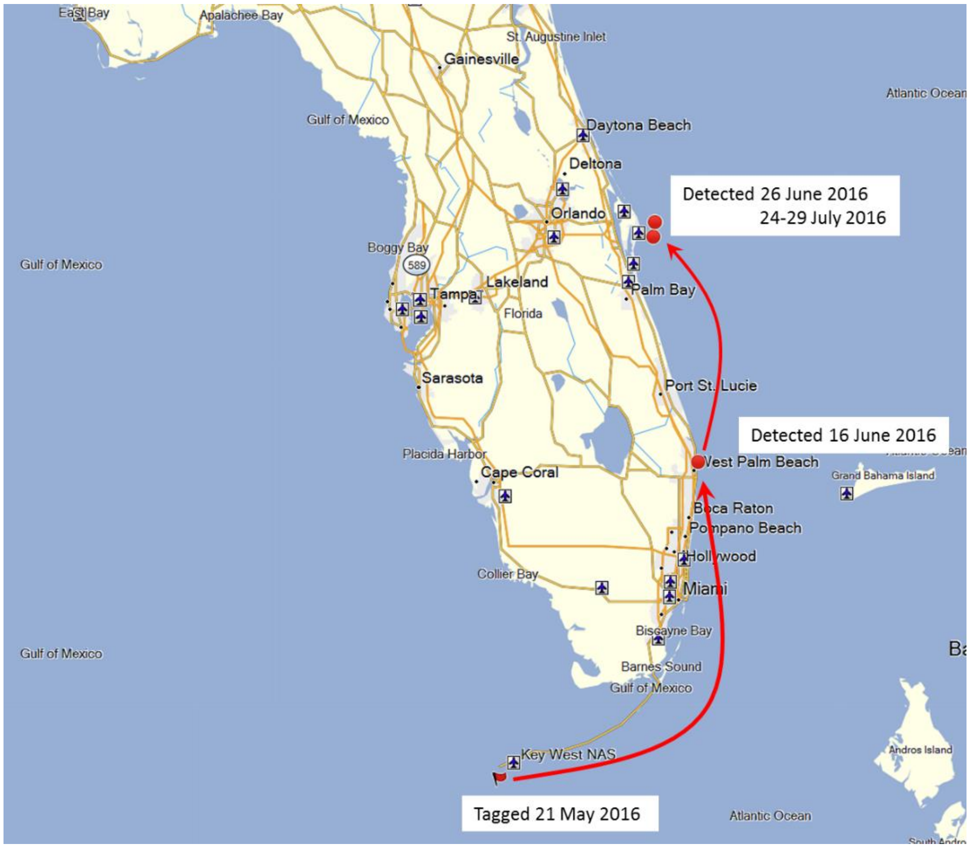


Figure 3: **Detections of sawfish 20868 on FACT array receivers.**

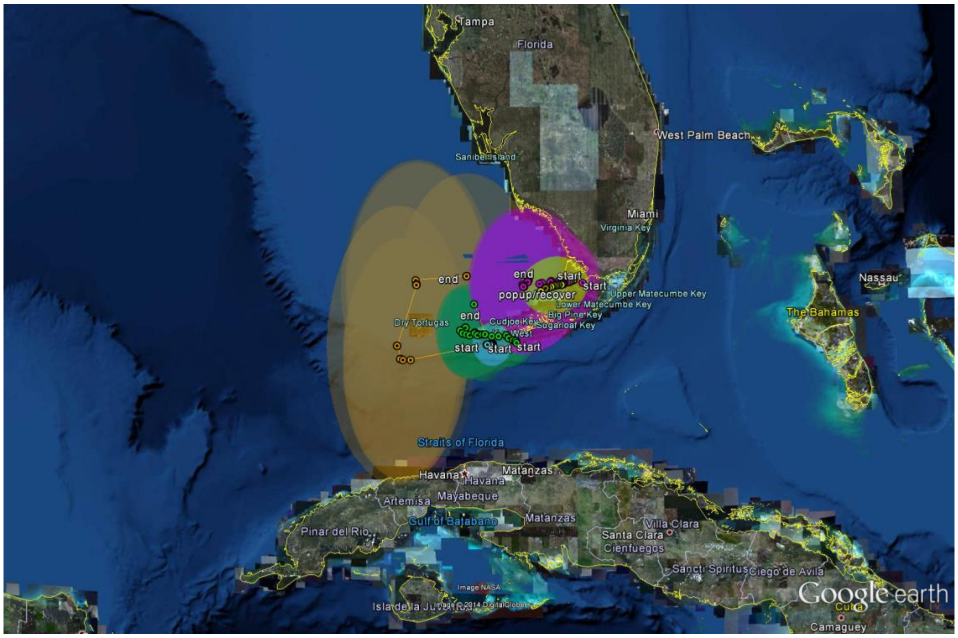


Figure 4: **Most likely tracks of five satellite tagged sawfish tagged in Florida Bay and the Florida Keys following application of raw data to a Kalmin Filter. Ellipses represent 95% confidence around tracks.**

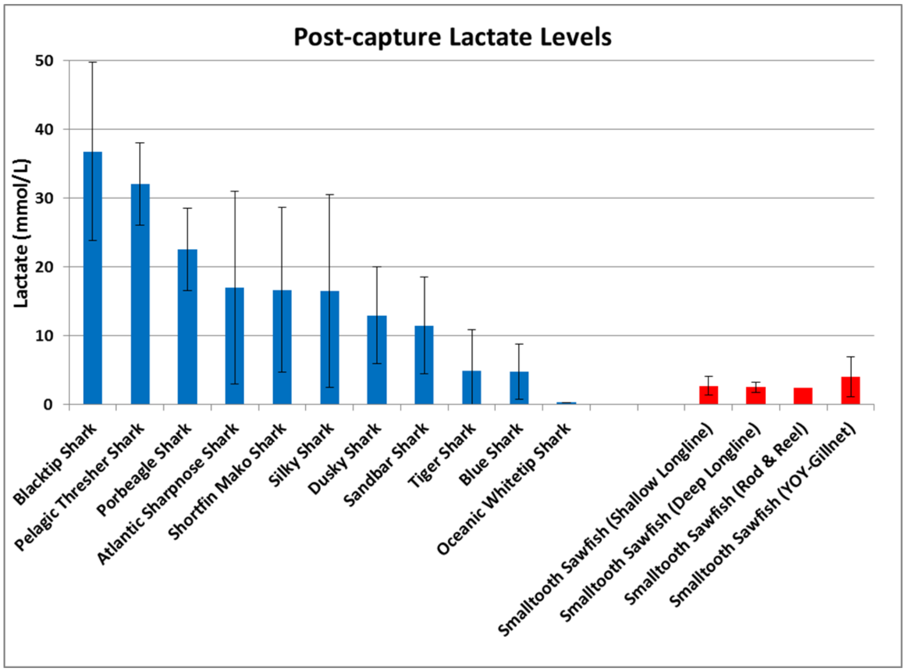


***Figure 5*: Blood lactate levels of smalltooth sawfish captured using deep longlines (45-70 m), shallow longlines (2-5 m), rod and reel, and gillnets during this study compared to lactate concentrations for coastal and pelagic sharks captured in longlines from Marshall et al. (2012). Rising lactate 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.**

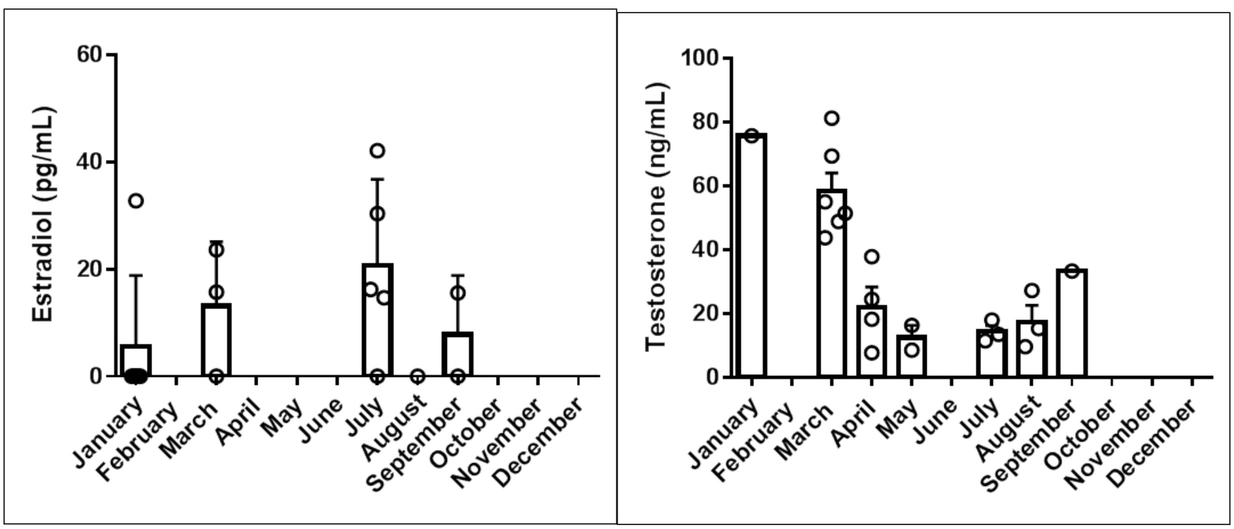


***Figure 6:* Preliminary results from plasma hormone analyses: Left – estradiol concentrations in large females exhibit no distinct pattern. Right - testosterone and 13,14-dihydro-15-keto-prostaglandin F2α (PGFM) concentrations in mature males, demonstrating increased levels in Mar-Apr.**

Information on collaborators/partners:

f. Name of collaborating organization: Dr. John Carlson, Adam Brame – NOAA Southeast Fisheries Science Center and Office of Protected Resources
g. Date collaborating established: November 2009
h. Does partner provide monetary support to project? Amount of support? Yes, through NGI
i. Does partner provide non-monetary (in-kind) support? Yes, satellite transmitters and satellite time
j. Short description of collaboration/partnership relationship: Our colleague from NOAA Fisheries supplies some of the satellite transmitters that we deploy and the satellite time needed to download the data

a. Name of collaborating organization: Dr. Jim Gelsleichter – University of North Florida
b. Date collaborating established: November 2009
c. Does partner provide monetary support to project? Amount of support? $5,000 subcontract requested for 2015
d. Does partner provide non-monetary (in-kind) support? No
e. Short description of collaboration/partnership relationship: Our colleague from UNF provides a field assistant to collect blood from sawfish in the field and analyzes blood samples for sex hormone concentrations.

a. Name of collaborating organization: Gregg Poulakis, Dr. Phil Stevens – Florida Fish and Wildlife Conservation Commission
b. Date collaborating established: November 2009
c. Does partner provide monetary support to project? Amount of support? 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? Amount of support? 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 two national documentaries produced in 2014:
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.

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

July 20, 2016 - SeaCamp, Big Pine Key, FL. Presentation to 120 SeaCamp students. Ecology of coastal and deepwater sharks and bony fishes.

September 2016 - President's Club College – Florida State University – Class for FSU Donors that are members of the President's Club on Research to Promote Recovery of Endangered Smalltooth Sawfish.

September 30, 2016 - EEE Honors Society at FSU. Research presentation to ~100 honors students on deep sea shark and endangered sawfish research at FSU.

October 31, 2016 - Plymouth Marine Laboratory – Seminar Series, Plymouth, United Kingdom. Using state of the art telemetry to study very large elasmobranch fishes: endangered sawfish and deep sea sharks.

I also wrote an article highlighting our research for the IUCN supported Sawfish Conservation Society.

Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology

NGI File # 15-NGI2-115

Project Title: Collaboratory Exploration with Scientists at AOML

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, OAR

Award Amount: $10,000

Project objectives and goals
The objective was to visit the Atlantic Oceanographic and Meteorological Laboratory (AOML) during Spring and early Summer 2016. The goals were to learn about the Hurricane Research Division (HRD) activities; meet AOML scientists; attend seminars, meetings, workshops, and conferences; and discuss AOML-MSU synergies for future collaboration. Included in these activities were also trips to the University of Miami, Florida International University, and the National Hurricane Center.

Description of research conducted during the reporting period and milestones accomplished and/or completed
Nothing to report this period. All travel funding was exhausted by May 2016.

Description of significant research results, protocols developed, and research transitions
Nothing to report this period. All travel funding was exhausted by May 2016.

Information on outreach activities:

- Governor Jindal appointed Fitzpatrick as a Commissioner on the St. Tammany Levee, Drainage, and Conservation District Board. St. Tammany Parish experience storm surge of 16 feet which traversed five miles inland. The parish has experienced many other surge events since, with the worse events being Isaac and Gustav. The HRD interactions allow me to know the cutting edge of hurricane forecasting.

- Fitzpatrick is a member of the National Hurricane Conference Hurricane History Committee.

- Fitzpatrick is a 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.

- Fitzpatrick is on the National Hurricane Museum & Science Center advisory panel

- Fitzpatrick is on the East St. Tammany Parish Storm Protection Committee

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

NGI File # 16-NGI2-116

Project Title: Gulf Sturgeon Genotyping

Project Lead (PI) name, affiliation, email address: Brian Kreiser, University of Southern Mississippi, brian.kreiser@usm.edu

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

Award Amount: $10,088

Project objectives and goals
The Gulf sturgeon (*Acipenser oxyrinchus desotoi*) is an anadromous fish found in eastern North America along the north central coast of the Gulf of Mexico. Like other species of sturgeon, Gulf sturgeon have experienced population declines over the past century, primarily due to the effects of impoundments, water quality degradation, and overfishing, which prompted their listing as threatened under the Endangered Species Act (USFWS, GSMFC and NMFS 1995). In recent years, numerous researchers have generously collected tissue samples from across the range of Gulf sturgeon. Previous funding from NOAA-NMFS allowed my laboratory to genotype a large number of individuals from each drainage system for 14 microsatellite loci. With these data, we recognize that the major drainage systems have their own genetically distinct stocks, and we can assign most individuals to one of these groups with a high degree of certainty.

The goals of this project were:
1. Genetic Database Organization
We will finalize a core set of individuals from our database to serve as the reference library for any future genetic assignment analyses.

2. Laboratory Work - new genotyping efforts
We have received a substantial number of samples since our last genotyping effort. Once we establish which individuals are of priority interest, we will genotype them using the same methods as our original project.

2b. Addendum to this goal added in 2016
I have been given the opportunity to analyze age-1 or age-2 fish collected by Adam Kaeser (USFWS) and Doug Peterson (U. Georgia) from the Apalachicola River during the summer of 2016. The goal of this work would be to use the genetic data to estimate how many males and females were involved in producing these year classes. This task was approved by Jason Rueter, the Gulf Sturgeon Coordinator at NOAA.

3. Data analysis and report writing
The individuals genotyped as part of this project will be analyzed using the same methods as the previous work to identify their natal origin. A report documenting these findings will be prepared for NOAA. The results will also be presented at a subsequent annual Gulf sturgeon workshop.

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

Genetic database and range-wide population structure
After quality control/quality assurance, we currently have a total of 1267 individuals genotyped for the range-wide analysis of population structure (Table 1). These individuals provide strong representation of the populations from the major river systems across the range of Gulf sturgeon. Highlights of the results of the analyses are outlined. (Note for the purposes of some of the analyses the Escambia Bay and Ochlockonee fish have been removed as these locations did not represent genetically distinct entities.)

Table 1. Sample size by drainage for Gulf sturgeon genotyped for this project.

Drainage	Sample Size
Pascagoula	196
Pearl	127
Escambia	70
Yellow	64
Blackwater	63
Escambia Bay	12
Choctawhatchee	263
Brothers/ Apalachicola	112
Ochlockonee	50
Suwannee	310

1. Genetic diversity across the drainages: Levels of genetic variation (number of alleles & expected heterozygosity) are fairly uniform across the range.

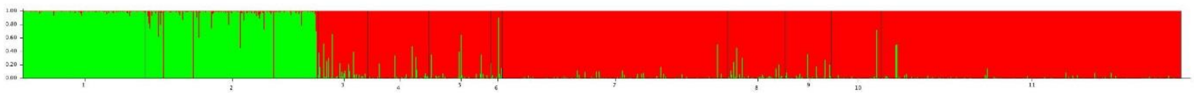
Table 2. Measures of genetic diversity (mean number of alleles and mean expected heterozygosity) for Gulf sturgeon. Standard errors are listed in parentheses.

Drainage	**Mean # of alleles (SE)**	**Mean Expected Het. (SE)**
Pearl	8.429 (1.27)	0.687 (0.04)
Pascagoula	10.36 (1.71)	0.708 (0.04)
Escambia	9.643 (1.54)	0.689 (0.05)
Blackwater	9.571 (1.66)	0.703 (0.05)
Yellow	8.643 (1.47)	0.699 (0.05)
Choctawhatchee	10.143 (1.72)	0.624 (0.07)
Apalachicola	9.429 (1.32)	0.648 (0.05)
Suwannee	9.643 (1.66)	0.682 (0.04)

2. Population Structure: The program STRUCTURE (v. 2.3.4; Pritchard et al. 2000) uses a Bayesian approach to assign individuals to some number of groups that are in Hardy-Weinberg and linkage equilibrium. We selected the best value of K by examining the likelihood values for each K and by using the ΔK method (Evanno et al. 2005) as calculated by the program Structure Harvester v 6.92 (Earl and von Holdt 2012). We then averaged the 20 runs for the best value of K with CLUMPP v. 1.1.2 (Jakobsson and Rosenberg 2007) and visualized the average ancestry coefficient (q) for each individual with DISTRUCT v. 1.1 (Rosenberg 2004).

The STRUCTURE analysis detected one level of population differentiation at K=2. These two genetic groups (Figure 1) are represented the Pearl and the Pascagoula Rivers in one group (“western”) and all others in the other (“eastern”). Most individuals tended to clearly assign to one or the other of the two groups with little admixture (bars with both colors). However, a few individuals collected in either a western or eastern drainage showed a high degree of ancestry (q > 0.95) in the other genetic group representing movement between drainages. In almost all cases, our samples were collected from fish located in the lower portions of the drainage systems and not on the spawning grounds in the upper reaches. Hence, individuals deemed to be of migrant origin were not necessarily breeding in that particular river system.

Figure 1. Results of the STRUCTURE analysis for Gulf sturgeon at K=2 for all individuals in this study from sites across the range. The bar plot shows the average proportion of ancestry of each individual in each of the genetic groups (*K*=2) identified by the analysis. Green represents the “western” genetic group and the red represent the “eastern” group.



Since additional population structure was still possible, we performed another set of analyses on individuals within each of the two genetic groups (e.g., hierarchical analysis; Vähä et al. 2007). Within the western group two more genetic groups were clearly supported: one representing the Pearl River and the other the Pascagoula River (Figure 2). Individuals in the Pearl generally strongly assigned to the Pearl River group. However, some individuals collected in the Pascagoula River had ancestry in the Pearl group, again likely representing individuals spawned in the Pearl but at that time residing in the Pascagoula system. Within the eastern group the population structure was more complicated with evidence of seven genetic groups (Figure 3). These genetic groups included populations representing the Escambia, Yellow, Apalachicola Rivers. However, in the Choctawhatchee and the Suwannee two genetic groups were found within each, potentially representing distinct spawning groups: one from the spring run and another spawning run in the fall. This phenomenon has been documented in Atlantic sturgeon (Balazik & Musick 2015). The Blackwater and Ochlockonee both seem to be comprised of individuals from neighboring drainages and do not likely support their own spawning population. In summary, most drainage systems appear to have genetically distinct stocks of Gulf sturgeon. However, some river or coastal systems more than others seem to contain individuals that were spawned in other rivers systems (Table 3).

Figure 2. Results of the STRUCTURE analysis for Gulf sturgeon from the western group at K=2. Red represents the genetic group associated with the Pearl River and the green represent the Pascagoula River group.

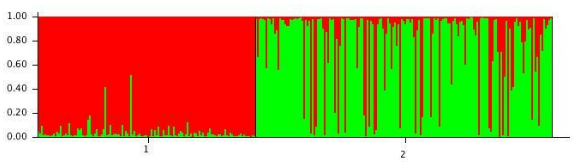


Figure 3. Results of the STRUCTURE analysis for Gulf sturgeon from the eastern group at K=7.

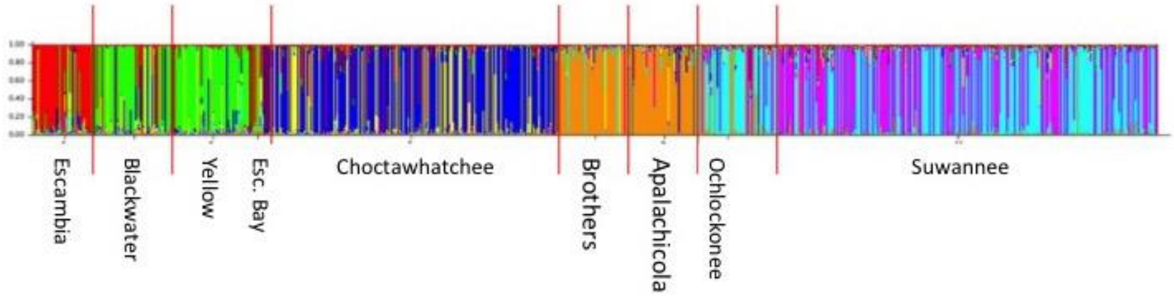


Table 3. Gulf sturgeon detected in each of the drainage systems as having an origin in a different genetic group. The number of migrant individuals from either western (W) or eastern (E) drainages is indicated along with the total number of migrants and the proportion they represented of the sample from each river system.

Drainage	# migrants (W)	# migrants (E)	Total	Proportion
Pearl	0	0	0	0%
Pascagoula	27	4	31	17%
Escambia system	0	17	17	9%
Choctawhatchee	0	7	7	3%
Apalachicola	0	9	9	8%
Ochlockonee	0	11	11	22%
Suwannee	0	2	2	1%

Sibship Reconstruction for Inferring the Number of Breeders of Gulf Sturgeon in the Apalachicola River

On the basis of discussions at the 2015 & 2016 Gulf sturgeon management meeting, a new area of interest is understanding the dynamics of recruitment in the various river systems (i.e., how many individuals are contributing to the reproductive efforts generating the youngest age classes?). This would complement the current work aimed at obtaining a census of adults present. The bulk of my new genotyping was aimed at juveniles collected on the Apalachicola River from 2013-2016. The data collected from these samples will provide a proof of concept in terms of the approach to using genetic analyses to estimate the number of breeding individuals.

Although the Apalachicola population of Gulf sturgeon is probably the fourth largest, it is not clear as to whether the population size is increasing since the listing of the species (Sulak et al., 2016). Estimates of the number of breeding adults would provide insight into the dynamics of recruitment in this important river system. While a census of adult populations provides important data necessary to manage populations, it is not necessarily the most accurate way to determine the number of spawning adults, which ultimately determines the demographic trajectory of a population. Genetic approaches can be used to estimate the number of spawning adults by measuring the relatedness of juveniles spawned in a particular location (e.g., Jay et al. 2014). Two important numbers to consider when dealing with an endangered species are the number of spawning adults (N_S) and the effective number of breeders (N_b). Both values can change from one year to the next, specifically when altered environmental factors have a direct effect on recruitment (Myers, 1998). If a small number of breeders produce a large number of offspring, the ratio of N_b to N_S will be low (Jay et al., 2014).

Between 2013 and 2016, juvenile Gulf sturgeon were collected from the Apalachicola River by Doug Peterson's lab (University of Georgia). The sample sizes by year were as follows: 2013 – n=31; 2014 – n=131; 2015 – n=22 & 2016 – n=34. The fork length of these individuals ranged from 371-537 mm. For the purposes of our analyses at this point we assumed that individuals from each collection year were from the same cohort (e.g., individuals collected in 2013 were all spawned in 2012, etc…). At this point, we have genotyped 114 individuals (31 – 2013 & 83 – 2014) for the same fourteen microsatellite loci used in the range-wide analysis. Sibship analysis and parental reconstruction were conducted using COLONY version 2.0.6.1 (Jones and Wang, 2010), which uses a maximum likelihood method to estimate pedigree relationships by identifying groups of full-sibling and half-sibling families based on their multi-locus genotypes. Analyses were conducted on each year's collections separately, from which we obtained estimates of N_S (the number of adults that contributed to the juveniles of that year class) and N_b (the effective number of breeding adults).

The Apalachicola juvenile samples possessed variation that was comparable to populations of adults from across the range (mean number of alleles per locus = 9.14; SE=1.4). The power of our data to detect unique individuals was high with a probability of exclusion of 1.0 when even just a subset of the fourteen loci were considered. The individuals from the 2013 collection appear to be mostly unrelated as none were full sibs and half sib probabilities were low for most dyads. A slightly higher level of relatedness was found in our 2014 samples with one full sib pair detected (p=0.96) and there were more half sib dyads that could be assigned with some degree of confidence (p>0.80). The levels of relatedness detected among juveniles is reflected in the values for N_b and N_S which where proportionally higher for the 2013 cohort compared to the 2014 cohort (Table 4). However, given the very low numbers of full sibs in both years it is apparent that the juveniles represent recruits from a diverse pool of parents.

Table 4. Results from the COLONY analysis of the 2013 and 2014 juvenile Gulf sturgeon from the Apalachicola River. The sample size (N) from each year is indicated along with the effective number of breeders (N_b with 95% confidence intervals) and the estimated number of spawning adults (N_S) contributing to each cohort.

Year	**N**	**N_b**	**95% CI N_b**	**N_S**
2013	31	38	23-70	28
2014	83	59	40-88	54

Data analysis and report writing
Results from this work have been presented at recent Gulf sturgeon workshops. We are in the process of completing a manuscript on the range-wide population structure. The parentage and kinship work on the Apalachicola juveniles will be completed this fall by an undergraduate as part of her honor's thesis, which will ultimately be submitted as a manuscript to an appropriate journal.

Description of significant research results
The massive Gulf sturgeon genetic database that we have built provides opportunities above and beyond the original scope of the work. We are still working with Gulf sturgeon researchers to identify how their research can be tied into the genetic data we have in hand. We are also pleased with the preliminary results for the parentage/kinship analyses of the juvenile

Apalachicola fish. We are confident that this new analytical approach to quantifying successful reproduction in Gulf sturgeon will help in researchers monitor adult populations. So far, this experimental framework has been well-received by the Gulf sturgeon community and several proposals have gone out that include a juvenile component for several other river systems.

Information on collaborators / partners (if applicable):

k. Name of collaborating organization: USFWS (Adam Kaeser) and University of Georgia (Doug Peterson)
l. Date collaborating established: 2016
m. Does partner provide monetary support to project? Amount of support? None
n. Does partner provide non-monetary (in-kind) support? Yes
o. Short description of collaboration/partnership relationship: Providing samples of juvenile Gulf sturgeon from the Apalachicola

Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology, Engagement

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NGI File # 15-NGI2-117

Project Title: Towards Fine-Tuning Satellite Algorithms for Ocean Acidification Product Suite (OAPS)

Project Lead (PI) name, affiliation, email address: Padmanava Dash, Mississippi State University, pd175@msstate.edu

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

Award Amount: $22,000

Project objectives and goals
The goal of this project was to pursue close collaboration between Mississippi State University (MSU) and the Atlantic Oceanographic and Meteorological Laboratory (AOML), so that data collected and processed by the MSU team could be successfully integrated into AOML's existing decision support systems. The main objectives of the project were to conduct literature review on the collection of in situ data, satellite data, satellite algorithms, OAPS algorithms, and their parameterizations, and visits to AOML so that in the following years if funding is available, the required in situ data could be collected including pH, T_A, DIC, and pCO_2 in the region of Gulf of Mexico where less accurate estimations are made because of Mississippi River outflow. The field data will be used in tandem with satellite data to create products that could be integrated into OAPS.

Description of research / milestones accomplished
All the project objectives were accomplished. A thorough literature review was conducted on collection of in situ data, satellite data, satellite algorithms, OAPS algorithms, and their parameterizations.

Dash started collaborating with Dr. Stephan Howden, who over the years has collected a large dataset from coastal waters of the Northern Gulf of Mexico. One M.S. student was involved in the project whose thesis is based on ocean acidification. They have conducted several geospatial analysis using the data from OAPS (1988-present) and have a manuscript in preparation.

Description of significant research results
Ocean Acidification Product Suite (OAPS), a tool originally developed by Gledhill et al. (2008), and now further improved and managed by scientists in the ACCRETE (Acidification, Climate, and Coral Reef Ecosystems Team) Lab of AOML’s Ocean Chemistry and Ecosystems Division (OCED) offers an important and unique opportunity for the synoptic visualization of the sea surface carbonate chemistry of the wider Caribbean and Gulf of Mexico (AOML NOAA, 2016). Ocean acidification parameters such as pH, aragonite saturation state (Ωarag) and calcite saturation state (Ωcalc) are estimated by the CO2SYS program using total alkalinity (TA) and surface ocean partial pressure of CO2 (pCO2,sw) as input (AOML NOAA, 2016; Gledhill et al., 2008). During our preliminary analysis of the ocean acidification parameters, it was observed that in the OAPS models, the variability in TA is mainly attributed to variation in sea surface salinity (SSS) with a minor dependence on sea surface temperature (SST) and variability in pCO2sw is mainly attributed to variation in SST with a minor influence from SSS. Hence, a slight under- or overestimation in either SSS or SST can impart large errors in the OAPS output

parameters. Especially, near river outfalls, there is a greater chance of error in the estimates as rivers bring enormous amount of fresh water, nutrients, particulate carbon and dissolved carbon to the ocean. Additionally, the organic carbon pump plays a greater role in the river outfall region, which intensifies coastal acidification through eutrophication and organic matter respiration (Cai et al., 2011; Gledhill et al., 2008; X. Hu & Cai, 2013; Lohrenz & Cai, 2006; Wang et al., 2013; Wanninkhof et al., 1997). The Mississippi River discharges freshwater at an annual average rate between 200 and 700 thousand cubic feet per second and carries roughly 550 million metric tons of sediment into the Gulf of Mexico annually. Occasionally, a large portion of the Mississippi River outflow heads southeast into the Gulf of Mexico and enters the Gulf Stream through the Straits of Florida. Thus, Mississippi River has also been detected to be traveled up the Southeast coast to the latitude of Georgia (C. Hu et al., 2005). Hence, Mississippi River water and outflow from other rivers affects the estimations of pH, Ωarag, and Ωcalc in the Gulf of Mexico, especially in coastal waters. Currently, the OAPS uses the same set of algorithms and models to estimate the OA parameters in the entire Gulf of Mexico and the greater Caribbean region, producing erroneous estimates in the coastal waters (D. Gledhill, personal communication, September 16, 2016). This project is aimed at fine-tuning some of the algorithms to obtain more accurate estimation and visualization of the sea surface carbonate chemistry in the Gulf of Mexico and investigating modifications in algorithm parameterizations for improved estimations of ocean acidification parameters in the Mississippi River outfall region, which could be integrated into the OAPS. While the improved estimations will be helpful to obtain a more accurate dataset of ocean acidification parameters in the Mississippi River outfall region, taking the global phytoplankton distribution into consideration, these improvements will also be helpful to obtain more accurate estimates of ocean acidification parameters on a global scale, when OAPS is expanded to visualize the ocean acidification parameters of the entire globe.

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

Related NOAA Enterprise Objectives: Science and Technology

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NGI File # 15-NGI2-118

Project Title: Sensing Hazards with Operational Unmanned Technology for the River Forecasting Centers (SHOUT4Rivers)

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

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

Award Amount: $1,088,425

Project objectives and goals

Task 1

a. Bimonthly weeklong overflights of the Pearl River coastal watershed using a small UAS designed for mapping operations with two major objectives
    a. collecting quality data to advance the science
    b. developing CONOPS
b. Obtain land-cover, land-use (LULC) information from the bimonthly overflights
c. Obtain land-water masks from each mission data
d. Organize and execute a workshop in the October-November 2014 timeframe to update the NWS/RFC personnel on UAS capabilities and to update the UAS manufacturers, integrators, and operators on RFC requirements, as well as to develop a longer term roadmap for the RFCs in collaboration with a representative set of RFCs

Task 2

a. Develop an image cache data portal for the data we collect
b. Develop a data management plan for LASE data
c. Develop a data dissemination portal for LASE data collected under NOAA UAS Program funding

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

Task 1

a. Moorhead presented two talks on the research results for NOAA Science Days and a related Media event held in July 2016.
b. Two journal papers on the ability to detect invasive plant species from the UAS-collected imagery in the Pearl River coastal watershed have been published.
c. A journal paper describing the ability and feasibility of using a small UAS to determine water quality from UAS data has been published.

Task 2

a. No new accomplishments

Description of significant results, protocols developed, and research transitions

Task 1

a. UAS Program Office funded a NOS project that effectively builds on our habitat analysis work at the Grand Bay NERR.

b. Multiple presentations on the research results (e.g., Coastal GeoTools, UAH)

Task 2

a. Webinar presentation on 19 July 2016 on the data portal we developed for the small UAS data we collected and on the data dissemination portal we developed for the other LASE data that the NOAA UAS PO had funded to be collected.

Information on collaborators/partners:

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

a. Name of collaborating organization: NRL/SSC
b. Date collaborating established: 1994
c. Does partner provide monetary support to project? No
d. Does partner provide non-monetary (in-kind) support? Yes, their time and advice. They assist in providing requirements and evaluating the applicability of the results
e. Short description of collaboration/partnership relationship: See previous answer. They are helping us understand the needs of the models. We are providing them with time-varying data so that can determine hydrologic processes. We are providing them with much higher resolution data than they previously had.

a. Name of collaborating organization: St. Tammany Parish Engineering Department
b. Date collaborating established: November 2013
c. Does partner provide monetary support to project? No
d. Does partner provide non-monetary (in-kind) support? Yes, their time and advice. They assist in providing requirements and evaluating the applicability of the results
e. Short description of collaboration/partnership relationship: See previous answer. We are providing them with time-varying data so that can determine hydrologic processes, in particular video showing where flood waters are going. We are providing them with much higher resolution surface image data than they previously had.

a. Name of collaborating organization: Grand Bay NERR
b. Date collaborating established: February 2015
c. Does partner provide monetary support to project? Yes Amount of support? $10,000
d. Does partner provide non-monetary (in-kind) support? Yes, their time and advice. They assist in providing requirements and evaluating the applicability of the results. They help with the data analysis, publications, and presentations. They ferry us to sites. They provide dorm rooms.
e. Short description of collaboration/partnership relationship: We have executed approximately 6 joint projects. We collect the UAS data, pre-process it, mosaic it, and share. They develop classification algorithms and use it in their monitoring and stewardship programs.

Information on any outreach activities
We have been interviewed by numerous local, regional, state, and national communication outlets (magazines, TV, radio, newspapers). We have produced several videos showing the value of UAS for environmental monitoring and analysis.

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

Related NOAA Enterprise Objectives: Science and Technology

NGI File # 15-NGI2-119

Project Title: Predicting the Impact of Anthropogenic Climate Change on Physical and Biogeochemical Processes in the Northern Gulf of Mexico – Part 1

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, OAR

Award Amount: $128,919

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 Gulf of Mexico (GoM) 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 CO_2 emission scenario, using the model configured in 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
The Modular Ocean Model (version 5, MOM5) was used to configure a global ocean-circulation model (1deg × 1deg) for the period 1979-2014, which includes the Tracers of Phytoplankton with Allometric Zooplankton model (TOPAZ) to simulate the cycles of carbon, nitrogen, phosphorus, silicate, iron, oxygen, considering three explicit phytoplankton groups (Dunne et al., 2010). This model is used to extract the boundary conditions for a 25 km resolution regional ocean model from the Gulf of Mexico (GOM25). Both global and regional ocean models are forced with surface flux fields from ERA-Interim reanalysis (Dee et al., 2011). GOM25 is built on the Regional Ocean Model System (ROMS) (Shchepetkin and McWilliams, 2005). The model domain encompasses the entire Gulf of Mexico, with open boundaries in the Yucatan channel (south) and Florida Strait (east). Open boundary conditions are Flather for the barotropic velocity (Flather, 1976), Chapman for the free surface (Chapman, 1985), and a combination of radiation and nudging for the baroclinic velocity and tracers (Marchesiello et al., 2001). The model has 30 terrain-following vertical layers, arranged to provide enhanced vertical resolution near the surface. Model bathymetry is from Smith and Sandwell (1997) data set version 12.1. GOM25 circulation model is coupled to Fennel's biogeochemical model (Fennel et al., 2006; 2011), which simulates the nitrogen cycle and dissolved oxygen. The selected Fennel model includes 8 components: nitrate, ammonium, phytoplankton, chlorophyll, zooplankton, small and large detritus, and dissolved oxygen. The bio-sediment and denitrification options are used to simulate nitrogen recycling at the sea floor. The model includes water and nutrient discharge from 14 major rivers along the United States coast, obtained from the US Geological Survey (USGS). A 20 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).

<u>Milestones accomplished</u>

1. Configuration MOM-TOPAZ ocean-biogeochemical model 1° horizontal resolution
2. Configuration of ocean-biogeochemical model ~25 km horizontal resolution (GOM25) and tuning of biogeochemical parameters
3. 20 year model spin-up and historical simulations for the period 1979-2014
4. Validation GOM25 against satellite data and in-situ observations

Description of significant research results, protocols developed, and research transitions
GOM025 reproduces reasonably well main circulation and hydrographic features over the Gulf of Mexico, such as the Loop Current, mesoscale eddies, cross-shore gradient of physical and biological surface fields (e.g. temperature, chlorophyll), and the summer's hypoxic region over the Texas-Louisiana shelf (Figs. 1 and 2). The next is configuring a higher resolution model for the Gulf of Mexico, which can better resolve ocean processes over the shelf region, deep ocean dynamics, and their interactions. To this effecting we are testing an 8 km ocean model, extracting the boundary conditions from a 25° resolution model for the entire North Atlantic model (MOM5) (Fig. 2).

Related NOAA Strategic Goals: Weather Ready Nation

Related NOAA Enterprise Objectives: Science and Technology

<u>References</u>

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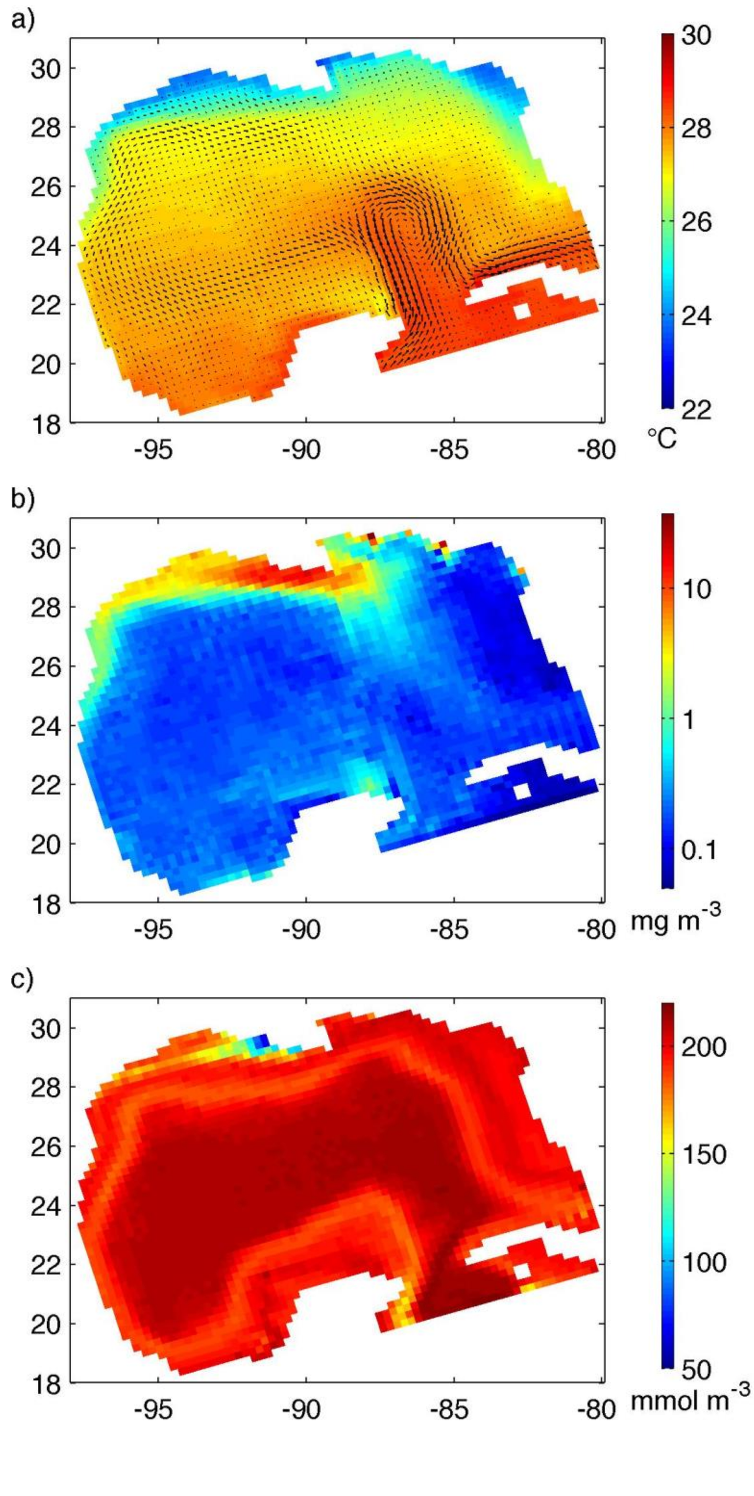

Figure 1. a) Annual mean sea surface temperature and surface currents (vectors); b) annual mean surface chlorophyll; c) July mean bottom oxygen concentration derived from the 25 km resolution model (GOM25)

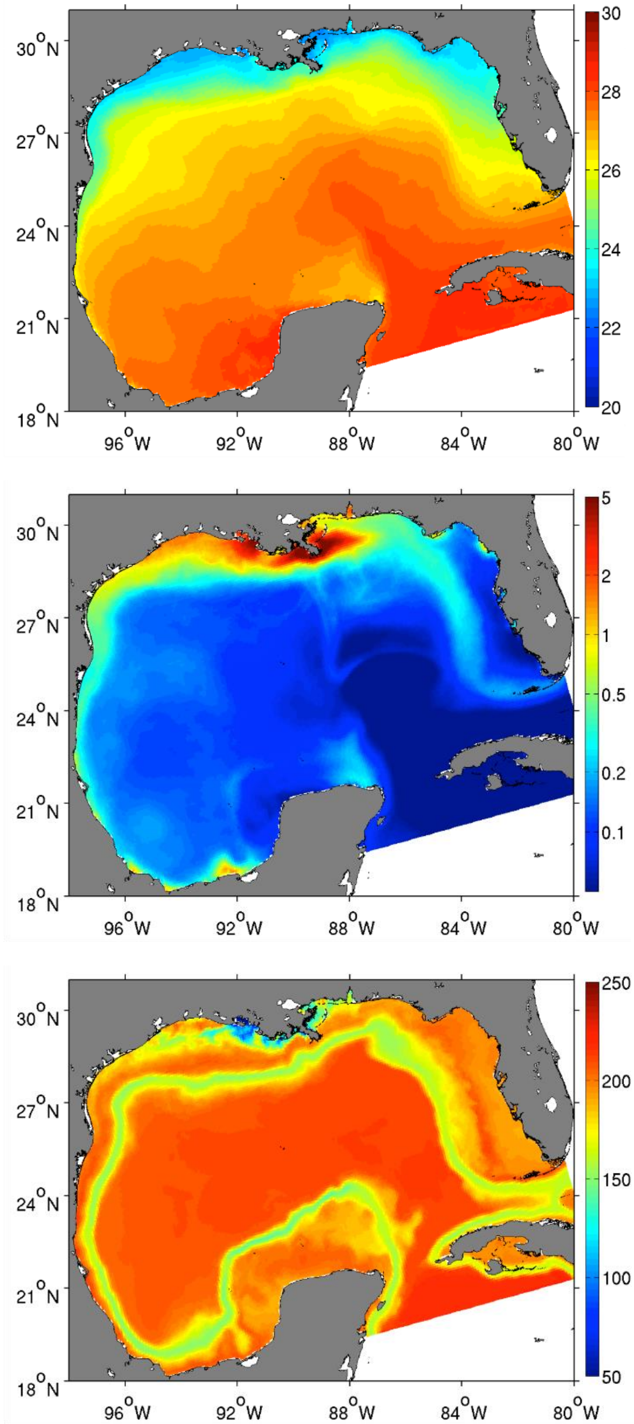

Figure 2. Annual mean of sea surface temperature (top), surface chlorophyll (middle) and July mean of bottom oxygen concentration (bottom) derived from 8 km resolution model (test-run).

NGI File # 15-NGI2-120

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

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Co-PI name, affiliation, email address: Eric Uhlhorn, AIR-Worldwide, eric.uhlhorn@gmail.com

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

Award Amount: $99,000

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. Currently, observations are limited to when data are acquired directly below the aircraft (i.e., nadir incidence), where the impacts of surface wind and wave directions are minimal. To enhance instrument capabilities for more general use when aircraft are not flying straight-and-level (i.e., off-nadir incidence), the surface directional impacts must be understood and quantified in high wind conditions, which is currently an active research topic.

The goals of this project are:

- Obtain additional measurements from NOAA hurricane reconnaissance flights as necessary;
- Extend SFMR software algorithms for general use at all wind speeds and practical incidence angles;
- 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

Further analysis of the SFMR high incidence angle data was conducted to further our understanding of the asymmetry present in the measurements. There were very few flights into tropical cyclones during the 2015 HRD Hurricane Field Program (HFP), none of which collected high incidence angle SFMR data, and only one flight during the 2016 HRD HFP that collected high incidence angle SFMR data. Therefore, additional SFMR high incidence angle data are still needed to fully develop algorithm corrections.

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

Several advancements have been made to understand how measurements from the SFMR vary with incidence angle. It was determined that an asymmetry in the wind-induced component of the off-nadir brightness temperature measurements was related to the wind direction and not wave direction. Figure 1 shows the running medians (10° bins) of the wind-induced component of the brightness temperature with respect to the wind and wave relative SFMR look angles for three different cases. Two of the cases shown in Figure 1 have similar wind and wave directions (Aug. 26, 2014 and Feb. 8, 2015) while the third case (Feb. 12, 2015) has wind and wave directions that are different by about 90°. For the cases with similar wind and wave directions, it was not possible to determine whether the peaks in the asymmetry that occur around +/- 90° wind/wave relative SFMR look angle were associated with the wind direction or the wave direction. However, for the case where the wind and wave directions differed by about 90°, a shift in the peaks was observed for the wave relative SFMR look angle, but not for the wind relative SFMR look angle. This result determined that the peaks in the asymmetry were robust to wind direction and not wave direction with respect to the SFMR look angle.

The peaks in the asymmetry are associated with the SFMR observing the surface in a crosswind direction. It was also noted that the asymmetry is present in observations made at incidence angles of 10° to 50° and disappears outside of those incidence angles. When considering the magnitude of the brightness temperatures, it was found that the total brightness temperature decreases with incidence angle, while the wind-induced component of the brightness temperature increases with incidence angle (Figure 2). A manuscript has been prepared detailing these results and will be submitted for publication in the near future.

Additional analysis of harmonic fits to the SFMR high incidence angle data in the form:

$$T_{Bw} = \sum_{n=0}^{2} A_n \cos n(\theta_r + \phi_n)$$

where T_{Bw} is the wind-induced brightness temperature, θ_r is the relative wind direction, and the As and ϕs are fitted parameters corresponding to the *n*-th harmonic amplitude and phase angles, respectively, has shown that the harmonic coefficients are in some agreement with previous studies over the wind speeds analyzed by each of those studies (Figure 3). However, the results from SFMR high incidence angle data indicates that some of the extrapolations made by the previous studies to extend the harmonic coefficient fits to higher wind speeds may not be correct. So far, SFMR high-incidence angle data have been collected in the storm relative locations shown in Figure 4. In order to complete the algorithm improvements, more SFMR high-incidence angle data needs to be collected in storm relative locations that have not been sufficiently sampled and also in regions of rain so that these relationships can be refined. After more data are collected to fill in the gaps, it will be possible to use the harmonic coefficient fits to develop a correction to the high-incidence angle SFMR measurements with respect to wind direction.

Data from the Hurricane Imaging Radiometer (HIRad) have also been investigated to identify if the brightness temperature measurements may be useful in aiding the refinement of the relationship between brightness temperature, incidence angle, wind speed, and wind direction. HIRad was developed as a follow-on to the SFMR and designed to obtain a swath of surface wind speed measurements over an incidence angle range of ±60°. However, the dropsondes that were deployed coincident with the collection of the HIRad measurements during the 2015 hurricane season are still being processed to obtain accurate latitude and longitude positions for the lowest layers of the dropsonde profiles. Until the position information is available, it was only possible to complete a preliminary analysis of the HIRad data.

Through the analysis of this data, along with data from other storms at nadir, it was found that there is a bias in the SFMR wind speed retrieval algorithm for wind speeds of 10 to 20 ms^{-1} and a gain error for wind speeds greater than 10 ms^{-1} (Figure 5).

All of these findings will be considered as further corrections are applied to the SFMR wind retrieval algorithm before completing the SFMR research data product and implementing software revisions for real-time operational use.

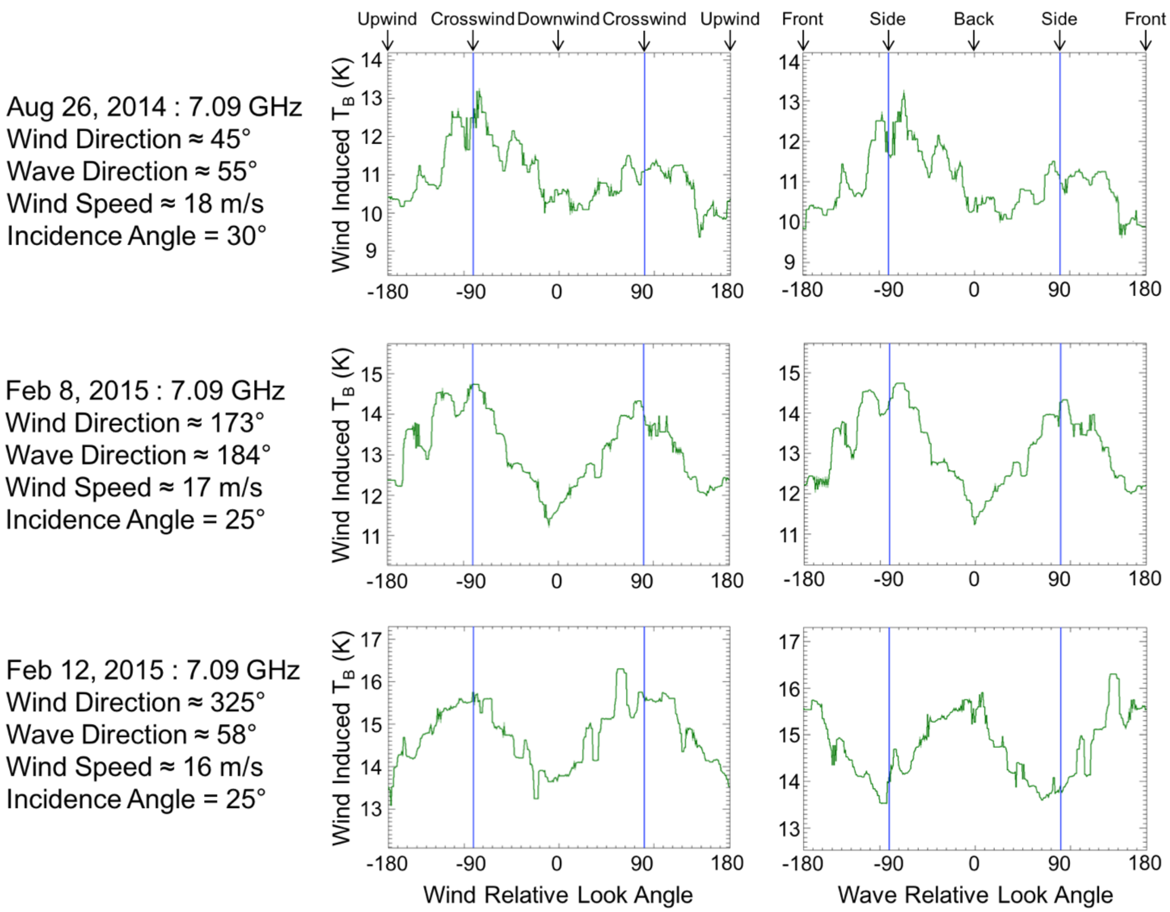


Figure 1: 7.09 GHz channel wind-induced brightness temperatures (T_B) as a function of wind relative SFMR look angle (left column) and wave relative SFMR look angle (right column) for flights on August 26, 2014 (top row), February 8, 2015 (middle row), and February 12, 2015

(bottom row). Green lines denote the 10° relative look angle bin running median values of wind-induced T_B. Vertical blue lines denote +/- 90° relative look angles. Wind direction, wave direction, wind speed, and incidence angle for each flight is given on the left. Labels at the top denote which relative SFMR look angles correspond to the SFMR observing the surface upwind, crosswind, or downwind for the wind relative SFMR look angles and the front, side, or back of the wave for wave relative SFMR look angles.

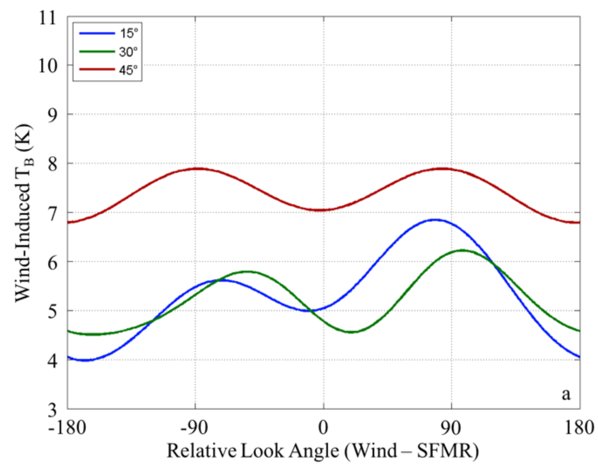


Figure 2: Harmonic fits to the wind-induced brightness temperatures vs SFMR relative look angle with respect to the wind direction for the 4.74 GHz channel for the flight in Hurricane Cristobal on August 24, 2014. The wind speed for the August 24, 2014 flight in the location of the circles was about 15.1 m/s. The line colors correspond to the incidence angles given in the legend.

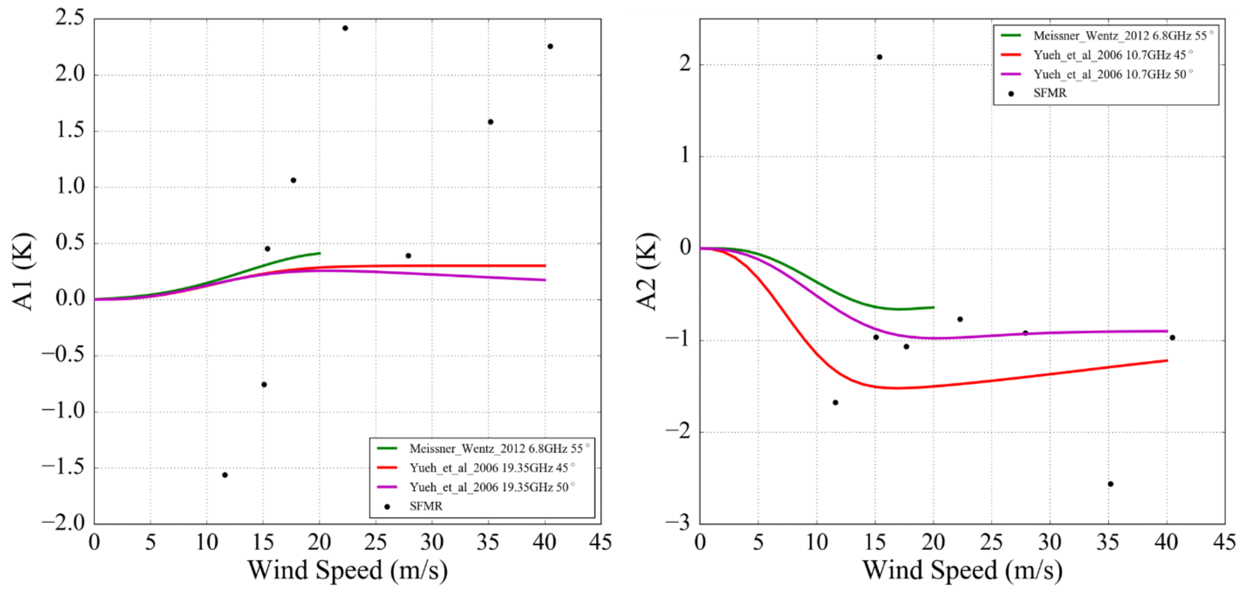


Figure 3: Harmonic fit coefficients A_1 (left) and A_2 (right) for the 45° incidence angle 7.09 GHz channel SFMR high incidence angle cases that passed quality control (black dots). Also plotted are the harmonic coefficient fits from two previous studies as noted in the legends.

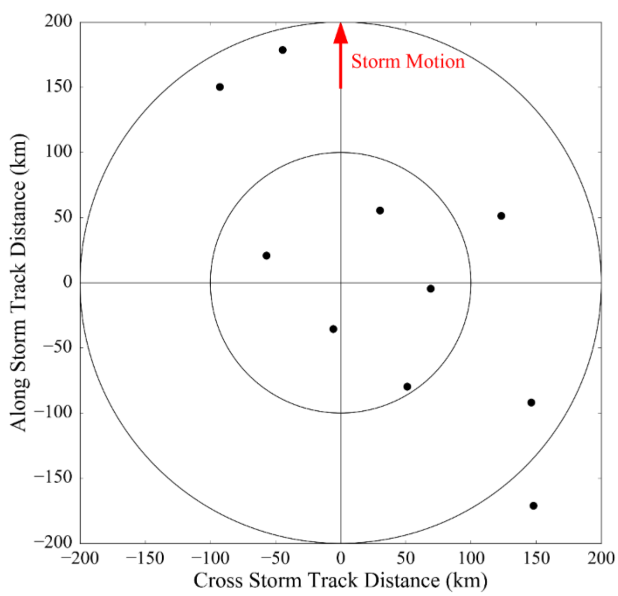


Figure 4: Storm relative locations of high-incidence angle SFMR data (black dots). Storm motion is towards the top of the plot and rings denote 100, and 200 km radii from storm center.

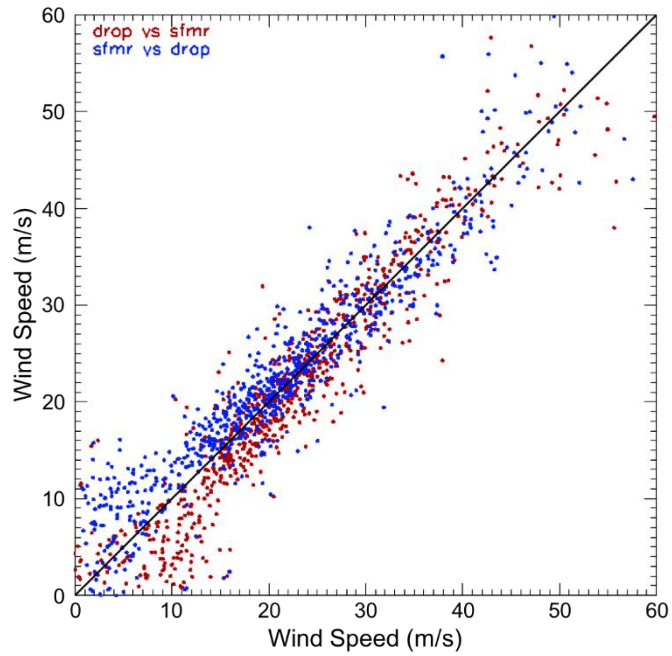


Figure 5: SFMR retrieved wind speed versus dropsonde WL150 surface adjusted wind speed (blue) and dropsonde WL150 surface adjusted wind speed versus SFMR retrieved wind speed (red). 1:1 line is shown in black.

Information on collaborators/partners:

p. Name of collaborating organization: NOAA/AOML/HRD
q. Date collaborating established: February 2013
r. Does partner provide monetary support to project? Amount of support? No
s. Does partner provide non-monetary (in-kind) support? Yes
t. 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

References:

Meissner, T. and F. J. Wentz, 2012: The emissivity of the ocean surface between 6 and 90 GHz over a large range of wind speeds and Earth incidence angles. IEEE Trans. Geosci. Remote Sens., 50, 3004–3026.

Yueh, S. H., W. J. Wilson, S. J. Dinardo, and S. V. Hsiao, 2006: Polarimetric microwave wind radiometer model function and retrieval testing for WindSat. *IEEE Trans. Geosci. Remote Sens.*, vol. 44, no. 3, 584–596.

NGI File # 15-NGI2-121

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

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

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

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

Award Amount: $1,410,074

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 (7/1/16-6/30/17) 29 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.

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 developed 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 – Develop, test, and implement new automated quality control methods.

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.

COD

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.

In addition to continuing to distribute SAMOS data and ensure its' archival at NCEI, a major accomplishment in 2016 was the migration of all our SAMOS data processing and data distribution services to a new virtual machine (VM) server environment. Central to this upgrade was the purchase of a fast SSD storage enclosure that allowed us to move all SAMOS data services onto SSD drives for improved external access performance. In addition, Jocelyn Elya (our lead programmer) led a group of talented undergraduate programmers to streamline all the SAMOS data processing and web service codes. The upgrades include (1) separating the data processing and web service codes onto separate VMs to spread the computational workload, (2) creating developmental processing and web systems to facilitate faster software additions and upgrades, (3) upgrades to data access services to speed web load times and subscription services, (4) upgrading to the latest THREDDS catalog software, (5) multiple code enhancements to make software easier to maintain and upgrade, and (6) enhancing security on the new servers. These upgrades all went operational in September 2016.

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). SAMOS presentations were made the Fourth International Workshop on the Advances in the Use of Historical Marine Climate Data (MARCDAT-4; 18-22 July 2016). Mr. Smith 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 2016, he contributed to the drafting WMO publications #471 and #558, JCOMM Technical Report 63, and participated in the Expert Team for Marine Climatology session hosted in conjunction with MARCDAT-4.

In early 2017, the SAMOS team developed several new quality control (QC) tests [Deliverable C7]. First we implemented (on 1 June 2017) a new land mask (based on the NCEI 1-minute topography dataset) to verify a ship observation is positioned over water. The second procedure will allow our analysts to automatically flag suspect observations for any ship and variable when we are notified of instrument malfunctions (or other errors) by the vessel operators. Finally, we have developed a test to compare differences between parameters of the same type (e.g., two sea temperatures) measured by different instruments on a vessel and flag the data when the difference exceeds an expected tolerance. The latter two tests are still developmental, but should be operational in the next few months.

<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 quality control, 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]. We plan to develop 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]. Kris and other members of the DAC team contributed to the development of the latest version of the R2R quality assessment (QA) XML schema, which was released in September 2016.

During 2016, Kris and Kristen Briggs began notifying all NOAA vessel technicians that we have developed 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. The system is still in the early stages of testing and adoption, but we are hopeful that more technicians will become familiar with the ITS and find it helpful to track discussions and problems related to SCS-connected devices.

The team continues interactions with R2R, OMAO, and NCEI [Deliverable O6] primarily by attending the UNOLS Research Vessel Technical Enhancement Committee meeting (November 2016) and via teleconferences.

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. In FY16, 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 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 of data scientists. In the reporting period, four undergraduate students (Ian Terry, Jennifer Yarboro, Jonathan Reynes and William McCall-Parker) studying computer science and/or informatics have worked part time for the DAC aiding our lead programmer on the migration of the SAMOS code to a new virtual machine environment and updating and upgrading our data delivery web pages and services.

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). Mr. Smith met with data managers and technicians at the National Oceanography Centre in Southampton (25 July 2016) to share experience with SAMOS data management with the UK research vessel community.

Informing the wider marine climate community of DAC activities was done through presentations at national/international meetings. SAMOS focused presentations were made at MARCDAT-IV (Southampton, UK, 18-22 July 2016).

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 # 15-NGI2-122

Project Title: Comparative Metagenomics to Indicate Sites under Anthropogenic Pressure

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, OAR

Award Amount: $126,274

Project objectives and goals
The main goal of the project is to better understand the health, function, and resiliency of marine ecosystems using modern metagenomics approaches with Next-Generation-Sequencing data. The objectives are to:

1) Determine the bacterial community composition, structure and diversity of the microbial consortia from specific sentinel U.S. coastal sites.
2) Determine whether differences among sites are correlated with location and anthropogenic stress.
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, and if so in what relative abundance.
4) If such sequences can be detected, determine whether there is a relationship between detection of these signature sequences 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. 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.

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 # 15-NGI2-123

Project Title: Expanding the Integrated Ecosystem Assessment for the Northern Gulf of Mexico Estuaries

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

Co-PIs names, affiliation, email address: Just Cebrian, DISL, jcebrian@disl.edu; Scott Milroy, USM, scott.milroy@usm.edu; Anna Linhoss, MSU, alinhoss@abe.msstate.edu; Cristina Carollo, HRI at TAMUCC, cristina.carollo@tamucc.edu; Richard Fulford, EPA, Richard.Fulford@ep.gov

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

Award Amount: $493,447.00

Project objectives and goals

The main objectives of this project are to expand the IEA in the northern Gulf of Mexico by focusing upon ecosystem management needs and evaluating possible management actions associated with restoration and management of oyster communities in several estuaries. A series of meetings will be conducted with local resource management agencies and industry representatives to identify ecosystem objectives, management issues, possible management actions, and data availability. Through the identification of management objectives, needs, and possible actions we will be able to determine commonalities across the selected estuaries (e.g, Mississippi Sound, Mobile Bay, and selected Louisiana estuaries). The expansion of the IEA will be focused around these commonalities in management objectives and possible actions (e.g. altering freshwater quantity and quality) to increase the likelihood that there will be applications to other estuaries with oysters throughout the Gulf of Mexico; thus broadening the impact of this work on marine ecosystem management.

The focus on oyster reefs in these estuaries provides two cascading benefits. First, it enables an active dialogue with managers that have specific oyster management mandates and an aim to use oyster reef restoration as way to recover environmental and economic values damaged by the Deepwater Horizon oil spill. Second, oyster reefs are a keystone species in these estuaries and provide a great number of ecosystem services (c.f. Coen et al. 2007). Thus, by focusing on oysters we can implement an ecosystem approach to management by evaluating how mandated and proposed management actions regarding a keystone species will alter the delivery of ecosystem services. NGI collaborators and the NOAA Gulf of Mexico IEA have already identified ecosystem services potentially provided by the Gulf of Mexico marine, coastal, and estuarine ecosystem (Carollo et al. 2013). The list of ecosystem services will be combined with indicators of ecosystem sustainability to evaluate the holistic impact of pending management actions and oyster reef restoration. Relevant aspects of human well-being that are likely to be affected by these ecosystem services will be identified from a report available from NOAA (Monitoring Well-being and Changing Environmental Conditions in Coastal Communities: Development of an Assessment Method, Dillard et al., 2013) and incorporated into the IEA. A survey will be developed using input from oyster subject matter experts and conducted with oystermen as the participants. The objective of the survey is to better understand how scientists can communicate oystermen needs to resource managers by including aspects of human well-being.

The holistic evaluation of ecosystem management alternatives relies upon our ability to predict the likely impact of these management decisions on the ecosystem state and the delivery of ecosystem services. A trophic simulation model (TroSim) and other ecosystem or oyster models used in the northern Gulf of Mexico (e.g., Apalachicola and Mobile Bays) were evaluated to determine their ability to model the outputs necessary to evaluate relevant ecosystem services, and to address the management needs identified in workshops.

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

Preliminary insights into the public and resource management agencies was gained by participation in an Oyster Council subcommittee on Oysters in the Environment as part of an initiative requested by the Governor of Mississippi. Two other committees (Oysters in the Economy and Innovative Technologies) also provided insights. The Oyster Council identified a number of management needs (in agreement with previous findings) that can be informed by scenario analysis using TroSim (and EFDC/WASP). Water quantity and water quality were major concerns identified (The Governor's Oyster Council for Restoration and Resiliency, Final Report, June 2015). Additionally, recommendations included the formation of organizations and partnerships for improved reef management activities and reef restoration, enhancement, and expansion associated with restoration funding from the oil spill of 2010. The recommendations also focused on changes in leasing and aquaculture activities that will require changes regulations. Inclusion of ecosystem services and valuation of these services can be used to inform decision makers.

Description of significant research results, protocols developed, and research transitions
A survey was developed using input from oyster subject matter experts in Louisiana, Mississippi, and Alabama. The Mississippi State University Social Science Research Center provide input on survey techniques and guidance on the questions included. Scientist from NOAA also reviewed the survey during the development. The survey is currently being conducted and a summary report will be provided to NOAA at the end of September 2017.

Results of the EFDC/WASP model for Saint Louis Bay were published.
Linhoss, A.C, Camacho, R., and Ashby, S. 2016. Oyster habitat suitability in the northern Gulf of Mexico. J. of Shellfish Research, Vol 35, No. 4, 841-849.

Information on collaborators/partners
Name of collaborating organization – Gulf of Mexico Alliance (GOMA)
Louisiana Sea Grant
Mississippi/Alabama Sea Grant
The Nature Conservancy
Louisiana Oyster Task Force
Mississippi Department of Environmental Quality
Mississippi Department of Marine Resources

Date collaborating established – May 2014
Does partner provide monetary support to project? No Amount of support?
Does partner provide non-monetary (in-kind) support? Yes, technical input/review

Short description of collaboration/partnership relationship – GOMA has Priority Issue Teams that focus on Habitat Conservation and Restoration and Environmental Education. There are many areas in common with the IEA project that allow technical exchanges.

This project was closely coordinated with NOAA's Gulf of Mexico IEA and the Gulf Coast Vulnerability Assessment (GCVA), an ongoing joint project of Department of the Interior, US Geological Survey and US Fish and Wildlife Service and NOAA under the Landscape Conservation Cooperatives (LCC). The GCVA includes oyster habitats as a major target habitat and information from this assessment (e.g. reef statistics, production/harvest rates, etc.) will be used in this project.

This project is also being coordinated with the US Environmental Protection Agency using information from "Indicators and Methods for Constructing a U.S. Human Well-being Index (HWBI) for Ecosystem Services Research, Smith et al., 2012." The report was prepared by the U.S. Environmental Protection Agency (EPA), Office of Research and Development (ORD), National Health and Environmental Effects Research Laboratory (NHEERL), Gulf Ecology Division (GED).

Information on any outreach activities
Meetings have been held with MS Department of Marine Resources, MS/AL Sea Grant, LA Sea Grant, MS State Extension Service, and several experts on oysters to develop the survey.

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

Related NOAA Enterprise Objectives: Science and Technology

References

Carollo, C., Allee, R.J., Yoskowitz, D.W., 2013. Linking the Coastal and Marine Ecological Classification Standard (CMECS) to ecosystem services: an application to the US Gulf of Mexico. Int. J. Biodivers. Sci. Ecosyst. Serv. Manag. 9, 249–256.

Coen, L., Brumbaugh, R., Bushek, D., Grizzle, R., Luckenbach, M., Posey, M., Powers, S., Tolley, S., 2007. Ecosystem services related to oyster restoration. Mar. Ecol. Prog. Ser. 341, 303–307.

Dillard, M.K., Theresa L. Goedeke, Susan Lovelace and Angela Orthmeyer. 2013. Monitoring Well-being and Changing Environmental Conditions in Coastal Communities: Development of an Assessment Method. NOAA Technical Memorandum NOS NCCOS 174. Silver Spring, MD.

NGI File # 15-NGI2-124

Project Title: Improving Coastal Precipitation Forecast through Direct Assimilation of GOES-R ABI Radiance in GSI-NAM/HWRF

Project Lead (PI) name, affiliation, email address: Xiaolei Zou, University of Maryland, xzou1@umd.edu

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

Award Amount: $478,875

Project objectives and goals

The objectives of this project are to refine the GOES and GOES-R satellite data assimilation part of the NCEP GSVARW for improved coastal quantitative precipitation forecasts. Specifically, scientifically sound, physically based, and operationally workable algorithms for bias correction, cloud detection, data thinning and quality control must be developed when incorporating the radiance observations from current GOES imager and future GOES-R Advanced Baseline Imager (ABI) instruments into the GSR/ARW system.

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

<u>(1) GOES Imager Radiance Assimilation</u>

During the project performance time period ending on 31 July 2016, the GOES satellite data assimilation part of the NCEP GSI/HWRF was refined to improve quantitative precipitation forecasts (QPFs) near the coast of Gulf of Mexico. In order to maximize the impacts of GOES data assimilation, an asymmetric vortex initialization was developed and incorporated into the GSI/HWRF for the first time. It was shown that direct assimilation of GOES-13 and GOES-15 imager radiance observations in HWRF resulted in consistently positive impacts on the track and intensity forecasts of the tropical storm Debby in Gulf of Mexico. The largest positive impact on the track and intensity forecasts came from a combined effect of GOES imager radiance assimilation and an asymmetric vortex initialization. This part of research was documented in the following journal paper:

Zou, X., Z. Qin and Y. Zheng, 2015: Improved tropical storm forecasts with GOES-13/15 imager radiance assimilation and asymmetric vortex initialization in HWRF. *Mon. Wea. Rev*., 143, 2485-2505. doi: 10.1175/MWR-D-14-00223.1.

<u>(2) GOES-R ABI Radiance Assimilation</u>

The launch of the Japanese Advanced Himawari Imager (AHI) on October 7, 2014 represents a new era of geostationary imagers since it provides more channels and higher spatial resolutions of visible and infrared channels than the current geostationary meteorological satellite (GMS) imagers. Compared with any previous GMS imagers, AHI has two more visible, two more near-infrared and seven more infrared channels. The AHI infrared radiance observations are assimilated into the Advanced Research Weather Research and Forecast (ARW) model through the National Centers for Environmental Prediction Gridpoint Statistical Interpolation (GSI) analysis system. In GSI, the cloudy and precipitation–affected radiances are removed through an infrared only cloud detection algorithm (Zhuge and Zou, 2016) that can be used in both day and night. The AHI biases were carefully estimated and incorporated into the GSI/ARW system (Zou et al., 2016). It was shown that the AHI data assimilation significantly improved the QPFs for a typical summer case with persistent precipitation over eastern China (Qin et al., 2016).

The GOES-R ABI is scheduled to launch in November 2016. Besides more channels, ABI will have three four times better resolutions and five times faster scans of the Earth over the current operational GOES satellites, GOES-13 and -15. The only major difference between the Advanced Baseline Imager (ABI) and the Japanese Advanced Himawari Imager (AHI) is that ABI has one less visible channel than AHI. This has no impact on data assimilation of ABI infrared channels. Therefore, the work completed in this project for AHI data assimilation will allow the implementation of GOES-R ABI data assimilation in the GSI system be accelerated as soon as the ABI data become available.

This part of research was documented in the following three journal papers:

Zou X., X. Zhuge and F. Weng, 2016: Characterization of bias of Advanced Himawari Imager infrared observations from NWP background simulations using CRTM and RTTOV. *J. Atmos. Oceanic Technol.*, doi: 10.1175/JTECH-D-16-0105.1.

Zhuge, X. and X. Zou, 2016: Test of a modified infrared only ABI cloud mask algorithm for AHI radiance observations. *J. App. Meteor. Climatol.*, doi: 10.1175/JAMC-D-16-0254.1.

Qin, Z., X. Zou and F. Weng, 2016: Impacts of AHI radiance assimilation on quantitative precipitation forecasts over Eastern China. *J. App. Meteor. Climatol.*, (submitted)

Zhuge, X. and X. Zou, 2016: Impacts of infrared land surface emissivity models on simulations of surface-sensitive AHI channels over different surface types. *J. Geophy. Res.*, (submitted)

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

Related NOAA Strategic Goals: Weather-Ready Nation

Related NOAA Enterprise Objectives: Science and Technology

NGI File # 15-NGI2-125

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

Project Lead (PI) name, affiliation, email address: Ken Heck, Dauphin Island Sea Lab, kheck@disl.org

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

Award Amount: $156,979

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

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

- 8 new metadata records published
- 13 metadata records in active progress
- 7 new datasets submitted to NOAA NCEI Ocean Archive
- Extensive revisions and updates completed for the Data Management Center website. In particular, all of the metadata pages were rewritten and the DISL Data Management policy was updated to reflect current standards of dataset documentation and sharing. http://www.disl.org/research/data-management-center/

Description of significant research results, protocols developed, and research transitions
The data management program at DISL, consisting of a formal Data Management Center, Senior Data Manager, Data Management Specialist, and Data Management Advisory

Committee, has been extremely successful at incorporating metadata creation, data archiving, and overall data management into the regular process of research at DISL.

Transition from FGDC CSDGM to ISO 19115-2 metadata standard has been completed. All metadata written with Data Management Center involvement, and all training workshops going forward, will be in ISO. DISL's customized ISO metadata writing tools continue to be available at http://cf.disl.org/datamanagement/ISO/ISO_index.html.

Information on collaborators/partners:

u. Name of collaborating organization:
   EarthCube OntoSoft Geoscience Papers of the Future Initiative
   http://www.ontosoft.org/gpf
v. Date collaborating established: May 16, 2013
w. Does partner provide monetary support to project? Amount of support? Yes, funding for travel to meetings related to GPF planning and outreach
x. Does partner provide non-monetary (in-kind) support? No
y. Short description of collaboration/partnership relationship: The GPF Initiative is about training geoscientists in best practices for documenting and sharing not just datasets, but also software (computational methods used to process datasets and models) and workflows (fully detailed data processing steps), to facilitate science reproducibility. OntoSoft hosts DISL's software documentation repository at http://disl.ontosoft.org/.

Information on any outreach activities:

- Mimi Tzeng attended the EarthCube All Hands Meeting on July 6-8, 2016 in Denver, Colorado. All Hands is the NSF EarthCube program's primary annual meeting. Approximately 115 attendees. Tzeng represented the EarthCube Governance Engagement Team and presented a poster about OntoSoft's GPF Initiative.
- Mimi Tzeng was a co-instructor for the GPF Training Workshop webinar on Sept 20, 2016.

Related NOAA Strategic Goals: Resilient Coastal Communities and Economies

Related NOAA Enterprise Objectives: Science and Technology

NGI File # 15-NGI2-127

Project Title: Shelf-Slope Interactions and Carbon Transformation and Transport in the Northern Gulf of Mexico: Platform Proof of Concept for the Ocean Observing System in the Northern Gulf of Mexico

Project Lead (PI) name, affiliation, email address: Stephan D. Howden (stephan.howden@usm.edu), The University of Southern Mississippi, School of Ocean Science and Technology, Department of Marine Science.

Co-PIs: Christian Meinig (christian.meinig@noaa.gov) and Scott Stalin (scott.e.stalin@noaa.gov), NOAA Pacific Marine Environmental Laboratory; Richard Jenkins (richard@saildrone.com), Saildrone, Inc.; Jeff Book (jeff.book@nrlssc.navy.mil), Naval Research Laboratory at Stennis Space Center; and Steven Lohrenz (slohrenz@umassd.edu), The University of Massachusetts at Dartmouth.

NOAA sponsor and NOAA office of primary technical contact: Chris Sabine, Pacific Marine Environmental Laboratory.

Award Amount: $1,179,110.00

Project Objectives and Goals:

1. Performing integration, testing and trial missions of the Saildrones in San Francisco Bay and/or Puget Sound

2. Demonstrating the effectiveness of the NOAA/PMEL PRAWLER mooring in conducting profiling measurements at the continental slope of the northern Gulf of Mexico (GoM);

3. Demonstrating the effectiveness of the NOAA/PMEL MADIC system on a mooring (hereinafter referred to as the DIC mooring) at the continental slope of the northern GoM;

4. Demonstrating the feasibility of operating the Saildrone in the northern GoM within a high amount of maritime activity, including commercial and recreational fishing, shipping, and oil and gas platforms (Figure 1) and associated servicing vessels.

5. Demonstrate the utility of “high-speed” (up to 9 knots) wind- propelled autonomous surface vehicles (ASV) as fast adaptive sampling response tools and to effectively fill in gaps between moorings at separations greater than the local correlation length scales;

6. Collect a dataset that can be used for regional ecosystem model development and for designing the observational systems needed for process studies of shelf-ocean exchange phenomena of import to the carbon cycle in the Gulf.

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

- PRAWLER and DIC moorings (Figures 1) recovered in March 2017 on the R/V Point Sur.

- Data from the instruments on the PRAWLER and DIC moorings were processed into scientific units.
- Saildrone SD-128, deployed on September 24, 2015. It logged approximately 10,090 km or 6,256 miles, until it sailed back near Cocodrie, Louisiana and was recovered on January 19, 2016, for an 118 day mission. The vessel was successfully navigated the entire time through the oil and gas platforms (Figure 1) and associated servicing vessels, as well as commercial and recreational fishing vessels and shipping vessels.
- The NRL 1000 m Slocum glider was deployed February 11, 2016 until February 16, 2016. The glider made a total of 349 survey profiles within the geographical box bounded between 28.95N to 29.25N and 88.6W to 88.25W.
- The USM 200 m glider was deployed on February 11, 2016 and recovered from the R/V Pt. Sur on the R/V Pelican on March 15, 2016.
- Data collected with CenGOOS buoy and HFR radars over the entire reporting period.
- Ocean color data from MODIS on Aqua and VIIRS were processed for chlorophyll-a concentration climatology, anomalies and pCO2.
- SMOS data were downloaded for sea surface salinity during the study period.
- Technical Report submitted to NOAA.

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

All six objectives were realized. Table 1 outlines the deployment periods of the monitoring platforms and the intervals of good data from the various instruments.

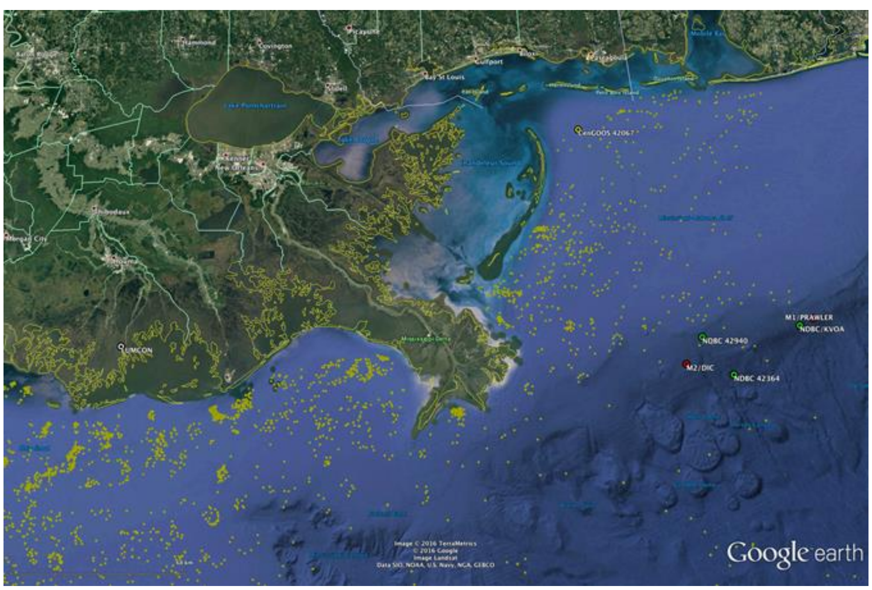


Figure 1.Study area showing the locations of the CenGOOS buoy, the M2/DIC mooring, and M1/PRAWLER mooring, nearby NDBC met/ocean stations and oil and gas platforms from BOEM.

The PRAWLER deployment was successful and provided 8 months of profiling data (e.g., Figure 1 and Table 1). During the deployment the PRAWLER failed and it was discovered that seals had improperly been designed, causing a small water leak that lead to a failure of the electronics. Fortunately, a spare PRAWLER was available as a replacement. This discovery lead to a redesign of the seals for subsequent deployments. The profiling data from the PRAWLER captured Mississippi River plume events, as well as internal waves, which are being investigated for cross-shelf transport. The comparison with the Navy Coastal Ocean Model (NCOM) output (Figure 3) indicates that although much of the variability is captured by the data-assimilative model, details of the in situ variability are missed. However, the model will be useful for understanding the mechanisms of internal wave generation captured by both the model and PRAWLER.

It was demonstrated that the Saildrone is capable of successfully navigating through the oil and gas infrastructure and numerous vessels of all types in the GoM while collecting valuable meteorological and oceanographic data. Figure 4 shows the complete path taken by Saildron SD-128 during the deployment. The mid-December offshore Mississippi River plume event was well sampled by the Saildrone (Figure 5).

Although there were some hardware and logistical challenges, the MADIC system was demonstrated to be capable of measuring time series of dissolved inorganic carbon in the GoM environment. The capability to monitor both DIC and pH is critical to constrain the carbonate system dynamics in the GoM. The detrended DIC time series is shown in Figure 6, with daytime and nighttime values indicated by red and black symbols, respectively.

The CenGOOS met/ocean/ocean acidification buoy, CODAR stations and glider, along with the Naval Research Laboratory glider, provided important mid to outer shelf measurements to complement the moorings on the slope. These data, along with the NCOM model output will help to understand the shelf-slope exchange processes during the study period.

Remote sensing data, including pCO2 obtained following Lohrenz et al., (2017), provided both a historical context to, and large-scale view of, bio-optical conditions during the study period, including during the Mississippi River plume event of mid-December 2015. Figure 6 shows the December 2015 monthly averaged pCO2 from MODIS Aqua. The monthly average smears out the event somewhat, but the effects of the offshore plume are evident near the M2/DIC mooring. The plume event is very clearly captured in the VIIRS imagery (not shown for brevity).

Information on collaborators/partners

Gregg Jacobs, of the Naval Research Laboratory at the Stennis Space Center, provided output from the operational Naval Coastal Ocean Model for this project. The products were an in-kind contribution.

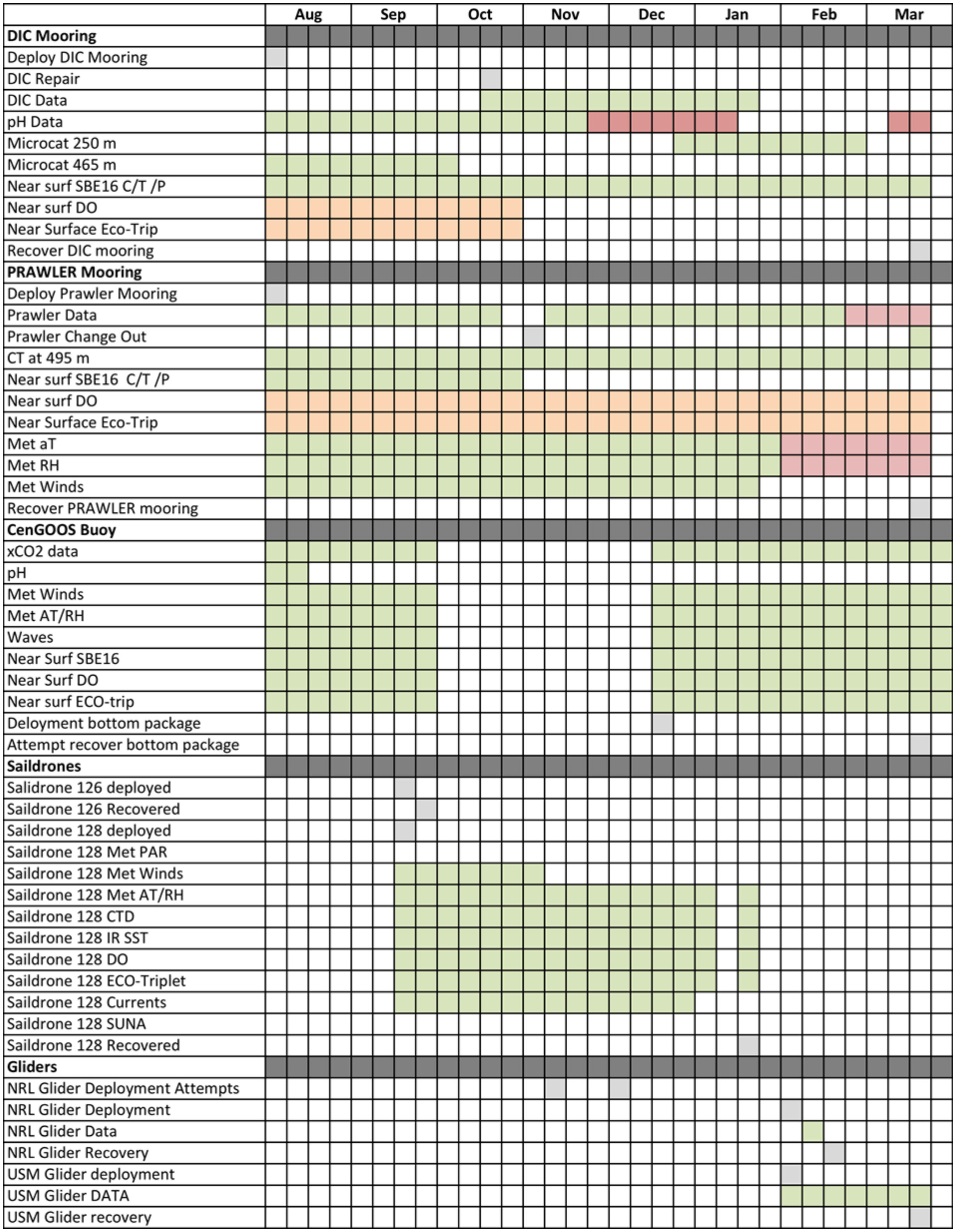


Table 1. Project timeline. Light gray indicate events. Green indicates data that are mostly good and just require some quality control. Red is either suspect or bad data. Orange indicates that data were collected, but not processed to scientific units.

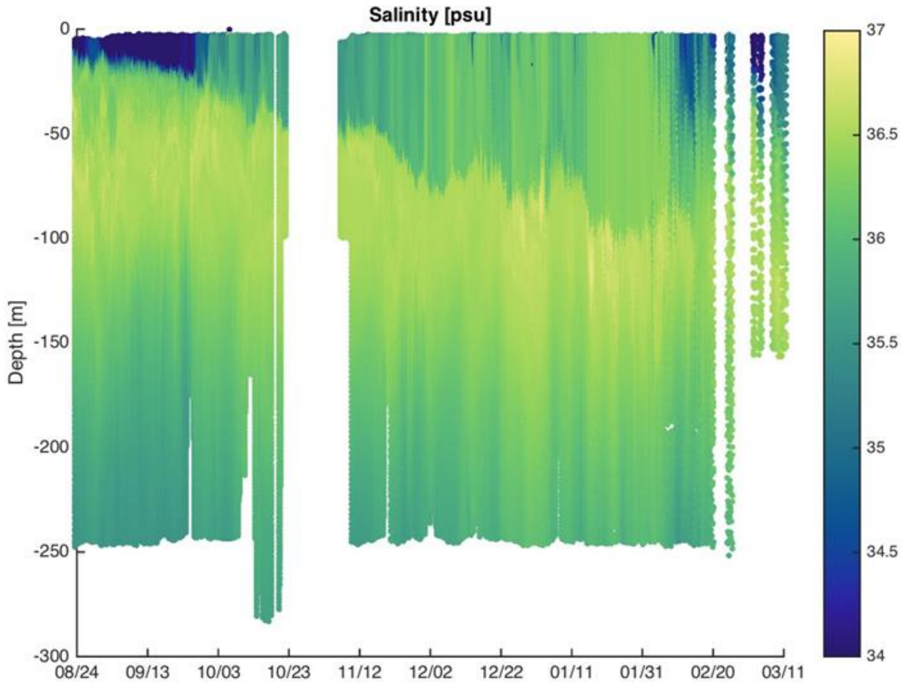


Figure 2. Salinity measured by the PRAWLER. Features of note are the late summer/early fall fresher surface water, mid profile salinity maximum, mid-December Mississippi River offshore plume event, early winter mixed layer deepening and internal waves on the halocline.

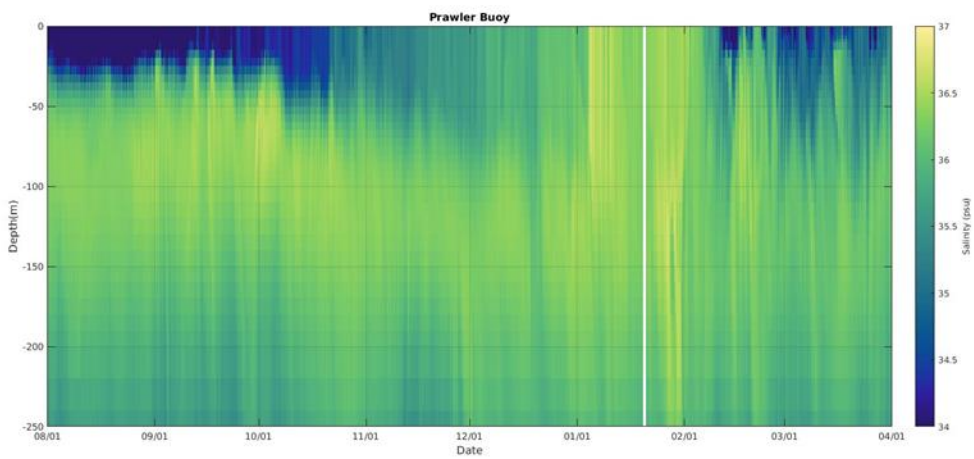


Figure 3. Salinity from the Naval Coastal Ocean Model at the PRAWLER mooring location over the same time period as Figure 2.

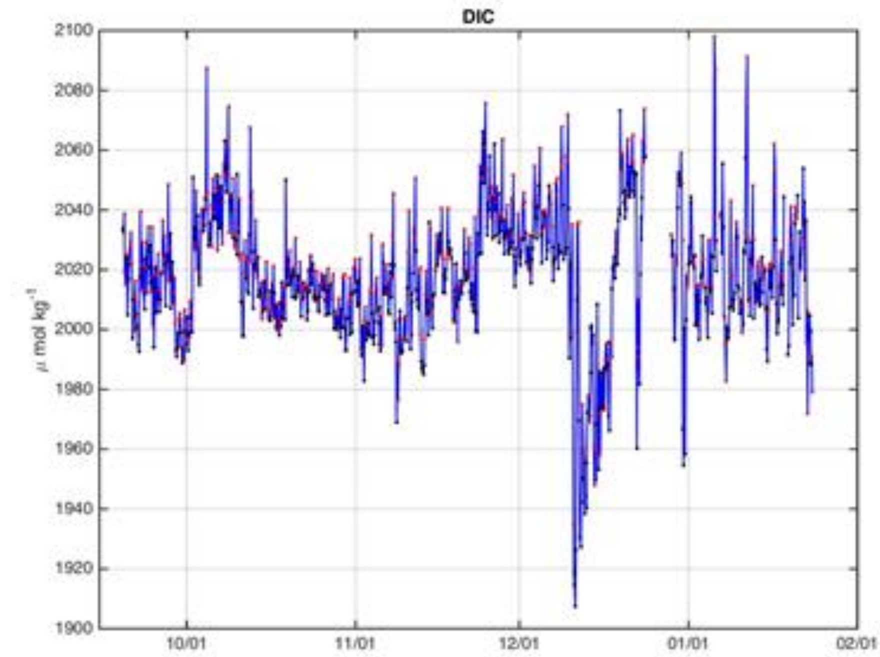


Figure 3. DIC with trend removed. Red symbols are values measured during daylight.

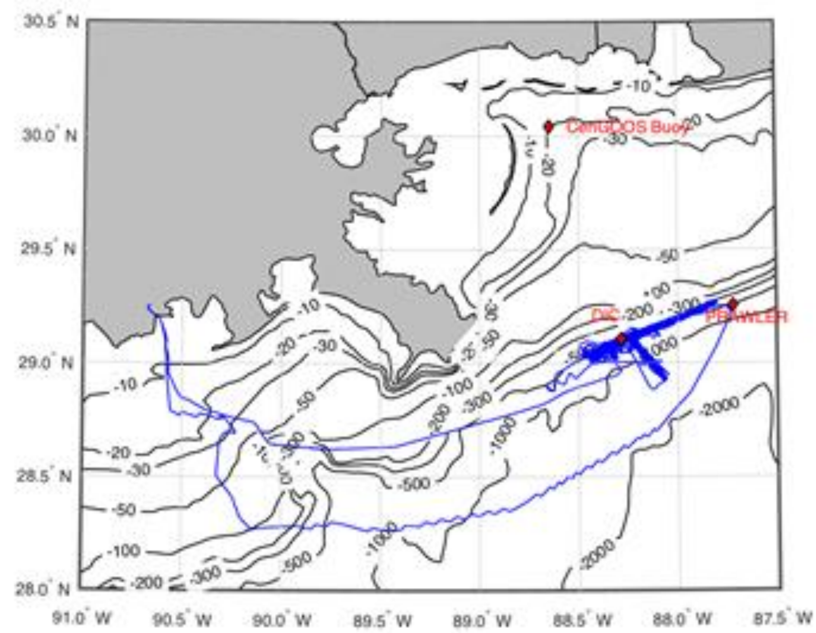


Figure 4. Path of Saildrone SD128 over the entire deployment

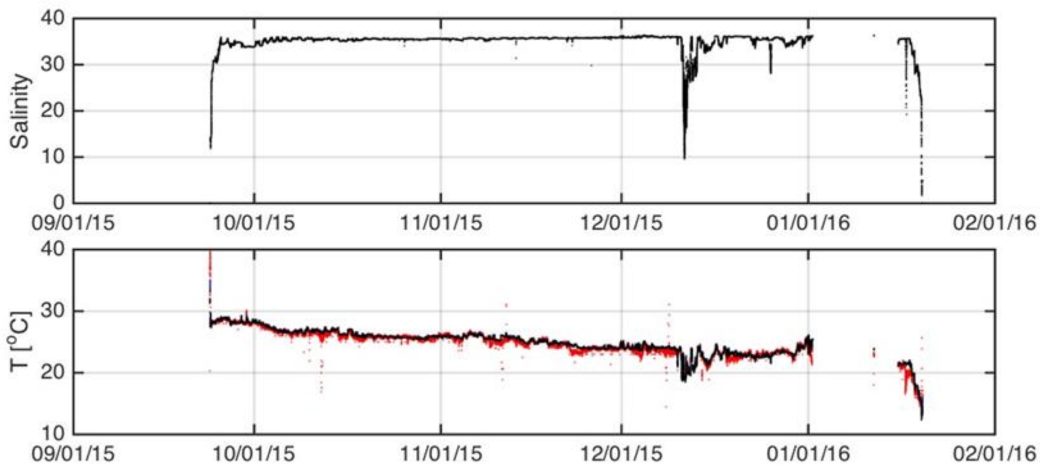


Figure 5. Near-sea surface salinity (top) and temperature (bottom) over the entire Saildron SD128 deployment

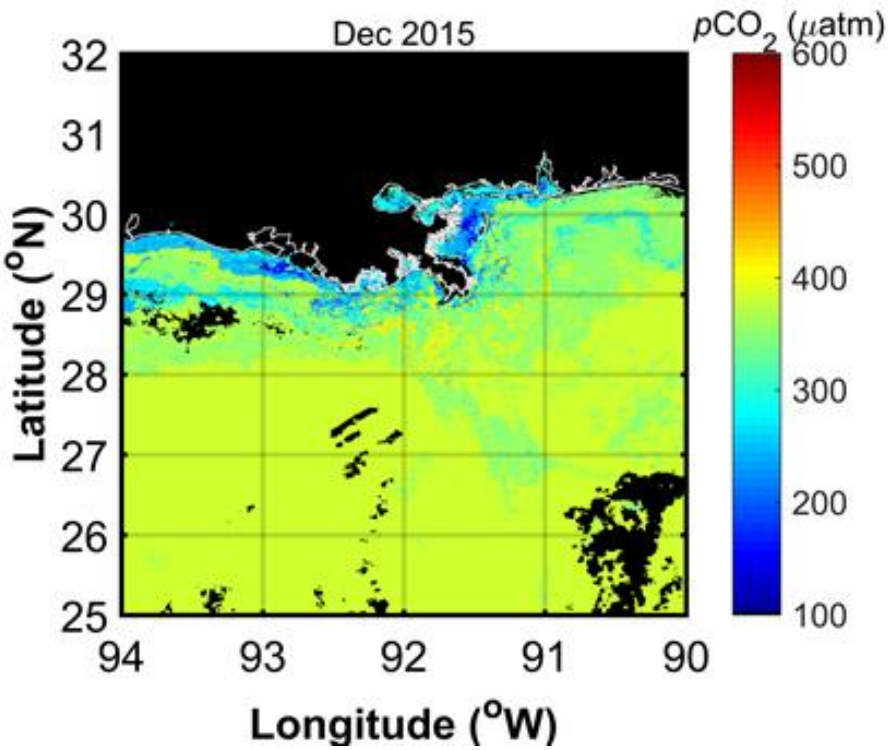


Figure 4. Mississippi River offshore plume event visible in this December 2015 composite of surface pCO2 following Lohrenz et al., 2017.

Information on any outreach activities: None

Economic development activities: Not applicable.

Publications and Presentations

Arnone R., R. A. Vandermeulen, I. M. Soto Ramos, M. K. Cambazoglu, G. A. Jacobs, S. D. Howden and A. D. Weidemann, (2016), Ocean Weather - Interaction of physical and bio-optical processes across a river plume dominated shelf in the Gulf of Mexico, Abstract #90462, Ocean Sciences 2016, 21-26 February, 2016, New Orleans, LA.

References

Howden, S.D., R. A. Arnone, J. Book, M.K. Cambazoglu, G. A. Jacobs, T. Miles, J. Moum, O. Schofield, A. Shiller, A. Weidemann, (2016), CONCORDE: Biophysical Observations, 2016 Gulf of Mexico Oil Spill and Ecosystem Science Conference, 02/01/2016-02/04/16, Tampa, FL.

Howden, S.D.; Cambazoglu, M.K.; Book, J.; Soto Ramos, I.; Parra, S.; Arnone, R.; Jacobs, G.; Miles, T.; Hode, L., Observed surface circulation and pathways over the Mississippi Bight with High Frequency Radars compared with in situ measurements, model output and remote sensing, 2016 Gulf of Mexico Oil Spill and Ecosystem Science Conference, 02/06/2017-02/09/17, New Orleans, LA.

Lohrenz, S., S. Chakraborty, W.-J. Huang, X. Guo, R He, Z. Xue, K. Fennal, S. Howden and H. Tan (2017), Satellite estimation of coastal pCO2 and air-sea flux of carbon dioxide in the northern Gulf, Submitted

NGI File # 15-NGI2-128

Project Title: Collaborative Research: Understanding the Current Flow of Weather Information and Associated Uncertainty, and Their Effect on Emergency Managers and General Publics-Public Perception Research Component

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

Co-PI(s) name, affiliation, email address: Daphne LaDue, University of Oklahoma, dzaras@ou.edu; Jack Friedman, University of Oklahoma, jack.r.friedman@ou.edu

NOAA sponsor and NOAA office of primary technical contact: Erik Rasmussen, NSSL

Award Amount: $51,510

Project objectives and goals
Recent efforts to focus on a comprehensive reimagining of both the operations of and research into severe weather have been profoundly shaped by the FACETs (Forecasting a Continuum of Environmental Threats) concept. FACETs seeks to reconsider and better integrate each of seven, key parts of the effort to protect life and property from the risks of severe weather: 1) grid-based threat probabilities, 2) observations and guidance, 3) the forecaster, 4) threat grid tools, 5) useful outputs, 6) effective response, and 7) verification methods. Central to the FACETs concept is not only an improvement in the hardware, software, interfaces of, and practices of forecasters, but it also relies on an essential integration of *social scientific* research at *all* stages in the continuum addressed by the FACETs concept.

This project, drawing on three different but co-informed research foci in the FACETs continuum, brings a team of social scientists to bear on severe weather forecasting, preparedness, and response. Specifically, we see our research as most directly contributing to a better understanding of the forecasters (#3), the useful outputs (#5), and the effective response (#6) elements of the FACETs concept. Our research teams will provide real-world, real-time observation data of both expert users and a sample of the publics' response to tornadic events in the Huntsville, AL WFO region. This research will be conducted *simultaneous* with the fielding of VORTEX SE, which will be conducted over three three-day research periods during the spring, convective season in the U.S. southeast during the first half of 2016. This project report covers the Team 3 Myers portion of the study, the public response to severe weather in Alabama.

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

Goals / Objectives / Tasks	Planned	Actual
Provide emergency management and other weather enterprise contacts for the region to establish the	Contact all emergency managers in study locations and	All EMs contacted and scheduled for Dr. LaDue's initial meetings. Dates, times, and

professional data sources for the other parts of the study	provide to Dr. LaDue.	travel paths provided to Dr. LaDue.
Conduct online survey, in-person survey, focus group, and interview protocol to obtain public perceptions of how decisions are made with current products and information disseminated through multiple modalities and how these products and information impact decision-making.	Goal was to launch surveys after major events. Interview EMs, broadcast mets, and NWS personnel in region to understand nature of events. Focus groups with impacted residents.	No major events occurred in study region. Delayed survey launch until later in the study period to capture all events. Expanded geographic region of study to capture respondents who experienced significant severe weather. 373 total survey responses. Conducted interviews with emergency managers, broadcast mets, and NWS personnel to understand the unusual nature of events. Season was not typical so interviews helped to inform interpretation of the data collected. Over 30 interviews completed. Focus groups were not done since there were no significant weather events to evaluate.

Table of Planned VS Actuals for Team 3 Myers

Milestone	**Planned**	**Actual**
Relationships set in place to allow researchers access to the populations being studied	By 12/31/15	Established baseline network of weather enterprise partners to make contact with study populations in first quarter of project. Process continued throughout survey and interview phase as severe weather did not evolve as expected. Expanded geographic boundary of project to include Central Alabama where severe weather did occur.
VORTEX SE operations period	March-April 2016	Monitored severe weather activity during operations period to determine when to launch survey and interviews. Interviews were conducted throughout the operations period and through late spring and summer.

		General survey was launched in April.
Final project report	By September 2016	Data analysis was done throughout data collection and completed in September. Final report draft completed in September.
Presentations and publications	(no date specified)	Multiple Integrated Warning Team Meetings and Weather Enterprise Workshops. National Weather Association and AMS Conferences Multiple media interviews in Alabama. Blog post for Weather Social website in production. Articles in production.

Description of significant results, protocols developed, and research transitions

Outcomes of the award:

- Provided emergency management network contacts and planned travel for Dr. LaDue's initial emergency manager meetings in the study region.
- Completion of online and in person surveys and interviews.
- Completion of analysis of data on public perceptions of tornadoes in North and Central Alabama.
- Weather enterprise outreach with analysis results. Multiple conference and workshop presentations and discussions using analysis results.
- The results of this study will serve as the baseline data for the household cohort study to be undertaken by the PI in FY 17. This study began October 1, 2017.

Performance measures defined in the proposal have been achieved.

Findings Related to the Public:

- Findings in North Alabama were consistent with results in Central Alabama, indicating that the differences in the amount of severe weather did not impact the results. In fact, North Alabama respondents were slightly more weather aware than Central Alabama respondents. Given that the more severe weather was in Central Alabama, North Alabama's higher level of awareness was most likely from the more significant impacts they have had in the last few years, meaning that they were more aware regardless of the lack of weather this season.
- The lack of severe weather in North Alabama allowed for findings regarding severe thunderstorm warnings. Most respondents were not taken by surprise with the weather, except in the cases of severe thunderstorms and the misfiring of sirens. Most of the weather during the study period was severe thunderstorms and respondents complained about the lack of a good warning process for severe thunderstorms. In several cases, respondents indicated that the warnings were not strong enough for the impacts of the severe thunderstorm. In some cases, they indicated that there was no warning for what they perceived to be very severe thunderstorms and then suddenly there was a tornado

warning out of the blue. This finding has come up in several previous studies and in some of the NWS service assessments. There is a real need to explore better ways to warn for severe thunderstorms.

- Respondents also described events for which they received warnings, but the tornadoes were gone before the warning could be issued. These are short-lived, short track tornadoes that spin up, do their damage, and are gone immediately. The public tends to blame the warning process for these events, because they don't understand the difficulty of warning on these types of tornadoes.
- Some of the respondents gave credence to the idea that there are tornado alley paths in their region. They recalled that impacts this season seemed to be related geographically to previous events. When describing 2016 impacts, respondents tended to refer to previous tornadoes in the same area. They also described differences, such as tornadoes or severe storms took a different than typical path. Respondents tended to want to make those comparisons when describing the new event.
- Some of the events took place during the night, which allowed for data collection on how people get warnings at night. People depend on polygon-based warnings at night to determine how they should respond. If they are in the polygon, they move their families to their designated shelter space. If they are not in the polygon, they go to bed and make sure that they have all of their modalities close by for new warnings.
- The major warning modalities for respondents are cell phone apps, television, NOAA weather radio, and sirens. Cell phone apps seemed to be the new modality and everyone seemed proud they knew to have them, but when asked what the most effective modalities were, meaning they most depended on, it was NOAA weather radio and television. This appears to be a result of timing. Respondents perceive that NOAA weather radio and television get the warnings our faster than the other modalities, but they do believe that cell phone apps are great when they are not at home and need warnings and they are also a potentially good modality for nighttime events. Many respondents indicated that they would prefer a cell phone app over the NOAA weather radio at night, just because of the noise associated with NOAA weather radio. The least effective modalities were social media, alert notifications, and sirens.
- The first response to a tornado warning is to wait and see for location confirmation. When asked what would motivate them to take shelter immediately, two-thirds indicated a confirmed tornado, followed by a tornado warning, location, timing, and a visual. Respondents continuously confirmed that they will not take action unless they confirm that that the tornado is going to come near their location. They want to "wait and see" with additional information about the path and location of the tornado. Polygons, timing, and confirmation evidence are critical to this "wait and see" mode for respondents.
- Primary shelters are interior rooms, followed by personal shelters, community shelters, and basements. Most respondents indicate interior rooms since not everyone may have a personal shelter. Personal shelters are not as common in Dixie Alley as they are in Tornado Alley. Basements are also not common in Alabama. More community shelters are available in Alabama after the 2011 tornadoes and are used by primarily by residents in manufactured homes. However, such respondents indicate that they decide to use those shelters only in the most extreme circumstances.
- Half of the respondents perceive that they get 1-3 tornado warnings per year and the other half perceive they get 4-6 warnings per year. This is fairly accurate. There are two tornado seasons in Alabama and if both seasons are active, the count would be 4-6 warnings on average.

- When asked about the number of warnings for Spring 2016, they recalled mostly severe thunderstorm warnings and to a lesser degree tornado watches. Around half of the respondents were aware of tornado warnings and flood warnings during the 2016 season. This is very accurate to the Spring 2016 season so there is good awareness of the warnings and the type of warnings.
- Just under half indicated that they never received an All Clear from a warning. About a third indicated they had received an All Clear message. Previous studies have raised the issue of not getting an All Clear message. Respondents are concerned about knowing when the danger has passed and this leads them to become fatigued responding to watches and warnings. There is a definite need to incorporate "All Clear" messaging in the warning process.
- Due to a lack of severe weather impacts, most respondents reported no property or physical damage. The damage that was reported involved mostly hail damage and tree damage. The greater impacts were in Central Alabama and the impacts did involve home damage, but the geographic distribution was small.
- For weather events during the 2016 season, the primary action taken was to gather more information. Less than half of the respondents in North Alabama sought shelter while nearly two-thirds of Central Alabama respondents sought shelter. This finding makes sense, given that the more severe weather was in Central Alabama.
- Most respondents had an emergency plan for severe weather. Respondents explained their plans and how they used them for the different types of warnings and for overnight events and unique events. Their plans are based on severity of the warning, location, and timing. Tornado warnings are the highest priority and their emergency plan is significant when location and timing make it their problem. They have plans for tornado watches, severe thunderstorms, and floods, but they are not of the highest priority so their plans are not as protective as their tornado warning plans.

Information on collaborators/partners
The PI for Team 3 is Dr. Laura Myers, Director and Sr. Research Scientist, Center for Advanced Public Safety, College of Engineering, at the University of Alabama Tuscaloosa. Dr. Myers' research team included Sara Gallman and Darrell Arnold, research associates.

Collaborated with Team 1 and Team 2 PIs, Dr. Daphne LaDue and Dr. Jack Friedman, The University of Oklahoma.

Organizational partners included the State of Alabama Emergency Management Agency, local county emergency managers, the National Weather Service Offices in Huntsville and Birmingham, Alabama, and local television stations and their broadcast meteorologists in the Huntsville and Birmingham DMAs.

Information on outreach activities:

- Analysis of the public perception data completed.
- The Team 3 Project PI has presented the analysis results in weather enterprise conference presentations and workshop presentations nationally and in the Vortex-SE study region.
  - Conference and workshop presentations completed
    - AMS Summer Meeting, July 2016
    - Huntsville, AL Integrated Warning Team Workshop, August 2016
    - National Weather Association 2016 Conference, September 2016
    - University of Alabama Engineering Leadership Workshop, September 2016

        - NWS Greer Integrated Warning Team Workshop, Charlotte, NC, October 2016
        - NWS Greer WFO workshop, Greer, SC, October 2016
        - NWS Tallahassee Integrated Warning Team Workshop, Thomasville, GA, November 2016
- The Team 3 Project PI has given multiple media interviews throughout the project period on the ongoing study and results.
- Articles and blogs in production
    - The Weather Social blog: Blog post on public perception results, https://thewxsocial.com/
    - Article drafts in production on multiple outcomes from public perception analysis. Intend to draft article with Dr. LaDue and Dr. Friedman, the other Team PI's on the project.

Related NOAA Strategic Goals: Weather-Ready Nation

Related NOAA Enterprise Objectives: Science and Technology

NGI File # 15-NGI2-130

Project Title: Advancing the Use of Airborne Lidar Bathymetry (ALB) for Navigational Charting

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: $293,619

Project Objectives and Goals

The goal of this project is to develop the methodology through which ALB data can be routinely incorporated into the navigational charting workflow of the Office of Coast Survey. This goal will be accomplished by undertaking a pilot project that evaluates ALB data as to their adherence to standards required for navigational charting, develop the documentation to support the submission of the data into the navigation charting workflow, and develop the data format for this submission.

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

Coos Bay Lidar to Chart Effort - Thirty-eight contemporary CZMIL surveys were examined and eleven of those surveys had sufficient over-water coverage to warrant further investigation. Of the eleven significant surveys only five overlapped to some degree with existing multibeam acoustic surveys. USM graduate students identified multiple locations of JALBTCX data that were acquired within the 2 years. A report was generated on these sites and delivered to NOAA for site selection. NOAA selected a site at Coos Bay, OR that consisted of significant bathymetric coverage and recent NOAA bathymetric multibeam data that could be used for data comparison. The main focus initially was driven around the use of ArcGIS in incorporating LAS data into a format where batch processes, and internal ArcGIS workflows could be potentially developed. This process was very time consuming and many hurdles were encountered, with limited success.

The software focus moved to PFMABE, a NAVO developed software package that is free for public use. This software package allows the user to ingest large amounts of digital LAS data, review and clean the data, and then generate bathymetric gridded exports. These data were then used to conduct a comparison against the current chart.

Data Density Analysis - In conjunction with the effort to assemble the Coos Bay lidar data for submission to Office of Coast Survey, one graduate student focused on the JALBTCX data in regards to meeting IHO order 1a, with regards to data uncertainty, object detection and data densities.

This project found that in Coos Bay, OR the data met IHO Order 1a for data uncertainty, did not meet the data density requirement and no statements could be made on object detection.

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

Coos Bay Lidar to Chart Effort - A full report on the data package was compiled with descriptions of how the data differed to the current chart and recommendations for updates to the chart.

The report included discussion on the following:

- Project description
- Project acquisition and Processing
- System calibration
- Data coverage
- Data density
- Data uncertainty
- Dangers to Navigation
- Charting updates

Also generated was a detailed workflow document for NOAA to follow for future JALBTCX LAS data incorporation into the NOAA charting pipeline.

NOAA Office of Cost Survey provided very positive responses on the final workflow documents as well as the report of the survey.

The results of this project were presented at the JALBTCX conference in 2017 in Savannah, GA.

Data Density Analysis - This project found that in Coos Bay, OR the data met IHO Order 1a for data uncertainty, did not meet the data density requirement and no statements could be made on object detection.

These results were presented during the poster session at U.S. Hydro 2017 in Galveston, TX.

Related NOAA Strategic Goals: Resilient Coastal Communities and Economies

Related NOAA Enterprise Objectives: Science and Technology

NGI File # 15-NGI2-131

Project Title: Infrastructure Development, Initial Data Analysis, and Field Campaign Activities

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

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

Award Amount: $704,404

Project objectives and goals

Milestone	Status	Details
Development of a "mini-MIPS", named the *Rapidly Deployable Atmospheric Profiling System* (RaDAPS)	Operational in late April 2016, completed in June 2016.	Components: 915 MHz wind profiler, microwave profiling radiometer, ceilometer, surface meteorological measurements[2]
Analysis of pre-existing data	Continuing	a) Impacts of terrain on tornado behavior b) Properties of low-level clouds around cold season tornadic storms, primarily QLCSs
VORTEX-SE 2016 deployments, including IOPs 4A-4D that utilized RaDAPS	Completed	See summary table for brief description of IOPs below

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

1. Infrastructure development: The *Rapidly Deployable Atmospheric Profiling System* (RaDAPS).

This platform is smaller and more agile than the Mobile Integrated Profiling System (MIPS). Work on the RaDAPS started in early September 2015 and was completed in June 2016. Three deployments were made for the last three IOP's (late April) of the VORTEX-SE 2016 field campaign. RaDAPS activities include the following.

a) Remodeling of a truck platform. A 2002 box ambulance (on a Freightliner truck with air-ride chassis) was available for this project. The box was removed and replaced with a 15.5 ft flatbed, and the cab was repainted. Other mechanical parts were installed:
    1. 7 kW generator and auxiliary fuel tank.
    2. Hydraulic leveling jacks
    3. The cab interior was remodeled, including swivels for the two seats in the cab. The truck has an extended cab with approximately two feet of open space

[2] UAH funding was used to procure additional instruments for the RaDAPS: METEK Micro Rain Radar,

between the seat back and back wall. During research operations, these seats can be rotated to access the wall-mounted computer controls (mouse, keyboard) and wall-mounted monitors. Refer to Fig. 1.

4. A computer cabinet was installed to the rear of the pass-through doorway (cab to previous ambulance interior). It houses the 915 MHz profiler electronics boxes, the 915 MHz profiler computer, and two additional computers.
5. An air conditioner was installed.
6. A 12 ft telescoping tower was installed to allow in situ wind measurements at the 4 m AGL level (Fig. 2).

b) The following instruments were installed, all shown in Fig. 2:
   1. DeTect 915 MHz wind profiler ($271k)
   2. Radiometrics 35-channel radiometer (MP-3000A, $161k))
   3. Vaisala CL 51 ceilometer (new, purchased with UAH funds, $31k).
   4. Lufft surface instrument package with T, RH, wind (ultrasonic), pressure, solar radiation, and precipitation ($3700). This instrument package is mounted on a telescoping tower that elevates the instruments to 4 m AGL.

Figure 1. View of the RaDAPS computer rack and work area, located in the rear of the cab.

Figure 2. RaDAPS instruments, from left to right: 915 MHz wind profiler antenna, Radiometrics microwave profiling radiometer, surface instrument cluster on a telescoping tower (in folded position), and a Vaisala CL 51 ceilometer. A Mesodome 360° camera (http://www.mesodome.com/, not shown) will be mounted on top of the computer cabinet adjacent to the telescoping tower.

2. Data analysis

A Ph.D. student finished a M.S. thesis, which examined the characteristics of tornadoes around topographic features. This study identified three common modes of behavior for tornadogenesis (TG) or tornado intensification (TI): (i) TG/TI occurring on the downslope, (ii) TG/TI occurring on top of plateaus (Sand Mountain), and (iii) TG/TI occurring as large scale circulations move upslope on top of Sand Mountain. In this latter category, about 50% of the tornadoes occurring on Sand Mountain have occurred over only 20% of the area of the Sand Mountain plateau in the vicinity of the upslope movement.

Another M.S. graduate student analyzed radar data to determine the relative fraction of tornadoes spawned by supercell vs. QLCS parent storms. The distribution over the total number of cases is about 50% in each category (March-May). While supercell-spawned tornadoes tend to be more prevalent from afternoon to early evening. QLCS events dominate the late evening to early morning hours, and also during all hours of the cold season (DJF).

Ceilometer data are now being 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. For example, in one supercell case, cloud fraction was 100% during the 3-h period ending with closest passage of the parent storm ~20 km north of the MIPS site. Cloud base height averaged about 500 m AGL during this particular event. This data base will be expanded to include 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 will also compare measured cloud base with the surface-based LCL for all proximity tornado events to validate and extend results presented in Craven et al. (2002).

3. Pre-VORTEX-SE deployment activities (2015-2016)

UAH facilities were deployed on potentially severe weather days, as summarized Table 1.

Table 1. Summary of Pre-VORTEX-SE deployments.

Date	Type of system	Systems deployed (and location)	IOP Summary
12/14/15	QLCS, no severe weather	MAX @ Tanner MIPS @ 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
12/23/15	QLCS, no severe weather	MAX @ Tanner, MoDLS @ KHSV MIPS @ SWIRLL	Documented development of a supercell storm on the south end of a QLCS line segment as the atmosphere destabilized during the nocturnal period. MoDLS documented turbulence over an extended smooth surface.
2/2/16	Scattered non-severe storms	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.
2/23/16	Nocturnal QLCS	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

4. <u>VORTEX-SE field campaign activities</u>

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 2016 field deployments

Date IOP #	Type of system	Systems deployed (and location)	IOP summary
3/1/16 Shakedown	QLCS, no severe weather	MAX @ Grove Oak, MoDLS @ Ft. Payne, MIPS @ SWIRLL	A weakening rainband moved over the domain. Upon ascent over Sand Mountain, distinct streaks in radial velocity were measured by the MAX radar. The MoDLS Doppler Wind Lidar recorded elevated turbulence apparently generated over Lookout Mountain.
IOP 1 3/13/16	QLCS, no severe weather	MAX @ Tanner MIPS @ SWIRLL	Nocturnal system weakened under appreciable cooling under clear skies.

1800 (3/13) 0915 (3/14)			
IOP 2 3/24/16 0900 (3/24) 2200 (3/24)	QLCS, no severe weather	MAX @ Courtland, XPOL @ Tanner MoDLS @ Courtland, MIPS @ Rogersville	Mesovortex was documented within a weakening QLCS, two CI events associated with wave reflectivity segments (WRS).
IOP 3 3/31/16 1800 (3/31) 0300 (4/1)	Supercell storms and EF-2 tornado event	MAX @ Courtland XPOL @ Florence MoDLS @ Courtland MIPS @ Russellville	Supercell storms (with tornado warnings) formed during the afternoon along the TN-AL border. Later, during the 0100-0200 UTC time frame, CI occurred along a NE propagating wave-like boundary, and a preexisting storm produced an EF-2 tornado near Priceville after the wave feature intersected it.
IOP 4A 4/27/13 1800 (4/27) 2330 (4/27)	BL evolution, QLCS	MIPS @ SWIRLL MAX and MoDLS @ Courtland, RaDAPS @	QLCS with a more intense storm on southern end north of TN-AL border (within ARMOR-KHTX lobe). Good BL evolution day.
IOP 4B 4/29/13 1730 (4/29) 2315 (4/29)	Weakening QLCS	MIPS @ SWIRLL MAX and MoDLS @ Courtland, RaDAPS @ Russellville	Weakening QLCS moved over domain, wave-like features were apparent in reflectivity. More intense QLCS segment in southern portion of domain after 2200 UTC moved over RaDAPS. WRS features were apparent.
IOP 4C 4/30/16 1400 (4/30) 2230 (4/30)	Mesoscale evolution, Supercells	MoDLS at Hartselle, MAX @ Courtland, MIPS @ SWIRLL, RaDAPS @ Russellville	The atmosphere over the VSE domain destabilized during the day as lower/middle tropospheric water vapor increased. Several isolated supercell storms, some exhibiting strong low-level rotation, formed over the network. Most intense storms were confined to a small domain. Observations from MoDLS suggest an evolving (heterogeneous) boundary layer.
IOP 4D 5/1/16 1630 (5/1) 2030 (5/1)	Boundary layer evolution	MoDLS at Priceville exit, MAX @ Tanner, MIPS @ SWIRLL, RaDAPS @ Boeing / County Line Rd	With severe deep convection unlikely, a BL experiment was conducted over a smaller domain centered over western Madison, Limestone and Limestone County. Convective initiation occurred around 21 UTC near the end of the IOP within the SW dual Doppler lobe of MAX and ARMOR (18 km baseline)

Description of significant research results, protocols developed, and research transitions
A comprehensive damage survey was conducted on the Falkville-Priceville tornado, which occurred on 31 March 2016. Ground surveys were completed by NWS/HUN office personnel, and this was supplemented with several follow-up surveys by UAH personnel. The secondary surveys disclosed that tornado formation occurred sooner and the tornado dissipated later. Some of these ambiguities were clarified by our SPoRT partners, a helicopter overflight, and several UAS overflights conducted by NOAA/ARL and ENRGIES, a private company in Huntsville. This collaborative activity will be documented in a poster or oral presentation at the upcoming Conference of Severe Local Storms.

Information on outreach activities
We continue to conduct guided tours of the SWIRLL building on a regular basis We have provided 17 formal tours since January 2016, and this rate continues to increase. Groups include senior citizens, social clubs, K-12, foreign groups, and other visitors. We also accept invitations to special conferences and “Weatherfests” when possible. For these events, several graduate students will drive 1-2 mobile facilities to the location of the event. Other “mobile” tours have been conducted at K-12 schools.

Related NOAA Strategic Goals: Weather-Ready Nation

Related NOAA Enterprise Objectives: Science and Technology

NGI File # 15-NGI2-132

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

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

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

Project objectives and goals

The MDEM project 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:

- Objective 1: Lidar datasets for the six Mississippi coastal counties were received by the principal investigator in November of 2016. The lidar data acquisition task was combined with lidar data collection tasks for other areas in the state and funded with funds from the U.S. Geological Survey and the U.S. Department of Agriculture.

  The lidar data meets QL2 standards and was reviewed by NOAA's Office of Coastal Management during the spring of 2017. The data has been made accessible on-line through the Mississippi Automated Resource Information Systems (MARIS) and the Office of Coastal Management.

- Objective 2: LIDAR data acquired in Objective 1, along with additional LIDAR data acquired in 2015 and high-resolution aerial imagery from 2006 and 2012, was used to develop an enhanced (1:4800) hydrography database compatible with the standards set forth by the USGS for the National Hydrography Dataset. The primary focus of this objective was to develop the enhanced hydrography for the HUC-8 watersheds which occupy area in the six Mississippi coastal counties. Cost savings realized in Objective 1 permitted additional hydrography datasets to be developed in the adjacent counties covered by LiDAR collected in 2015 (external to the data acquired in Objective 1) for counties north of the six coastal counties. A complete list of HUC_8 basin addressed in the hydrography datasets developed are:

  - Mississippi Coastal - all (03170009)
  - Lower Pearl- part (03180004)
  - Pascagoula - all (03170006)
  - Escatawpa - part (03170008)
  - Black - part (03170007)
  - Lower Chickasawhay - all (03170003)
  - Upper Chickasawhay - part (03170002)

- Lower Leaf - part (03170005)
- Upper Leaf - part (03170004)
- Middle Pearl-Silver - all (03180003)

The hydrography database was submitted to the USGS for inclusion in their extensive

NHD holdings. MDEQ QA work consisted of (1) review of completeness of the developed hydrography line work and data attributes, and (2) coordination with the USGS review for incorporation into the NHD. As in Objective 1, data developed in this objective is available through publicly accessible geospatial clearinghouses.

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 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: Weather-Ready Nation, Resilient Coastal Communities and Economies

Related NOAA Enterprise Objectives: Engagement

NGI FILE #15-NGI2-133

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

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

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

Award Amount: $468,713.00

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

<u>Technical Assistance and Coordination</u>

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. Progress was made in planning a hypoxia research coordination workshop that aims to establish a cooperative hypoxic zone monitoring program. Regional groups were identified to inventory ongoing monitoring related to hypoxia in the respective regions.

Technical assistance was provided in conjunction with NGOMEX recently funded hypoxia and living marine resource models. Drs. Ashby and Lewitus participated in a coordination workshop and provided insights into the application of the modeling in the hypoxic zone. A workshop with the NGOMEX funded hydrodynamic and water quality models was planned for March of 2017 but was cancelled due to inclement weather. The workshop was rescheduled for September 13-14, 2017.

<u>Observations and Monitoring</u>

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 scheduled for July 2016 by LUMCON was cancelled due to ship scheduling issues. As a result of the cancellation, an event-oriented cruise was conducted from

22-23 August 2016 to acquire oceanographic and biological data on two cross-shelf transects across the hypoxic zone. Objectives of this cruise were to:

- Collect data and samples from 12 stations (7 along Transect F, 8 along Transect C);
- 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;

The R/V Pelican (Chief Scientist Nancy Rabalais, LUMCON) conducted observations along transects south of Terrebonne ("Transect C", capturing discharge from the Mississippi River) and off the Atchafalaya River outflow ("Transect F"). These two river systems provide the majority of freshwater and nutrient input to the Gulf. Results from this late/summer – early fall event cruise were used to develop hind casting projections with three deterministic models developed through NGOMEX and currently in prototype testing through the IOOS COMT program for transition to operations. Data were used to characterize the dynamics of the dead zone from spring through late summer based on data supplemented by the cruise using the following models:

- 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 were presented to the Gulf Hypoxia Task Force at their December 2016 Public Meeting. A more detailed summary of the cruise is included as Appendix A.

<u>Hypoxia research coordination workshop</u>: The 6th *Annual NOAA/NGI Hypoxia Research Coordination Workshop: Establishing a Cooperative Hypoxic Zone Monitoring Program* annual workshop co-led by NGI and NOAA was conducted in September of 2016. The purpose of the workshop was to identify likely and potential commitments for support of a multi-partner Gulf of Mexico Hypoxic Zone monitoring program, and plan the follow-up coordination needed to move forward with implementation.

Workshop Input: A pre-workshop monitoring strategy with current and proposed programmatic and financial requirements to inform workshop proceedings.

Workshop Output-1: Workshop report identifying partners and mechanisms necessary to implement and sustain a Cooperative Hypoxic Zone Monitoring Program (draft in review by Workshop Steering Committee).

Workshop Output-2: Establishment of small teams of workshop attendees to advance implementation of key elements of Gulf monitoring identified at the workshop. Workshop discussions led to identification of eight workgroups to develop building blocks for a cooperative, sustainable 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.

Also, since the modelers workshop originally scheduled for March of 2017 was cancelled, a follow-up coordination meeting is planned prior to the *7th Annual NOAA/NGI Hypoxia Research Coordination Workshop* (schedule tbd).

Description of significant research results, protocols developed, and research transitions
The areal extent of the dead zone in FY 2015 was measured based on mid-summer ship survey. The 2015 area of low oxygen, commonly known as the ‘Dead Zone,’ measured 16,760 square kilometers (6,474 square miles). The result was greater than model predictions that were based on predicted nutrient loads (5,875 square miles). Near real-time data was posted to the web site (http://www.gulfhypoxia.net) along with graphic representation of the data.

Information on collaborators / partners

z. 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 membership of the committee is: 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

aa. Date collaborating established: July 2009
bb. Does partner provide monetary support to project? Amount of support? None Reported
cc. Does partner provide non-monetary (in-kind) support? Yes
dd. Short description of collaboration/partnership relationship: Workshop co-sponsor

Information on any 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

Appendix A

Summary of 2016 Hypoxia Season Activities

Nancy Rabalais
Louisiana Universities Marine Consortium

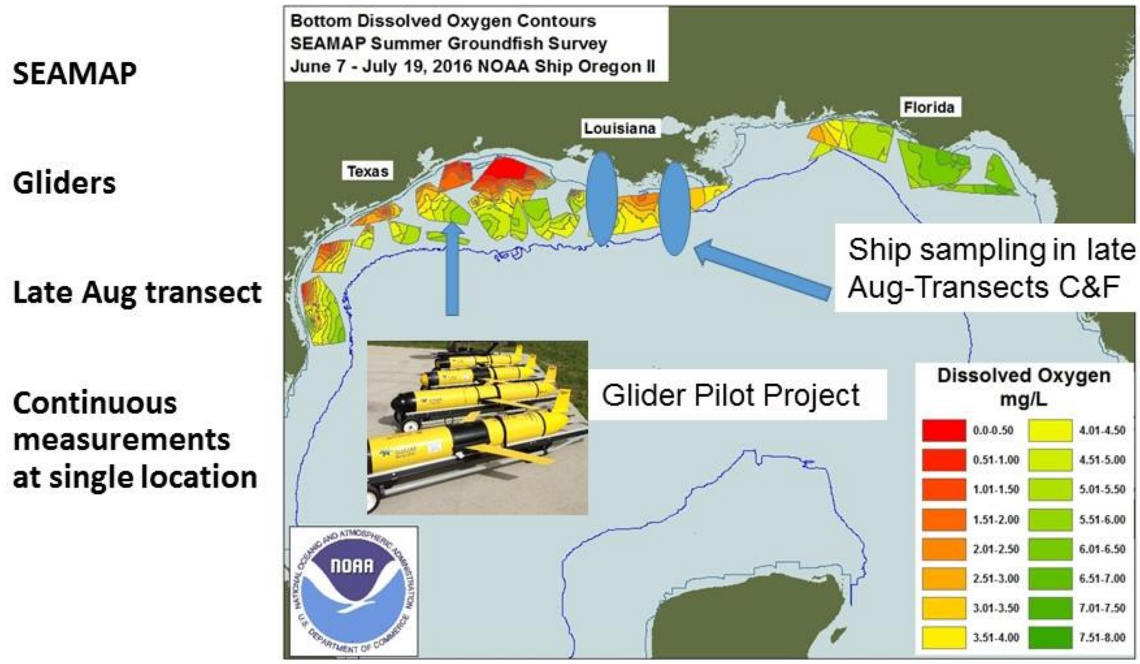
Attempts to utilize NOAA Nancy Foster for 2016 Shelfwide Cruise

The use of the NF for the 2016 cruise began on 2-14-14 with a Ship Time Request. Considerations for use of the NF for 2016 began in summer of 2015. Between then and the cancellation of the cruise in July 2016, the PI, Nancy Rabalais, and her staff submitted forms, attended conference calls, worked with NOAA NOS Kimberly Puglise to make the effort work successfully, submitted similar forms in a different format, continued to work with Puglise as a liaison with NOAA OMAO, had medical exams with TB tests, submitted forms related to their competency to be on the NF, and waivers for foreign nationals. We also negotiated several dates of operations, and times and locations of pick up and drop off. We bought and prepared materials for the cruise. We rented vehicles to move personnel and equipment to the departure dock and for pick up at the final dock. We did this several times with the changes in the dates of the cruise. We finally tried to change our crew as possible to meet alternative dates for departure and return. Eventually the cruise was cancelled because of NF engine problems and the lack of suitable alternative dates of sufficient duration to conduct a shelfwide cruise. We then worked with NOAA NOS to find suitable vessels as alternatives, including RV Pelican and RV Manta. Neither were available at the appropriate time for the shelfwide cruise.

Hypoxia season 2016 activities

The standard 2016 shelfwide cruise was cancelled because of mechanical failure of the NOAA Nancy Foster. However, there were significant events related to a coral die-off at the Flower Gardens Banks off the Texas/Louisiana Border. As a result, NOAA's National Center for Coastal Ocean Studies funded activities in 2016 to supplement available information that would facilitate predictive models for conditions of hypoxia in 2016. This included transects C and F on August 22-23, glider transects along the Louisiana/Texas border that included the Flower Garden Banks.

Bottom-water continuous oxygen data were collected from July through October. A glider was deployed in the area between Galveston Texas and the Flower Garden Banks (Texas A&M University). The efforts of two 3-D dynamic physical models coupled with biogeochemical components were engaged to predict what the 2016 shelfwide hypoxic area might have looked like. The SEAMAP summer groundfish survey mapped oxygen conditions from the Rio Grande to the Mississippi River delta between June 7 and July 19. There were areas of low oxygen in nearshore waters along the Texas coastline and a large area of low oxygen off southeast Louisiana.



Collection of dissolved oxygen data in 2016 by various groups.

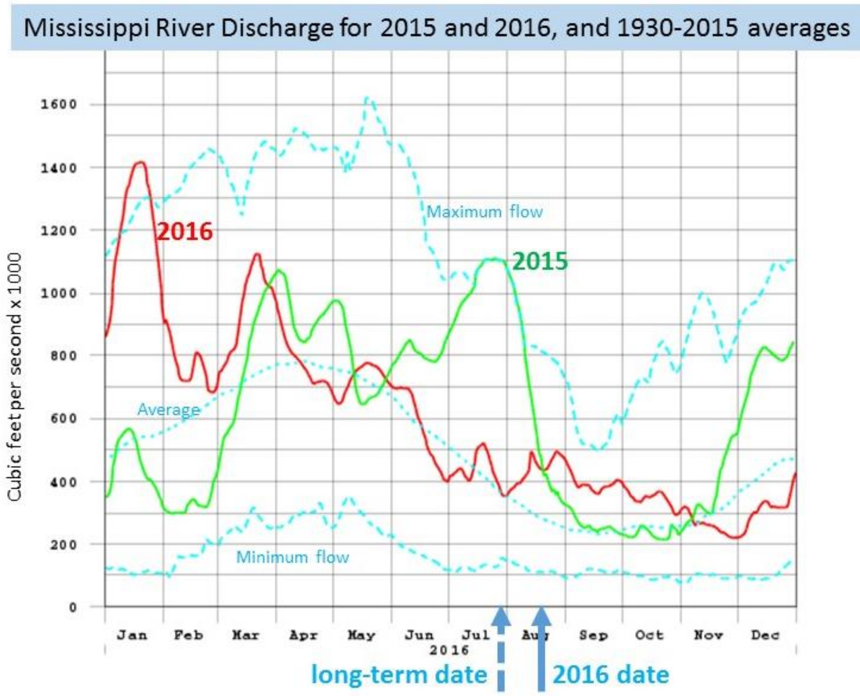
<u>LUMCON Sampling efforts for 2016</u>

Transects C and F from the series of typical shelfwide stations were part of a cruise during 22-23 August for comparison with long-term data. Cruise participants were:

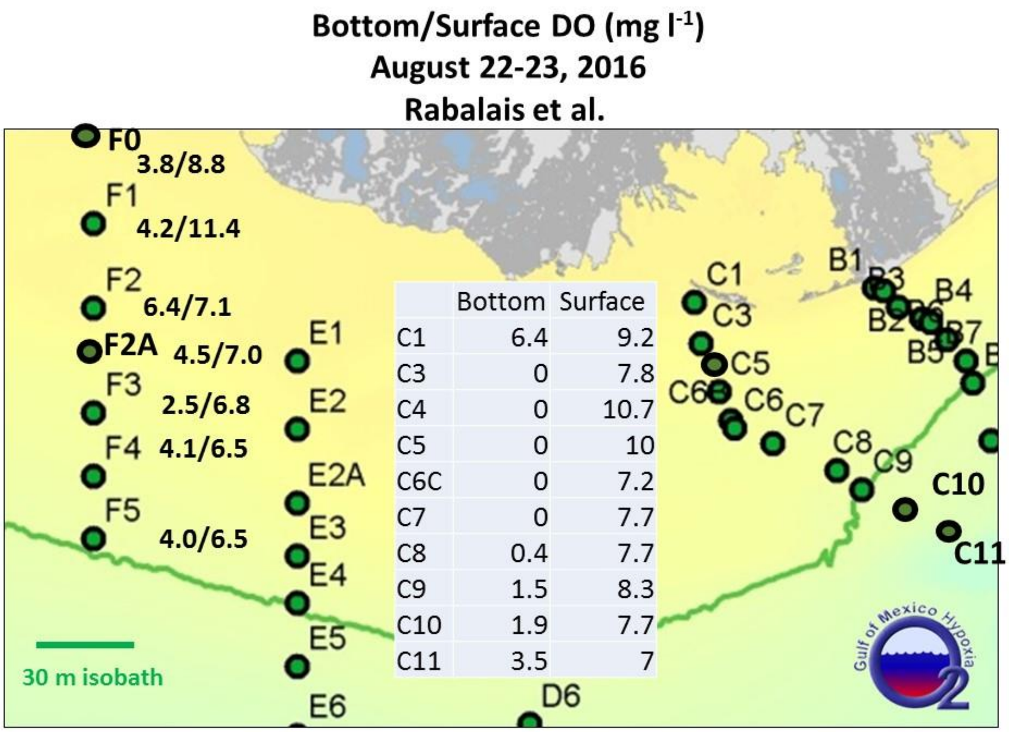
Nancy Rabalais, LSU/LUMCON, Chief Scientist
Shivakumar Shivarudrappa, LUMCON, Postdoctoral Associate
Logen Pietraroia, LUMCON, Research Assistant
Xinping Hu, Texas A&M University – Corpus Christi, Visiting Scientist
Hongjie Wang, Texas A&M University – Corpus Christi, Visiting Ph.D. Student

The smaller crew was possible because of the timing of departure and work resulted in daylight operations. Also, the available attendees was reduced significatnly with the changes in date of the summer cruise (i.e., vacations or other activities planned). The TAMUCC participants were for the collection of underway pCO2 measurements and sediment samples necessarya for the completion of a Ph.D. student’s research (planned well before the cancellation of the shelfwiede cruise).

The timing of the August cruise was well beyond the time originally identified, but still within a higher than normal discharge of the Mississippi River.



River discharge for 2016 was high in May, when the prediction was made, decline through the summer, with some above average flows in August to October.

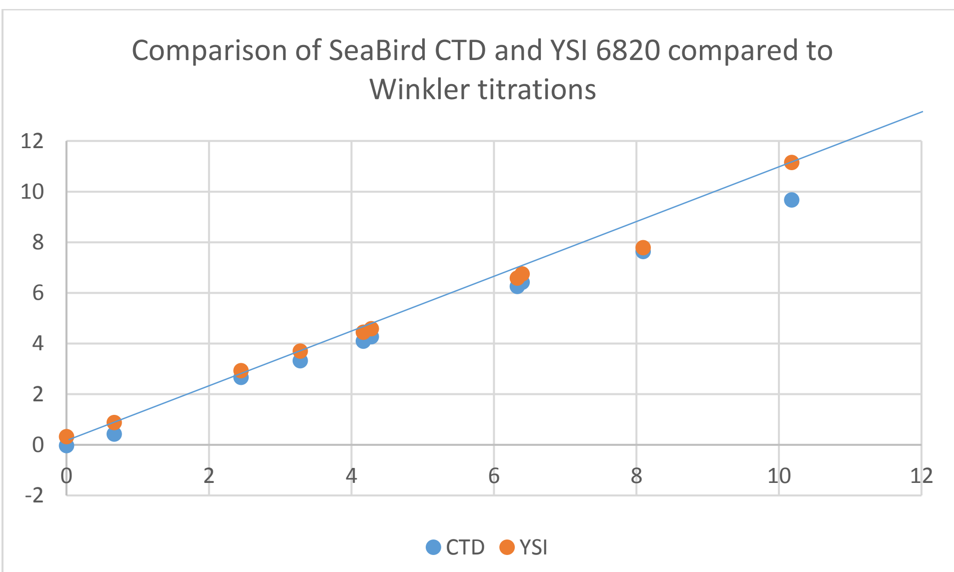


Hypoxia was not present along the F transect for the 22-23 August cruise, but was severely low for much of the C transect and into much deeper water than usually recorded. Several stations were anoxic, without any dissolved oxygen. [See sample Winklers.]

Samples prepared for Winkler titrations showing from left to right: anoxia, extremely low oxygen, and well-oxygenated waters.

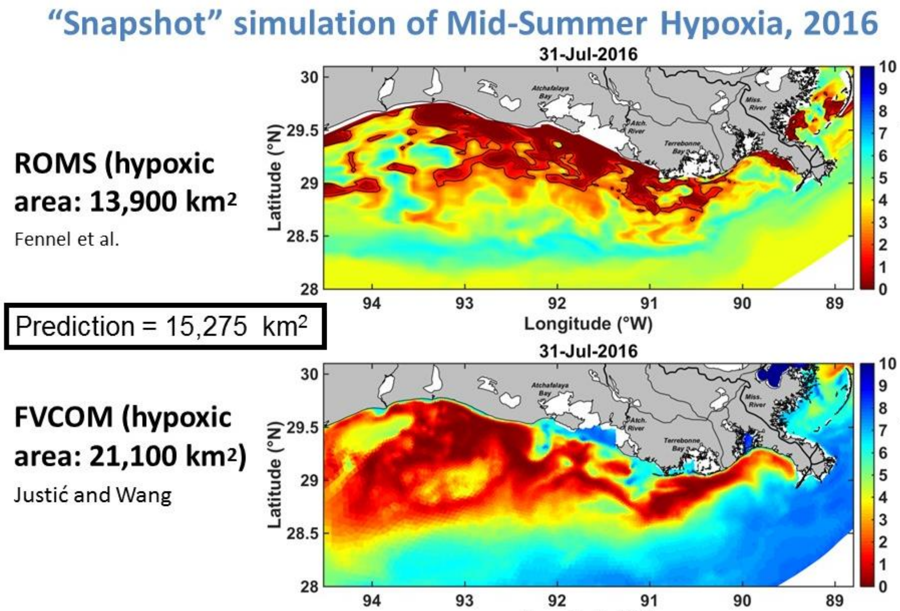
Provision of 2016 data for model development

There was rapid turn-around of the transect C and F data from the YSI 6820 meters. The more complicated post-processing of the CTD SeaBird data are still underway, along with quality control/quality assurance for those data, nutrients, chlorophyll, and other parameters for submission to NOAA NCEI. The comparisons of the SeaBird CTD and the YSI 6820 were close to each other and the Winklers, but there was a consistent offset from the 1:1 relationship. The data were corrected, but this is not final until the full QA/QC is applied to all data.

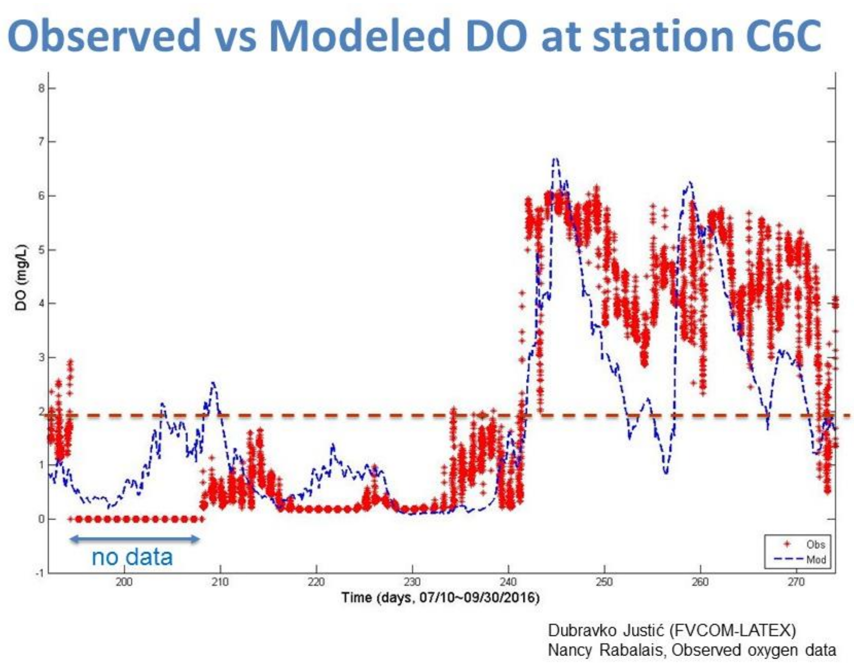


SeaBird and YSI DO data versus the Winkler titrations.

The data were supplied to the Hetland/Dimarco, Fennel et al. and the Justić and Wang modeling groups for validation of their 2016 hypoxia simulations.



Two models simulations predicted the bottom-water area of hypoxia during the last week of July, the usual time of the cruise.



The Justić and Wang FVCOM model simulated the bottom-water dissolved oxygen at station C6C.

These data and various analyses and presentations of the data were provided to Rob Magnien for his presentation to the Mississippi River Nutrient/Gulf of Mexico Hypoxia Task Force for its December 16, 2016 meeting in New Orleans, Louisiana. Rabalais, Turner and Justić were present.

Press coverage of the 2016 hypoxia season was posted at http://www.gulfhypoxia.net along with information from the 2016 hypoxia season work by LUMCON.

NGI FILE # 15-NGI2-134

Project Title: Telepresence, Information Management, and Data Product Development for Stennis Exploration Command Center

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

Co-PI(s) name, affiliation, email address: Adam Skarke, Mississippi State University, skarke@gri.msstate.edu

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

Award Amount: $278,986

Project objectives and goals

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

Working closely with the OER *Okeanos Explorer* Program, a suite of iconographic information products, which are available via the OER Digital Atlas and online web portal, has been developed. Coupled with the high definition video streams from the *Okeanos Explorer* explorations, the post-cruise management of this data is challenging due to the spatial and temporal dimensions of the data, the data volume, and the need to extract empirical data form the video for scientific use. The goals of this project are to: 1) enhance methods for scientific participation in sea going oceanographic research expeditions from shore using telepresence, including the management and operation of the Stennis ECC during ocean exploration dives; 2) develop innovative data access and visualization tools to allow the broader science community to utilized OER data and; 3) provide infrastructure and data management support for exploration research data.

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

Research Conducted/Milestones for Goal 1: During the reporting period, the ECC was operated for support of eight live ocean exploration activities:

- July-August 2016: *Okeanos Explorer* / Deepwater Wonders of Wake: Exploring the Pacific Remote Islands Marine National Monument

- August-September 2016: *Okeanos Explorer* / Telepresence Seafloor Mapping in the Pacific Remote Islands Marine Nationa Monument – Ake Island Unit
- December 2016: *Okeanos Explorer* / Shakedown, Calibration, and Testing in the Main Hawaiian Islands
- January-February 2017: *Okeanos Explorer* / CAPSTONE Telepresence Mapping in Pacific Marine Protected Areas
- February-April 2017: *Okeanos Explorer* / 2017 American Samoa Expedition: Suesuega o le Moana o Amerika Samoa
- March 2017: *Okeanos Explorer* / Discovering the Deep: Exploring Remote Pacific Marine Protected Areas
- April 2017: *Okeanos Explorer* / Telepresence Mapping in American Samoa and the Cook Islands
- April-May 2017: *Okeanos Explorer* / Mountains in the Deep: Exploring the Central Pacific Basin

During non-dive times the ECC was utilized to replay high-definition video streams from the dives, to both demonstrate the ECC capabilities to visitors and dignitaries, as well as to support and promote ocean exploration and STEM in general. Additionally, a receive-only video system with audio was operated in support of outreach within the Portera High Performance Computing Center facility in Starkville for all of the above listed *Okeanos Explorer* activities.

Research Conducted/Milestones for Goal 2 (*Develop innovative data access and visualization tools to allow the broader science community to utilize OER data):* Caitlin Ruby, who held the master's level graduate assistantship position specified in the project narrative, successfully defended her M.S. thesis on March 9. 2017 and graduated from MSU on May 6, 2017. Caitlin completed her master's degree in the Mississippi State University Department of Geosciences under the direct advisement of Co-PI Skarke and maintained a 4.0 GPA throughout her graduate career. Her academic concentration was geospatial sciences and her graduate research focused on developing geospatial tools for the visualization and analysis of video data collected with the NOAA remotely operated vehicle Deep Discoverer.

Caitlin's graduate research at Mississippi State University and resulting thesis document directly supported the milestones identified in goal two of the project narrative. Specifically, her research developed novel methodologies for visualizing video data collected from a mobile platform in the deep sea with geographic information systems. Caitlin formally presented the results of her graduate research at the National Oceanic and Atmospheric Administration's (NOAA) Environmental Data Management Workshop January 9-10, 2017 and in a meeting with the NOAA Office of Coastal Management for the Gulf Region on April 20, 2017.

In recognition of the merit of her graduate research associated with this project, Caitlin was awarded first place for an oral presentation at the Mississippi State University Graduate Student Symposium held on March 30, 2017. Additionally, she has been nominated for the 2018 NOAA Knauss Marine Policy Fellowship by the Mississippi-Alabaman Sea Grant Consortium.

The full text of Caitlin's M.S. thesis can be accessed here: http://search.proquest.com/docview/1889833726/fulltextPDF/8E3C89AAE3F4494DPQ/1?accountid=34815

Research Conducted/Milestones for Goal 3: During this reporting period, the data and information sharing infrastructure was utilized for the storage of over 6.3 Terabytes of web-accessible data that is referenced from the NCEI catalog. This web-accessible data consists of 80 Okeanos mission data sets. The infrastructure served data to 4,695 unique IP addresses during the reporting period.

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

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

On July 26, 2016 Caitlin Ruby presented her research and a general overview of remotely operated vehicle applications to approximately 20 middle and high school teachers participating in the "Technology in Marine Science" workshop hosted by the Dauphin Island Sea Lab of the University of Southern Alabama.

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

Related NOAA Enterprise Objectives: Science and Technology

NGI File # 15-NGI2-135

Project Title: Certificate Program Curriculum Development in Social Science Applications for Meteorologists

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

NOAA sponsor and NOAA office of primary technical contact: Ming Ji, NWS

Award Amount: $45,397

Project objectives and goals
The goal of this project is to develop curriculum for a training program in social science applications to meteorologists and meteorology professionals in FY16. The program will consist 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 OCLO to provide the curriculum content and delivery methods in FY16 for future delivery of the courses beginning 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.

Description of significant results, protocols developed, and research transitions

- Development of course content for five courses containing multiple modules of instruction.
- Feedback assessment of content with OCLO provided information on how to approach this content with the trainees. It was determined that this should be developed and taught at a 300 level of instruction and it should emphasize that meteorologists should collaborate with social scientists to do weather enterprise research and not conduct social science research alone.
- The course content was modified to reflect that feedback.
- Audio recordings of the course content have been completed and were placed into the eLearning shell. This involves an extensive process of matching the audio to the PowerPoint, the visual images and other slide content. A significant amount of research has been done to capture appropriate images and examples relevant to the intended audience.
- All five courses were finalized in the eLearning shell and were reviewed and editied by the team.

- The five courses were delivered to OCLO as the final deliverable in preparation for pilot testing in the next grant, FY17.

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 outreach activities:
Conference and workshop presentations completed:
AMS Summer Meeting, July 2016
Huntsville, AL Integrated Warning Team Workshop, August 2016
NWS Greer Integrated Warning Team Workshop, Charlotte, NC, October 2016
NWS Greer WFO workshop, Greer, SC, October 2016
NWS Tallahassee Integrated Warning Team Workshop, Thomasville, GA, November 2016
Weather Enterprise Partner Workshop, Tuscaloosa, AL, November 2016

Publications and Presentations:
Presentation on curriculum to OCLO, Kansas City, MO

Related NOAA Strategic Goals: Weather-Ready Nation

Related NOAA Enterprise Objectives: Science and Technology

NGI File # 16-NGI2-139

Project Title: Improvements to TAO Delayed-Mode Data Processing

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

Co-PI(s) name, affiliation, email address: Yee Lau, Mississippi State University, lau@gri.msstate.edu

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

Award Amount: $81,167.40

Project objectives and goals
The Tropical Atmosphere Ocean (TAO) array (renamed the TAO/TRITON array in 2000) consists of approximately 50-70 moorings in the Tropical Pacific Ocean, telemetering oceanographic and meteorological data to shore in real-time via the Argos satellite system. The array is a major component of the El Niño/Southern Oscillation (ENSO) Observing System, the Global Climate Observing System (GCOS) and the Global Ocean Observing System (GOOS). The data is available from the National Data Buoy Center (NDBC) at: http://tao.ndbc.noaa.gov .

Existing procedures to process the 55 delayed-mode TAO data currently requires numerous legacy programs in different programming languages, and in multiple machines with different operating systems residing at separate physical locations within the NDBC's Mission Control Center. This process is fragmented, labor-intensive, and can also cause errors in the input. This project developed a unified user-friendly software package in one GUI environment for the Windows 7 operating system which will significantly reduce data processing time and operator errors.

Description of research conducted during the reporting period and milestones accomplished and/or completed
Through meetings and interactions with NDBC, Yee Lau incorporated existing NDBC programs as well as new programs in a Java GUI interface. The process was done iteratively through NDBC meetings, NDBC staff software testing, and emails.

This new GUI incorporates a user-friendly and customizable front-end seamlessly with existing TAO delayed-mode data processing programs. Only minor changes in terms of user inputs have been changed in the NDBC Legacy programs. The resulting TaoGUI performs the following tasks:

- Connects to a NDBC MySQL database
- Creates data directories and transfers data
- Concatenates Tube data
- Gets required metadata & data calibration files
- Creates processing event logs
- Converts and concatenates data to usable format
- Trims data

- Previews time-series data graphically
- Provides edit and quality-control edit data
- Flags data
- Calculates derived data
- Saves and exports data and metadata
- Calculates estimated data file sizes and alerts user if needed
- Retrieves start and end time from deployment, recovery, and repair logs
- Matches subsurface sensor property numbers and types with existing sensor files
- Identifies processed and unprocessed delayed-mode processing steps
- Constructs default user settings to minimize user input time
- Provides flexibility to change default user settings
- Passes user settings as input arguments to PERL and MATLAB scripts

Description of significant results, protocols developed, and research transitions
A unified user-friendly GUI, known as TaoGUI, has been developed for the Windows 7 operating system as the gateway to the existing TAO delayed-mode data processing programs. The free and popular open source NetBeans IDE and Java Scene Builder applications have been used to facilitate rapid GUI prototyping as well as software program development and management. This Java GUI requires a main configuration file to set up default directories and variables, and a sql configuration file to connect to the MYSQL database. It utilizes a cascading style sheet (css) to provide a convenient way to customize the look and feel of the GUI.

The GUI has 3 components: a top, middle, and bottom section. The top section displays the current user name, current selected station and deployment information, and 7 action buttons. These buttons allow the user to look at a summary log, flag data, transfer final data files to web-staging area, send email to TAO group members, clear the message area, stop the current process, and read the document manual.

The middle section of TaoGUI contains 12 main task (tab) pages and 5 sub-task pages. Each tab page (except the very 1st one) corresponds to an existing TAO delayed mode data processing step. In general, each tab page (processing step) should be completed in sequence by its order of appearance in the tab pane. The color rectangle around each tab label indicates if the tab page has been processed before. The default colors are red for unprocessed tabs, and yellow for processed tabs

The “Station/Deployment” tab page is the entry point of TaoGUI. It allows user to select a station from the map, and a deployment from the deployment lists so that subsequent processing tasks can begin. The second task copies the tube data and the sensor data from the lab directories. The next steps involve concatenating the tube data, reformatting the data into a legacy format, performs quality control, plots for further evaluation, followed by options to edit the data.

The bottom section has a message area which displays GUI status and all program output messages.

Information on collaborators/partners:
Karen Grissom, Dawn Petraitis, Matthew Winterkorn, Daniel Pounder (NDBC)

Related NOAA Strategic Goals: Climate Adaptation and Mitigation

Related NOAA Enterprise Objectives: Science and Technology

NGI File # 16-NGI2-140

Project title: High Resolution Digital Surface Model (DSM) Creation from UAS Data

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

NOAA sponsor and NOAA office of primary technical contact: Cecelia Linder, NMFS

Award Amount: $9,540

Project objectives and goals

To create a high resolution digital surface model (DSM) of 600 acres or less of land, which is part of a marsh reconstruction project.

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

We used a small UAS to create a digital surface model (DSM) of a marsh reconstruction project in Bayou Dupont, located approximately 15 miles south of New Orleans and approximately 3 miles west of the main stem of the Mississippi River. The horizontal and vertical resolution of the resulting DSM was 2 inches.

The UAS collected a series of overlapping images, all within a few hours. We determined about 25 ground control points (GCPs) using a Trimble Geo 7 Series Premium Centimeter Kit with TerraSync Centimeter Edition Software. We used 5 of these GCPs to fix the DSM and 20 as check points (CPs) to compute the accuracy of our solution.

Deliverables included:

1. The individual images that were captured and the associated metadata for both images and the flight log files
    a. The individual images were provided in JPEG format
    b. Log files were provided in ASCII text format and included the latitude, longitude, and altitude of the payload for each image taken
2. An orthophoto of the area based on the DSM in GeoTIFF format. The resolution was 2 inches.
3. A digital surface model (DSM) was provided in GeoTIFF format. The DSM was generated at the same resolution as the orthophoto.
4. The GCPs for soil collection points

Description of significant results, protocols developed, and research transitions

We showed that a 1000 acre marsh can be overflown by a small UAS and imagery obtained at 2 inch resolution in one day. Using about 5 GCPs, the resulting mosaic can be geo-referenced to sub-inch accuracy in hours. Creating a 3D point cloud takes longer and requires more overlap between each image.

Economic development activities

The research showed that a local operator can collect the requisite data. It demonstrated the capability of the UAS to provide the necessary information.

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

Related NOAA Enterprise Objectives: Science and Technology

NGI File # 16-NGI2-141

Project Title: Bias characterization and hurricane initialization using ATMS, SSMIS, and AMSR-2

Project Lead (PI) name, affiliation, email address: Xiaolei Zou, University of Maryland, xzou1@umd.edu

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

Award Amount: $188,626

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

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

- Further refinement of ATMD warm core retrieval algorithm
- Hurricane initialization using ATMS and AMSR-2 retrievals

Description of significant research results, protocols developed, and research transitions
Further refinement of ATMD warm core retrieval algorithm
The Advanced Technology Microwave Sounder (ATMS) is a cross-track microwave radiometer. Its temperature sounding channels 5-15 can provide measurements of thermal radiation emitted from different layers of the atmosphere. In a past study, the traditional Advanced Microwave Sounding Unit-A (AMSU-A) temperature retrieval algorithm was modified to remove the scan biases in the temperature retrieval and to include only those ATMS sounding channels that are correlated with the atmospheric temperatures on the pressure level of the retrieval (Tian and Zou, 2016). A performance comparison between the two algorithms was carried out for Hurricane Sandy when it moved from tropics to middle latitudes. It was shown that scan biases that are present in the traditional retrieval are adequately removed using the modified algorithm. In addition, temperature retrievals in the upper troposphere (~250 hPa) obtained by using the modified algorithm have more homogeneous warm core structures and those from the traditional retrieval are affected by small-scale features from the low troposphere such as precipitation. Based on ATMS observations, Hurricane Sandy's warm core was confined to the upper troposphere during its intensifying stage and when it was located in the tropics, but extended to the entire troposphere when it moved into subtropics and middle latitudes and stopped its further intensification. The modified algorithm was also applied to AMSU-A observation data to retrieve the warm core structures of Hurricane Michael. The retrieved warm core features are more realistic when compared with those from the operational Microwave Integrated Retrieval System (MIRS).

Zou, X. and X. Tian, 2016: ATMS and AMSU-A derived warm core structures using a modified retrieval algorithm. *J. Geophy. Res.,* **121**, 12,630-12,646. doi: 10.1002/ 2016JD025042.

Further improvements are made to the modified warm core retrieval algorithm developed by Tian and Zou (2015). These mainly included (i) a latitudinal dependent regression equation and (ii) a principle component analysis (PCA) based removal of noise in ATMS observations. A journal paper is near completion:

Tian, X. and X. Zou, 2017: Further refinements of an ATMS hurricane warm core retrieval. *Quart. J. Roy. Meteor. Soc*., (to be submitted)

Hurricane initialization using ATMS and AMSR-2 retrievals

Significant improvements have been obtained for the forecasts of hurricane track, but not intensity, especially during the first 6-12 hours. In this study, a simplified four-dimensional variational (4D-Var) vortex initialization model is developed to assimilate the geophysical products retrieved from the observations of both microwave imagers and microwave temperature sounders. The nonhydrostatic axisymmetric hurricane model developed by Rotunno and Emanuel (1987) is used as the dynamic constraint for assimilating the ATMS and AMSR2 retrieval warm core temperature, sea surface temperature, sea surface wind speed, cloud liquid water path, and total precipitable water. The goal is to generate more realistic initial vortices than the bogus vortices currently incorporated in the Hurricane Weather Research and Forecasting (HWRF) model in order to improve hurricane intensity forecasts. Hurricane Gaston (2016) is selected for testing the newly proposed satellite observation based 4D-Var vortex initialization algorithm. Preliminary numerical results showed promising features of the vortex structures at initial times.

Tian, X., 2017: Improved satellite microwave retrievals and their incorporation into a simplified 4D-Var vortex initialization using adjoint techniques. *Ph. D. Thesis*. University of Maryland, USA.

Tian, X. and X. Zou, 2017: A simplified 4D-Var hurricane-vortex initialization assimilating AMTS and AMSR2 retrieval products using a nonhydrostatic hurricane model and its adjoint. *Mon. Wea. Rev*., (to be submitted)

Information on outreach activities:

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

- Type – Speaker
- Name of event - The 97th AMS Annual Meeting
- Date - January 22-26, 2017
- Location - Seattle, Washington
- Description - A poster presentation
- Approximate Number of Participants - several hundred scientists participating in the meeting

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

Related NOAA Enterprise Objectives: Science and Technology

NGI FILE # 16-NGI2-142

Project Title: Northern Gulf of Mexico Sentinel Site Cooperative Intern

Project Lead (PI): Steve Ashby, Mississippi State University, sashby@gri.msstate.edu

NOAA sponsor and NOAA office of primary technical contact: Kristen Laursen, NMFS, kristen.r.laursen@noaa.gov

Award Amount: $14,340.00

Project objectives and goals

The Northern Gulf of Mexico Sentinel Site Cooperative (NGOM SSC) is one of the five Sentinel Site Cooperatives within the broader NOAA Sentinel Site Program (SSP). The NGOM SSC is a partnership focused on sea-level rise and inundation in the northern Gulf of Mexico. A broad array of partners working along the science to stewardship continuum make up the Cooperative and work together to fill identified gaps and needs in sea-level rise science and management. To assist in this project, the Northern Gulf Institute will provide an intern to work with researchers to compile relevant data and conduct analyses as appropriate.

The intern will implement priority tasks and actions outlined in the Northern Gulf of Mexico Sentinel Site Cooperative's (NGOM SSC) 2016 work plan. Priority actions include the following:

- Work with partners to develop a survey to help identify parameters for Continuously Operating Reference Stations (CORS) inventory.
- After appropriate parameters are identified, reach out to partners to conduct a comprehensive inventory of CORS within the boundaries of the Cooperative (e.g., coastal counties extending from the Pearl River in Louisiana to the Suwanee River in Florida).
- Develop a list of points of contact for elevation data in the region.
- With assistance from partners, identify a list of standards to apply to elevation data sets.
- Complete an elevation data inventory within the boundaries of the Cooperative.
- Time permitting, the intern may work with DOI partners to conduct a gap analysis of the CORs and elevation data.
- Present findings at relevant meetings (e.g., GOMA Data and Monitoring team) and begin to develop a data sharing plan.

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

This project was completed in October of 2016.

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

An inventory of CORS parameters was developed in collaboration with the NGOM SSC. The complete dataset is being hosted by the GCPO LCC's Coastal Planning Atlas, https://gcpolcc.databasin.org/datasets/557fea38d6df484c9e1acb63a8510423.

Information on collaborators/partners

Name of collaborating organization – Gulf of Mexico Alliance (GOMA)
Date collaborating established – May 2014
Does partner provide monetary support to project? No Amount of support?

Does partner provide non-monetary (in-kind) support? Yes, technical input/review
Short description of collaboration/partnership relationship – GOMA has a data management team that is a source of data for this project.

Information on any outreach activities:

Results were presented at the GOMA All Hands Meeting and at the NOAA GoM Regional Collaboration Team Gulf Forum

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

Related NOAA Enterprise Objectives: Science and Technology

NGI File # 16-NGI2-143

Project Title: Continuing secure archival 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: $31,815

Project objectives and goals
USM provided secure archival for NMFS in two bunkers as part of a continuing arrangement.

Description of research conducted during the reporting period and milestones accomplished and/or completed
USM provided secure archival for NMFS in two bunkers as part of a continuing arrangement.

Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology

NGI File # 16-NGI2-145

Project Title: NOAA Weather Radio All Hazards Network Transformational Change Stakeholder Engagement Phase One

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

Award Amount: $166,733

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 / milestones accomplished
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 date 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 to develop multiple reports for the Office of Dissemination.

Description of significant research results
- Engaged with Tyra Brown and her team to strategize data collection methods for specific stakeholder groups.
- Created a template for developing background knowledge and strategy choices for stakeholder group leads.
- Worked with leads to select samples and strategies for data collection.
- Developed survey and interview instruments to collect data.
- 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-NGI2-146

Project Title: Processing of side-scan sonar and multi-beam data

Project Lead (PI): Steve Ashby, Mississippi State University, sashby@gri.msstate.edu

NOAA sponsor and NOAA office of primary technical contact: Christopher Gledhill, NMFS, christopher.t.gledhill@noaa.gov

Award Amount: $152,964.00

Project objectives and goals

The National Marine Fisheries Service (NMFS), Southeast Fisheries Science Center, collects multibeam sonar and side-scan sonar data during fishery independent surveys. The following tasks are required to process the backlog of data and export processed data to ESRI ArcView GIS.

Task 1. Process multibeam data:
a) Inspect navigation and attitude data, remove any errors and interpolate
b) Organize and inspect soundspeed profiles, apply soundspeed corrections
c) Clean errors and outliers from multibeam soundings
d) Generate bathymetry surfaces
e) Export bathymetry to GIS
f) Generate backscatter surfaces and classify seabed
g) Export backscatter maps to GIS

Task 2. Process sidescan data:
a) Inspect/correct navigation and layback data
b) Inspect/correct altitude data
c) Adjust TVG, Gain, Equalization and other parameters where necessary
d) Produce mosaics
e) Digitize seabed to indicate bottom type.
f) Export mosaics to GIS

Task 3. Compare and assess sidescan and multibeam data where coincident data exist.

Task 4. Create an inventory of bathymetric mapping (see http://www.safmc.net/ecosystem-management/mapping-and-gis-data).

Task 5. Document all work on how each data set is processed. Standard processing protocols should be developed.

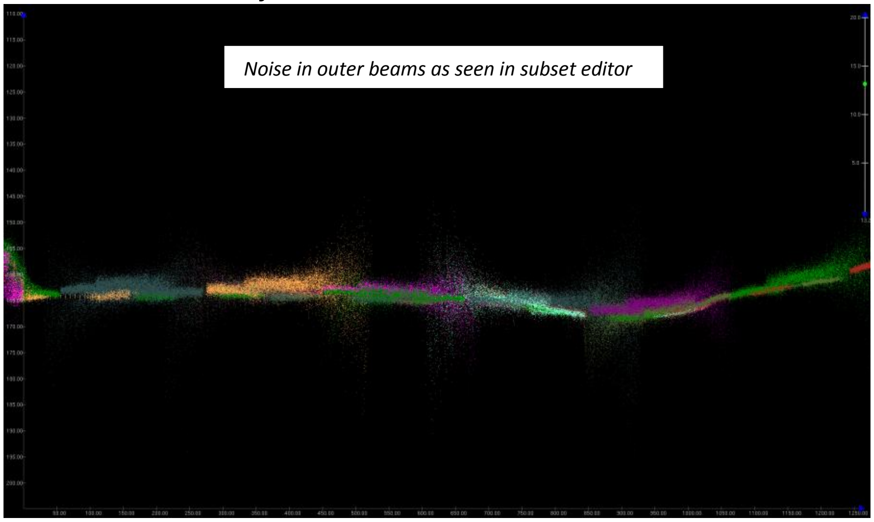
Task 6. A summary of activities will be prepared quarterly.

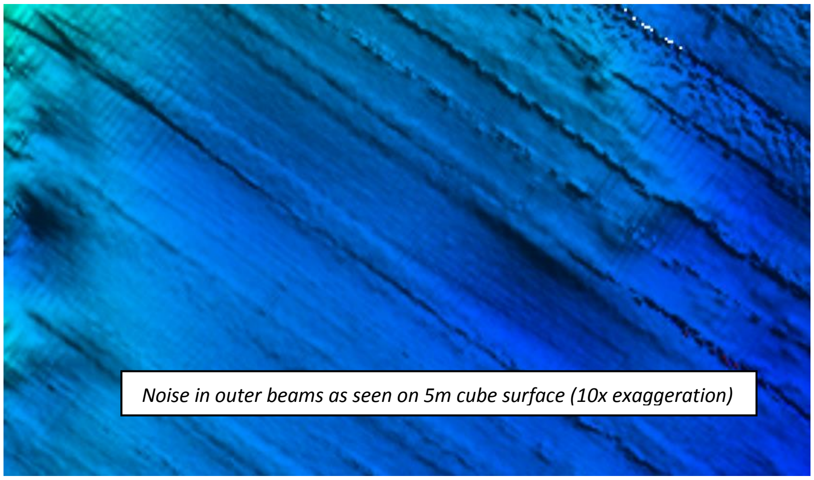
Description of research conducted during the reporting period and milestones accomplished and/or completed

Processing of the data continued throughout the reporting period. There is ongoing collaboration with the Pascagoula NMFS Lab to develop methods for habitat mapping using the data.

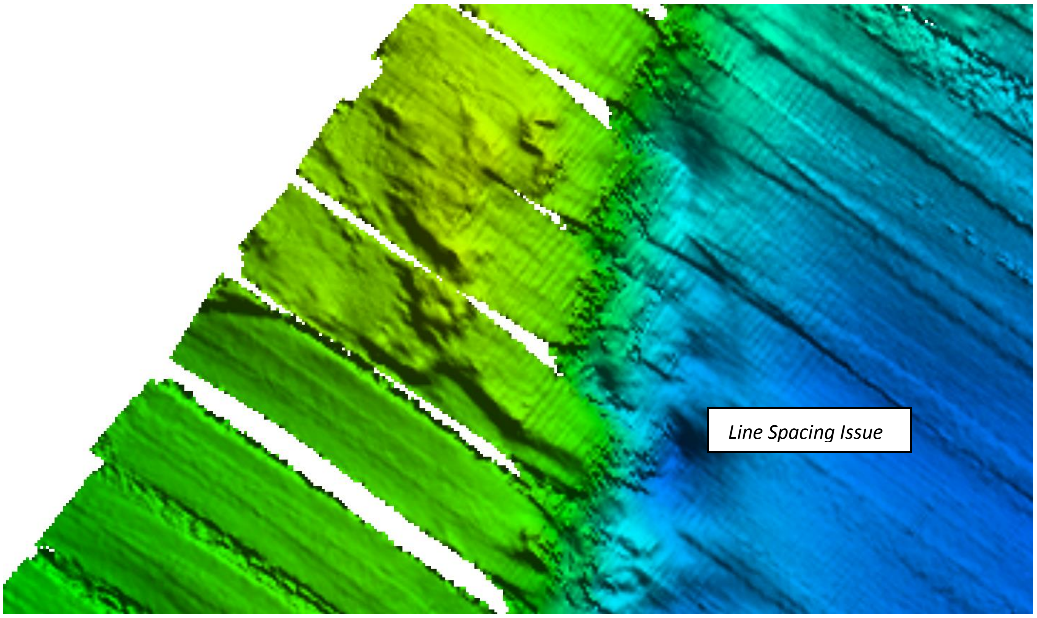
Description of significant research results, protocols developed, and research transitions
Significant progress has been made on processing the data. For example:
2016BLOCK90

1. Converted GSF data into Caris successfully
2. No CTD/SV data for block
3. Applied CTD data from 761601-Block558E-DN149 (Not ideal)
4. Merged lines successfully
5. Created 5m Cube surface
6. Noise in outer beams visibly noticeable in subset editor and 5m cube surface

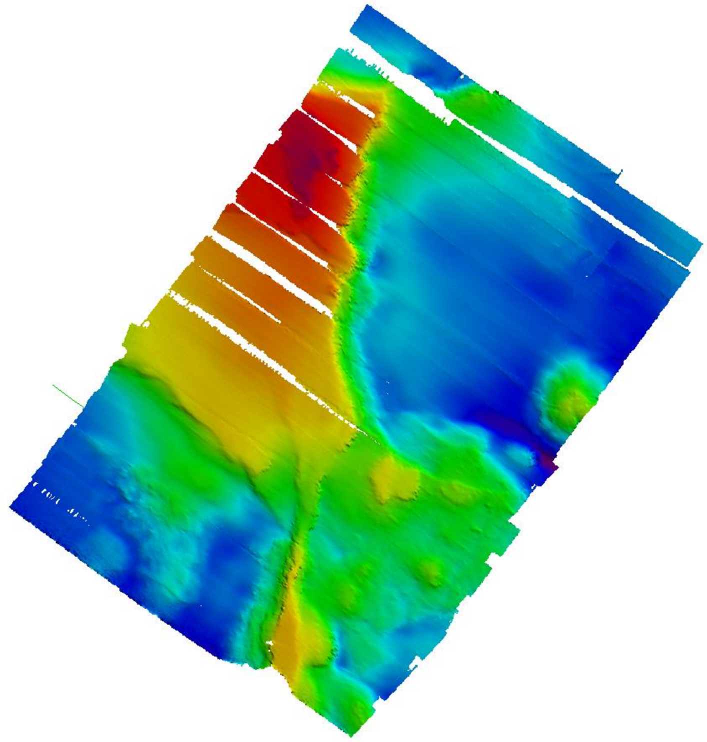




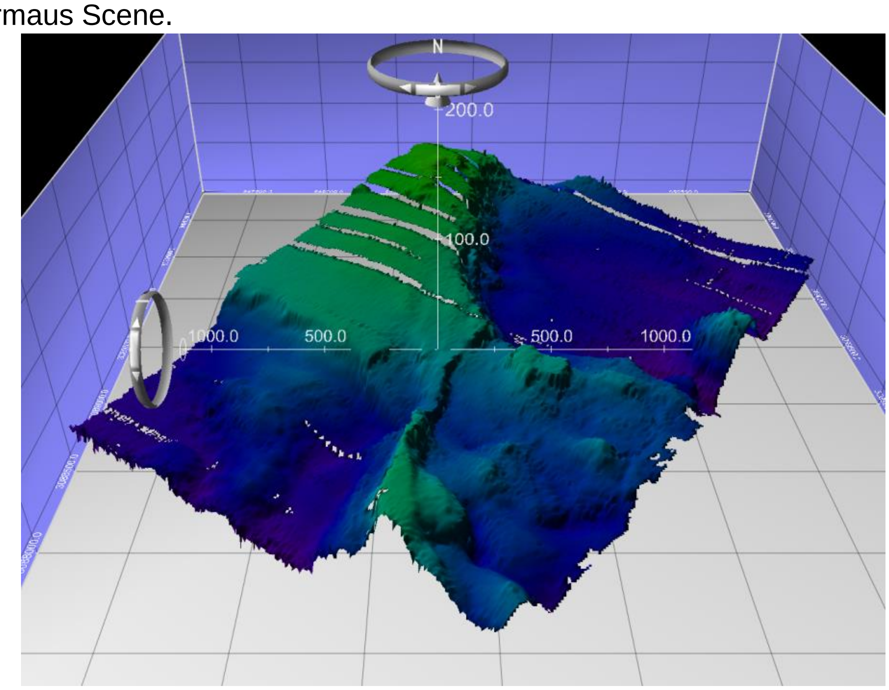
7. Adjusted the vessel file roll and yaw settings to smooth surface – only rendered slight improvement
8. Another issue noticeable in the cube surface is the lack of overlap – lines are spaced too far apart and there are data gaps as well as insufficient levels of coverage at nadir. Generally, you want at least 200% coverage (100% overlap).



9. Cleaned data in swath editor. Outer beams where rejected due to noise artifacts are still visible.
10. Spot checked data using subset editor, focusing on areas of high hypothesis count/strength and obvious artifacts in depth layer.
11. Overall visual of cube surface after cleaning. As you can see, the line spacing and noise in outer beams are visually apparent in surface.



12. Imported cleaned data into Qimera, created a 10m dynamic surface, and exported into Fledermaus Scene.



Information on collaborators/partners

Information on any outreach activities:

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

Related NOAA Enterprise Objectives: Science and Technology

NGI File# 16-NGI2-147

Project title: Northern Gulf Institute Diversity Internship Program

Project Lead (PI) name, affiliation, email address: Samuel Clardy, University of Southern Mississippi, samuel.clardy@usm.edu

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

Award Amount: $52,581

Project objectives and goals

The primary objective of the NOAA-NGI Diversity Internship Program is to support work experiences for undergraduate and graduate students of diverse educational backgrounds, ethnicities and experiences in the Gulf of Mexico region at NOAA line offices and other NOAA-affiliated organizations.

The Diversity Internship Program places interns at various organizations and laboratories throughout the Northern Gulf of Mexico coastal region. Potential mentors submit possible intern projects on the mentor project description form found on the program's website (http://gcrl.usm.edu/mec/internship.program.php). Mentors are selected based in part on matching mentor projects to student interests as well as on the relevance of proposed projects to regional issues as delineated in the Gulf of Mexico Research Plan, the Gulf of Mexico Alliance Action Plan and the NGI Strategic Plan.

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

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

The 2016 cohort of interns and mentors have been selected and are currently interning at their locations and with mentors at the locations listed in Table 10 below.

Table 1 2016 NOAA-NGI Diversity Interniship participants, mentors, and intership location

Name	**Current Institution**	**Internship Location**	**Mentor**
Kristian Burns	Southeastern Louisiana University	NMFS/Pascagoula Laboratory	Andre DeBose
Rachelle Thomason	University of New Orleans	NWS/Lower Miss River Forecast Center	Suzanne Van Cooten
Alex Fields	University of Louisiana	Mote Marine Laboratory	Katie McHugh
Emily Fischbach	Rutgers University	Mississippi State and Weeks Bay NERR	Eric Sparks
Meghan Angelina	University of Tampa	USM/GCRL	Frank Hernandez

An orientation session was held at the Gulf Coast Research Laboratory from May 26-28. Interns received an introduction to NOAA (NOAA project liaison – Julie Bosch), the Northern Gulf Institute (NGI Co-Director – Steve Ashby), Gulf Coast Research Laboratory (Associate Director, Marine Education Center – Sam Clardy, Project Coordinator, - Amelia McCoy) and enjoyed an introduction to the Gulf of Mexico and a trip to Deer Island, MS aboard GCRL's research vessel, the Miss Peetsy B. Interns also received training in data management and metadata (NCEI personnel – Katherine Woodard and Kathy Martinolich) and completed pre-program assessments.

The Diversity Internship Summit was organized and held at the Science and Technology Center located at Stennis Space Center on August 5, 2016. The interns gave a presentation on their work and informed us of their future plans. There was an opportunity for the interns to network with other NOAA representatives at the NOAA career roundtable. The summit was completed with an exit evaluation to monitor the strengths and weaknesses of the intern experience.

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-NGI2-149

Project Title: Storm Surge and Sea Level Rise on a Changing Landscape

Project Lead (PI) name, affiliation, email address: Scott Hagen, Northern Gulf Institute, Louisiana State University, shagen@lsu.edu

NOAA sponsor and NOAA office of primary technical contact: David Kidwell, NOS

Award Amount: $203,872

Project objectives and goals

The project objectives are to collaborate with NOAA and its partners to transition and apply the Dynamic Surge tool to the Hampton Roads region to quantify the dynamic effects of sea level and projected landscape changes on storm surge. Results from this project will be centered on scenario projections of storm surge depth and extent under a suite of storm conditions, sea level rise rates, landscape changes, and possible management actions. This project represents the first transition of the Dynamic Surge tool following its development in the Gulf of Mexico. In addition to the specific project activities identified below, the process and requirements for transition should be notified for possible future applications.

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

Additional bathymetric and topographic data sets for the Chesapeake Bay and Hampton Roads region were acquired as well as the NOAA FY08 VDatum ADCIRC mesh. Wind and pressure data for fourteen synthetic storms were obtained from the USACE NACCS study. In addition, present day and future land use land cover (LULC) data sets were obtained from the USGS. These data were implemented into the Dynamic Surge tool. Generalized Hydro-MEM model results from the mid-Atlantic coast were used in conjunction with the future LULC data were implemented to derive surface roughness parameters for the ADCIRC model.

Initial “what-if” scenarios were to examine the peak storm surge response if the entire marsh from the inlet of Chesapeake Bay to Ocean City were lost for a variety of synthetic storm events and sea level rise scenarios.

A localized ADCIRC and Hydro-MEM model was developed for the region from Chesapeake Bay to Ocean City. The Hydro-MEM modeling results will provide site specific information on the loss of marsh for the study region and its effect on storm surge inundation in Hampton Roads will be evaluated.

We found that some level of mesh refinement was required for the Hampton Roads region and have implemented.

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

The initial phase of transitioning the Dynamic Surge tool from the northern Gulf of Mexico to the Hampton Roads region has been complete. This advancement in the modeling paradigm now allows for localized refinements of the study area, such as localized marsh modeling and model local model enhancement for the Hampton Roads study area. Details on this transition will be included in a yet to be submitted scientific publication.

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-NGI2-150

Project Title: Core infrastructure enhancements, operations, and preliminary research activities supporting VORTEX-SE 2017 field campaign activities, Phase 1: Infrastructure enhancements and evaluation

Project Lead (PI) name, affiliation, email address: Kevin Knupp, Professor, University of Alabama, Huntsville. e-mail: kevin.knupp@uah.edu, phone: 256-824-7947

NOAA sponsor and NOAA office of primary technical contact: John Cortinas, Office of Atmospheric Research.

Award Amount: $477,338.00

Project Objectives and Goals

Milestone	Status	Details
ARMOR upgrade - new antenna & pedestal - new radome - new receiver assembly - OMNI display system	Operational on 14 August 2017	Project was delayed due to busy Baron schedule, FAA delays, and requirement do crane work on weekends.
Procurement of Remtech Doppler mini-sodar	Procured January 2017 Operational February 2017	Now an optional component for the Rapidly Deployable Atmospheric Profiling System (RaDAPS)
Site surveys for additional radar sites for the Spring 2017 VSE field campaign	Completed	See summary table for brief description of IOPs below
Evaluation of other non-standard radar data.	Continuing effort	The Redstone Arsenal (U.S. Army) Doppler radar has not been operational during the entire 2017 calendar year due to hardware problems.

1. ARMOR upgrade

Figure 1. ARMOR radar with new radome located at the Huntsville International Airport.

The ARMOR, upgraded recently by Baron Services with help from UAH personnel, is now operational. The total cost was $389k. This upgrade included the following components:

(1) A new antenna (4.3 m vs. the original 3.7 m) that reduces the beamwidth to 0.9 deg and reduces sidelobe energy;

(2) A new pedestal;

(3) A new radome with quasi-random panels (Fig. 1);

(4) A new Baron receiver, including a Baron Signal Processor, a Baron Control Processor, the Baron multi-radial Calibration, Baron Open Data System, and Clean AP system (Fig. 2);

(5) New Gen 3 Antenna Mounted Electronics (AME), Microwave Assembly, and Rotary Joint with Fiber Optic I/F and Bite Cal system;

(6) OMNI Scientific Display and Baron Radar Product Generator (installed in the SWIRLL Operations Center).

This project was delayed due to late arrival of funds, a busy Baron schedule between October 2016 and February 2017, and delays produced by FAA errors (loss of survey information from a previous upgrade in 2006).

Fig. 2. ARMOR receiver components (black) are located at the top of the rack. The pre-existing transmitter assembly units are located at the bottom (cream colored).

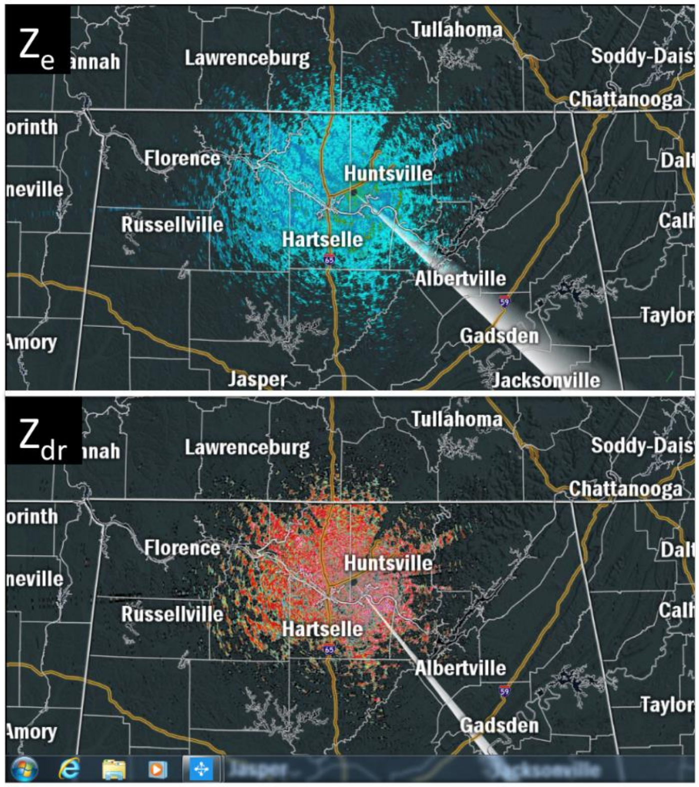


Fig. 3. PPI at 0.5 deg elevation of equivalent reflectivity factor (Z_e) and differential reflectivity (Z_{dr}) near 2000 UTC on 23 August 2017. This was a day with a well-developed convective boundary layer and scattered cumulus clouds. Maximum range of detection exceeds 60 km. The high values of Z_{dr} characterize insects. This is a significant increase in sensitivity over the ARMOR performance before the upgrade.

2. Procurement of Remtech Doppler minisodar

A Remtech PA0 model sodar was procured (lowest bid) for a cost of $46,657.50 including shipping. The sodar was delivered and tested on January 18, 2017, and utilized during the 2017 VORTEX-SE field campaign. In its default operational mode, the sodar acquires wind profiles (wind speed/direction and vertical motion) averaged for 5-min periods. The first range gate is near 20 m, and gate spacing is 10 m. When sited in ideal open locations, coverage to 200-400 m AGL is typical. Thus, the sodar fills in important wind profile data below the first usable gate of the 915 MHz wind profilers, which have a lowest usable gate of 200-300 m AGL. These high vertical resolution sodar data will be used to define the high-resolution wind profile within the surface layer, which has not been well resolved in previous studies. In additional to providing a better estimate of storm-relative helicity, the profile will facilitate estimation of surface roughness for neutral conditions (e.g., log-wind profile).

3. Site surveys

Site surveys for radars, profiling systems, and soundings were conducted during this project. Over the eastern domain, four radar and five profiling sites were identified on Sand Mountain and the adjacent Tennessee River Valley near Scottsboro. A location for the NSSL CLAMPS

profiling system and the University of Massachusetts FM-CW profiling S-band radar were identified and procured at the Scottsboro airport. UAH personnel coordinated the services of an electrical contractor to establish line power availability at the Scottsboro airport site (198 m MSL) and also for the MoDLS site (394 m MSL) at Northeastern Alabama Community College on Sand Mountain, located 151 deg, 17.8 km from the CLAMPS site.
Over the western domain, radar sites were identified near Browns Ferry Nuclear Power Plant, Capshaw, and Killen. These were used along with pre-existing sites at the Courtland airport and near Tanner. Profiling sites were discovered east of Leighton (an excellent site), Browns Ferry, and Hartselle.

4. Evaluation of data from operational platforms

During and prior to the 2016 field campaign, UAH completed an agreement with WAFF-TV for access to raw radar data (Sigmet format) from their C-band radar (1 MW transmitter, RVP8 processor). We also interacted with the Redstone Arsenal Meteorological team, who has maintained an S-band radar. This aged system is not currently operational, but the team has procured funds for a new high frequency S-band dual polarization radar that will be available in 2018. Thus, there has not been a recent opportunity to evaluate that radar, although these radar data have been used successfully in the past (Mullins 2015).

Appendix A. Publication Documentation

Publications completed during the reporting period:

	Institute Lead Author	NOAA Lead Author	Other Lead Author
Peer-Reviewed	7	2	5
Non Peer-Reviewed	52	2	15

Appendix B. Employee Support

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
July 1, 2016 - September 30, 2017
Personnel (all schools combined)

Category	Number	B.S.	M.S.	Ph.D.
>= 50% Support				
Research Scientist	8	1	3	4
Visiting Scientist	2	0	0	2
Postdoctoral Fellow	2	0	0	2
Research Support Staff	6	1	4	1
Administrative	0	0	0	0
Total (>= 50% support)	**18**	**2**	**7**	**9**

Category	Number	B.S.	M.S.	Ph.D.
Employees w/ <50% support	45	13	13	19

Category	Number	B.S.	M.S.	Ph.D.
Undergraduate Students	12	12	0	0
Graduate Students	16	0	9	7

Category	Number	Name of Lab
# of employees / students that are located at the Lab (include name of lab)	6	2 - AOML 1 - NMFS (Stennis) 3 - NMFS (Pascagoula)
# 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
Mercer, Andrew	National Oceanic and Atmospheric Administration (NOAA)	Transition of Matching-Learning Based Rapid Intensification Forecasts to Operations	$100,186.00
Fitzpatrick, Patrick	Gulf of Mexico Alliance	CONsortium for oil spill exposure pathways in COastal River-Dominated Ecosystems (CONCORDE)	$102,715.00
Sherman-Morris, Kathleen	National Oceanic and Atmospheric Administration (NOAA)	Improving Accessibility and Comprehension of Tornado Warnings in the Southeast for the Deaf, Blind, and Deaf-Blind	$103,434.00
Ritchie, Jarryl B	BP America	GOMA BP Gulf of Mexico Research Initiative Web Support Project	$2,312,953.00
		Total	**$2,705,602.85**