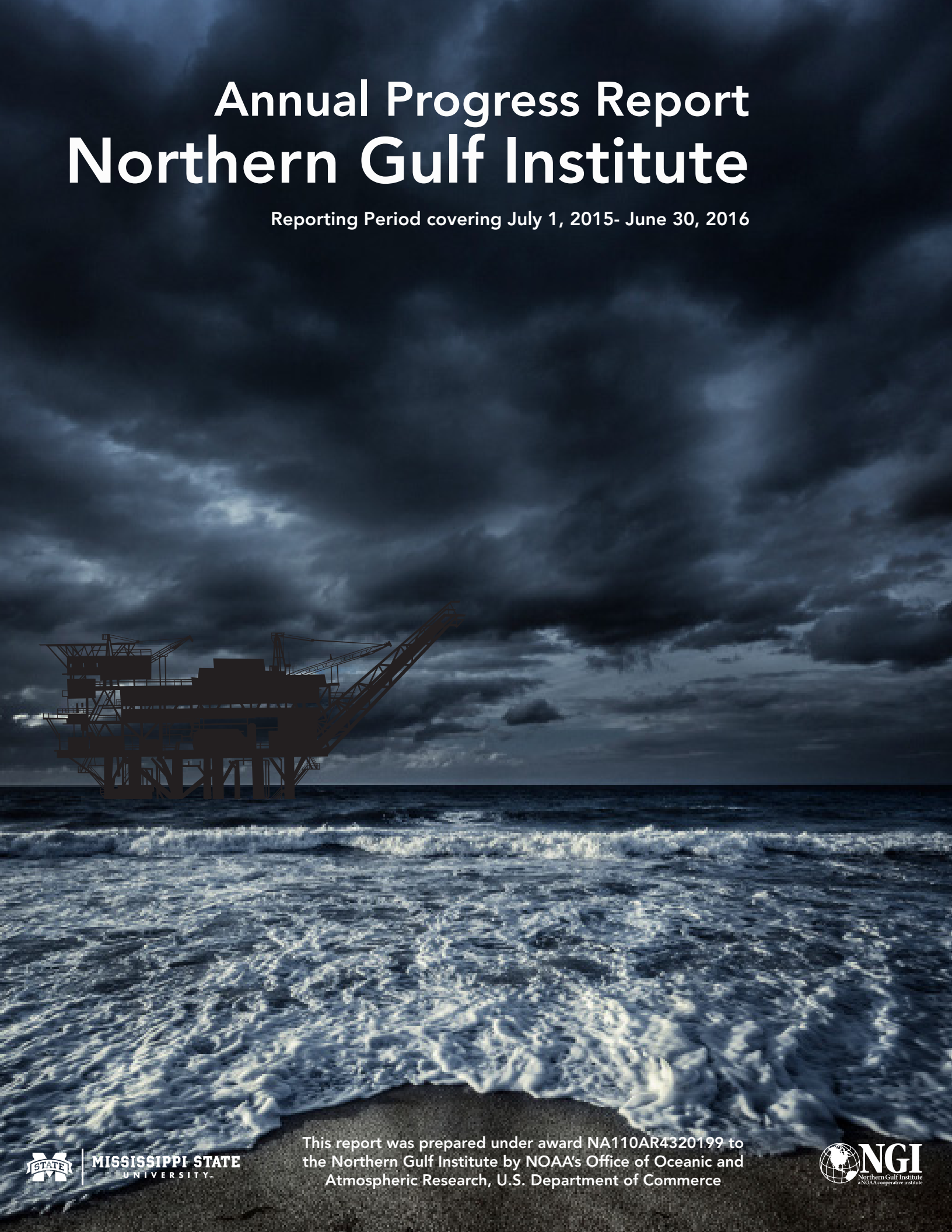
Annual Progress Report
Northern Gulf Institute

Reporting Period covering July 1, 2015- June 30, 2016



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MISSISSIPPI STATE UNIVERSITY

NGI Northern Gulf Institute a NOAA cooperative institute

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Award NA11OAR4320199

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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, 2015 to June 30, 2016. 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 $22 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 2006 and research initiatives at the NGI partner institutions began in February 2007. Significant efforts are being made to address important questions related to NOAA's long-term goals of Climate Adaptation and Mitigation, Weather-Ready Nation, Healthy Oceans, Resilient Coastal Communities and Economics, and NOAA enterprise-wide capabilities. The second five-year cooperative agreement began in October 2011.

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

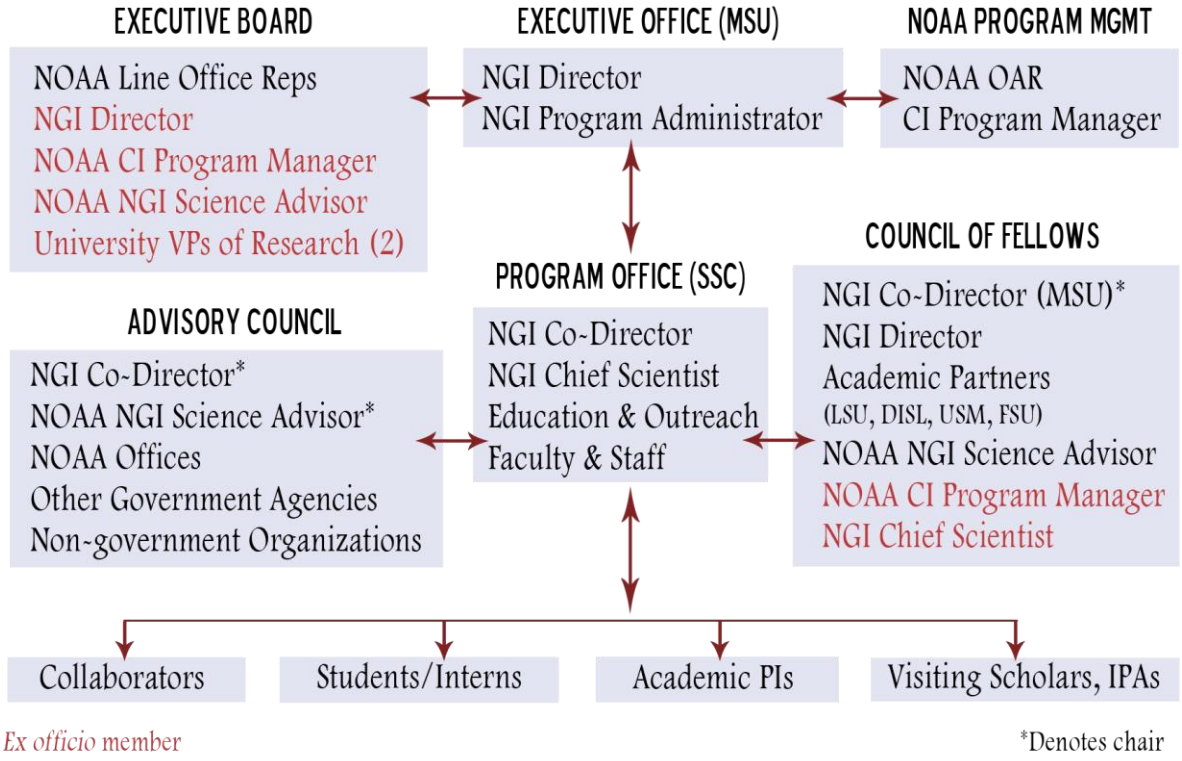

Figure 1 NGI organization diagram

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

The NGI Program Office located at the Stennis Space Center, Mississippi, is staffed by MSU employees, including the Co-Director 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, 2015 through June 30, 2016, the NGI Council of Fellows consisted of:
Steve Ashby, Ph.D., Mississippi State University (chair)
Monty Graham, Ph.D., University of Southern Mississippi
Eric Chassignet, Ph.D., Florida State University
Robert Twilley, Ph.D., Louisiana State University
John Valentine, Ph.D., Dauphin Island Sea Lab
The Fellows participate in regular teleconferences to remain up to date between face-to-face meetings.

The NGI Executive Council

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

Bonnie Ponwith, Ph.D., Director, NOAA SE Fisheries Science Center (Chair)
Margaret Davidson, Senior Leader Coastal Inundation and Resilience Science and Services
Louisa Koch, Director, NOAA Office of Education
Alan Leonardi, Ph.D., NOAA Ocean Exploration and Research
David Shaw, Ph.D., VP for Research & Econ. Dev., Mississippi State University
Gordon Cannon, Ph.D., VP for Research, University of Southern Mississippi
Candice Jongsma, Ph.D., OAR CI Program Manager (*Ex-officio*)
Shannon Louie, NOAA NGI Science Coordinator (*Ex-officio*)
Robert Moorhead, Ph.D., NGI Director (*Ex-officio*)

The NGI Advisory Council

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

Steven Ashby, Ph.D., MSU/NGI Co-Director (Chair)
Duane Armstrong, NASA Stennis Space Center
Sharon Mesick, NOAA National Centers for Environmental Information
David Brown, Ph.D., NOAA National Weather Service, Southern Region
Alyssa Dausman, USGS, RESTORE Council
Todd Davison, NOAA Gulf Coast Services Center
Lisa Desfosse, NOAA National Marine Fisheries Service
Kristen Fletcher, Coastal States Organization
Judy Haner, The Nature Conservancy
Karl Havens, Ph.D., Florida Sea Grant College Program
Julien Lartigue, Ph.D., NOAA RESTORE Act Science Program Director
Kristen Laursen, NOAA Fisheries Service
Larry McKinney, Harte Research Institute
Helmut Portmann, NOAA National Data Buoy Center
Matt Romkens, USDA National Sedimentation Lab
Ayesha Gray, Grand Bay National Estuarine Research Reserve
Ben Scaggs, EPA Gulf of Mexico Program
LaDon Swann, Ph.D., MS-AL Sea Grant Consortium
Robert Twilley, Ph.D., Louisiana Sea Grant
Suzanne Van Cooten, Ph.D., NOAA National Weather Service LMRFC
Jamie Miller, Mississippi Department of Marine Resources
Jeff Waters, US Army Corps of Engineers
Chuck Wilson, Ph.D., GOMRI Chief Scientist

Executive Summary of Important Research Activities

This year NGI focused on assessment of data from multiple platforms for improved algorithms, development and enhancement of models, utilization of innovative observation techniques (e.g. unmanned systems, acoustics, and cameras) for habitat characterization and assessments, and transition of research to operations.

Research in support of healthy oceans and resiliency included several projects. These studies will increase our understanding of the connectivity of habitat types to fisheries for stock assessments and vulnerability of threatened and endangered species.

- Developed a coupled physical-biogeochemical modeling system. Data from the simulations will be used to determine prey availability for Gulf of Mexico fish species under different climate regimes simulated by NOAA-AOML scientists. Fish metabolic requirements and dependence on environmental factors (e.g., temperature), which will define whether or not fish populations may be prey-limited under different climate scenarios, are being developed through collaboration with NOAA-SFSC scientists.
- The GOM025 model now 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.
- Determined past habitat use of juvenile to adult Gulf sturgeon in a coastal river in the Northern Gulf of Mexico using trace elements and isotopic analysis. The life history of sturgeon movement can be identified by comparisons with water samples from individual river systems and analysis of pectoral fin spines.
- The massive Gulf sturgeon genetic database that we have built provides opportunities above and beyond the original scope of the work. Using sonar tracking, researchers have recognized that adult Gulf sturgeon can travel far from their natal rivers as they utilize coastal habitats. In the cases where we have genetic data for these monitored individuals, we can develop further insight into the scope of these movements by identifying where the fish was located relative to where it was spawned. With the future inclusion of age-1 and 2 fish from the Apalachicola, we should also be able to take a new analytical approach to quantifying successful reproduction in Gulf sturgeon in a much quicker time frame rather than waiting for the recruits to enter the currently monitored adult population.
- Continued determining habitat use and movement patterns for adult smalltooth sawfish with two additional trips to expand the database.
- Continued marine debris research. Preliminary results from a sampling program on barrier islands 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.
- Observed and monitored 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 were conducted via a cruise to established stations in July 2015.

Data assessment focused on satellite data, weather forecasting, and climate. Examples include:

- Bias characterization and hurricane initialization using ATMS, SSMIS, and AMSR-2 derived products. The ATMS optimal filter removing the striping noise in the ATMS SDR data was transitioned to NOAA/STAR/SMCD, who then produced 45 days de-striping ATMS SDR to different operational NWP centers including ECMWF and NCEP for them to test the impacts of striping noise on NWP.

- Data management for Eco Assess continued with emphasis on participation with the National Science Foundation's EarthCube Test Governance Project, which included co-authoring the EarthCube Strategic Science Plan: Geoscience 2020 and earning a Community Service Award at the 2015 All-Hands Meeting in Washington, DC.
- An Artificial Intelligence based modeling framework was developed for improved forecasting of tropical cyclone rapid intensification (RI). Analysis conducted during the development revealed a suite of important variables and gridpoints that are relevant for distinguishing intensification patterns within cyclones.
- Protocols were developed for collecting and processing *in situ* optical data used for ocean color cal/val. These included the above water ASD and the floating hyperpro instruments. Protocols are under evaluation with the cal/val team for transition to operations.
- *In situ* data used for calibration of VIIRS products was shown to be variable and not consistent between all instruments for all stations. The VIIRS ocean color products from NOAA MSL12 were shown to be similar and often an improvement to the NASA ocean color products.
- Improved ATMS sensor data record (SDR) data quality for weather and climate studies resulted in the characterization of geolocation accuracy of Suomi NPP Advanced Technology Microwave Sounder (ATMS) measurements.
- A physical model for Television Frequency Interference (TFI) correction over coastal ocean near North America and Europe was developed. TFI signals are found in observations from the Advanced Microwave Scanning Radiometer 2 (AMSR2) over coastal regions near United States and Europe.
- Improved quantitative precipitation forecasts by Microwave Humidity Sounder (MHS) radiance data assimilation are now possible with a newly added cloud detection algorithm. Specifically, satellite microwave humidity sounding data are assimilated through the Gridpoint Statistical Interpolation (GSI) analysis system into the Advanced Research Weather Forecast (WRF) (ARW) for a coastal precipitation event. A detailed analysis shows that using MHS data from both NOAA-18 and MetOp-A in GSI degraded precipitation threat scores in a 24-h model forecast. The root-cause for this degradation is related to the MHS quality control algorithm that is supposed to remove cloudy radiances.
- Better understanding of how measurements from the Stepped-Frequency Microwave Radiometer (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. Surface wind speed observations from SMFRs 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.
- A cloud mask (CM) algorithm was modified, tested, and applied to Advanced Himawari Imager (AHI) on board Himawari-8 data for assessing AHI radiance assimilation. Results show that the new infrared only CM algorithm achieves a lower false alarm rate and a higher Probability of Correct Typing (PCT) than the Clouds from the AVHRR Extended System (CLAVR-x) technique over ocean. However, the new algorithm has a relatively high leakage rate (LR) of 7.54% over land during daytime in the presence of low stratus clouds.
- Research on climate variability on ocean surface turbulent fluxes increased the ability to realistically model and observe small scale variability. An appropriate mechanism was developed for assimilating the observations and retaining the small scale features in a realistic fashion. Also identified was the need for a constellation of observing systems and the consequent need for very carefully intercalibrated data to avoid spurious small scale variability.
- It was demonstrated that observations of fine scale surface vector winds and SST are both vital to the ocean observing system. The result that variability on small spatial scale causes large changes to the ocean system is new.

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

- Development of geospatial products continued with videos provided by the Okeanus Explorer. Shiptrack and ROVTracking Thinning, CTD data processing for incorporation into the Digital Atlas, and support for the Digital Atlas Reachback. One of the highlights included the use of storymapping for OER missions for effective education and outreach.
- Time series of xCO_{2air}, xCO_{2sw}, pH, wind speed, conductivity, temperature, and salinity data continued to be collected by buoys in the Gulf of Mexico. This time series will help determine the seasonal and long-term trends of ocean acidification, and air-sea exchanges of CO_2.
- Algorithm development to improve the Ocean Acidification Products Suite (OAPS) was initiated during preliminary analysis of the ocean acidification parameters. It was observed that the variability in Total Alkalinity (TA) is mainly attributed to variation in sea surface salinity (SSS) with a minor dependence on sea surface temperature (SST) and variability in pCO2 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, particulate carbon and dissolved carbon to the ocean. The role of organic carbon from river inputs such as the Mississippi River is also being investigated.
- Measured acoustic data collected for fisheries assessments were integrated and compared with Atlantis ecological model runs to calculate the theoretical backscattering strengths. Initial assessment suggests a disagreement in equilibrium biomass concentrations of the nekton. The model showed 20 to 30 dB more scattering (100x-1000x) on the outer shelf and in the deep water. This gap could be from the effect of mesopelagic fish or the nekton-zooplankton or from some pelagic groups which are unstable in the model.
- The Dynamic Surge tool originally developed in the Gulf of Mexico is being transitioned to a site in the Chesapeake and Delaware Bay region.
- Modifications were made to the TroSim model, specific to oyster reef production, in order to provide a means of scenario-testing for natural resource managers (e.g. Mississippi Department of Marine Resources) to use as a potential tool for decision-support. An existing EFDC/WASP model that was developed for the Bay St Louis was modified to include scenario analysis for local oyster reefs.
- Unmanned aerial systems applied methods developed last year to include measurements of suspended solids and colored dissolved organic matter were used in a data collection effort for a harmful algal bloom that occurred in the NGOM. Applications for invasive terrestrial species of vegetation were also conducted at a NERR and a barrier island. A high resolution Digital Surface Model was created for a marsh restoration project demonstrating the applicability of UAS technology for hard to access sites.

Several new projects were initiated during the reporting period. Examples include:

- 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. The operational objectives are focused on demonstrating new technologies that can be used to monitor carbon and nutrient fluxes and transformations in the Gulf of Mexico. Data were collected from a mooring station, mobile platforms (unmanned systems), and cruises of opportunity.
- Understanding the Current Flow of Weather Information and Associated Uncertainty, and Their Effect on Emergency Managers and General Publics-Public Perception Research Component. Developed qualitative analysis of spring severe weather season to determine events and non-events to provide context for public perception research protocols.

- Advancing the use of Airborne LIDAR Bathymetry for navigational charting – data from airborne platforms collected along the coast of the US are being assessed for over water data collection that can be used near shore for navigational charting.
- Curriculum was developed for a training program in social science applications for meteorologists and meteorology professionals.
- NOAA Weather Radio All Hazards Network Transformational Change Stakeholder Engagement was initiated.
- Improvements to TAO Delayed-Mode Data Processing were conducted.

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

- The Geospatial Education and Outreach (GEO) Project continued to deliver workshops (10) that focused on both commercial and open source GIS applications and reached over 100 local managers. New courses that were designed around the needs identified by workshop participants over the past several years were made available in the fall 2015 and spring 2016.
- The NOAA/NGI Diversity Intern Program sponsored 6 students in 2015 and 5 in 2016.
- Working in collaboration with the NOAA Northern Gulf of Mexico Sentinel Site, an intern was hired to inventory CORS information and engage stakeholders.
- 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

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

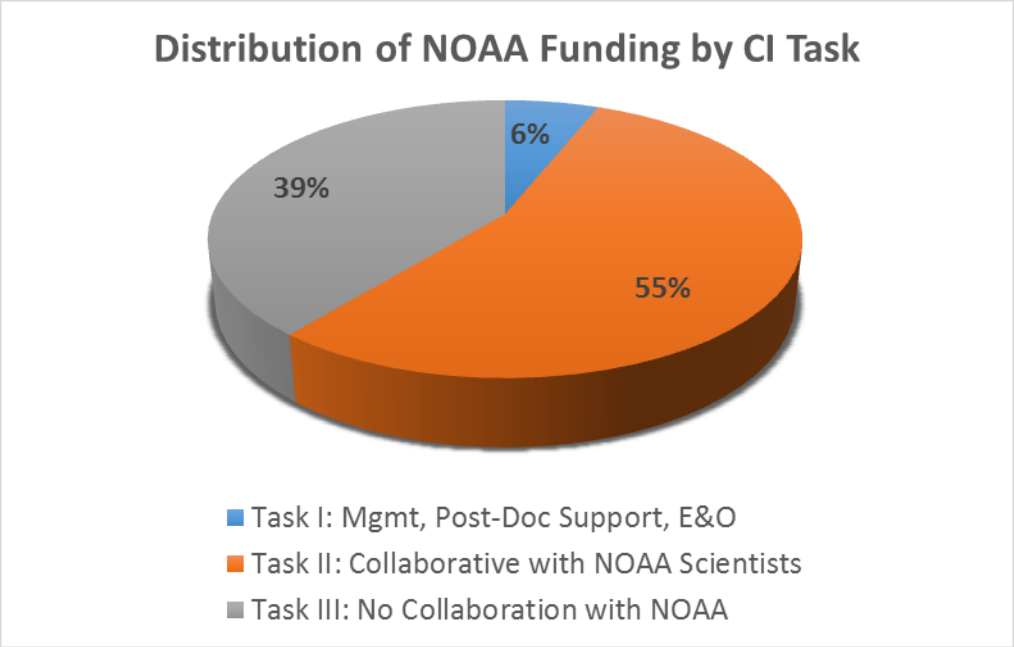

Figure 2 Distribution of NOAA funding by the three cooperative institute task categories.

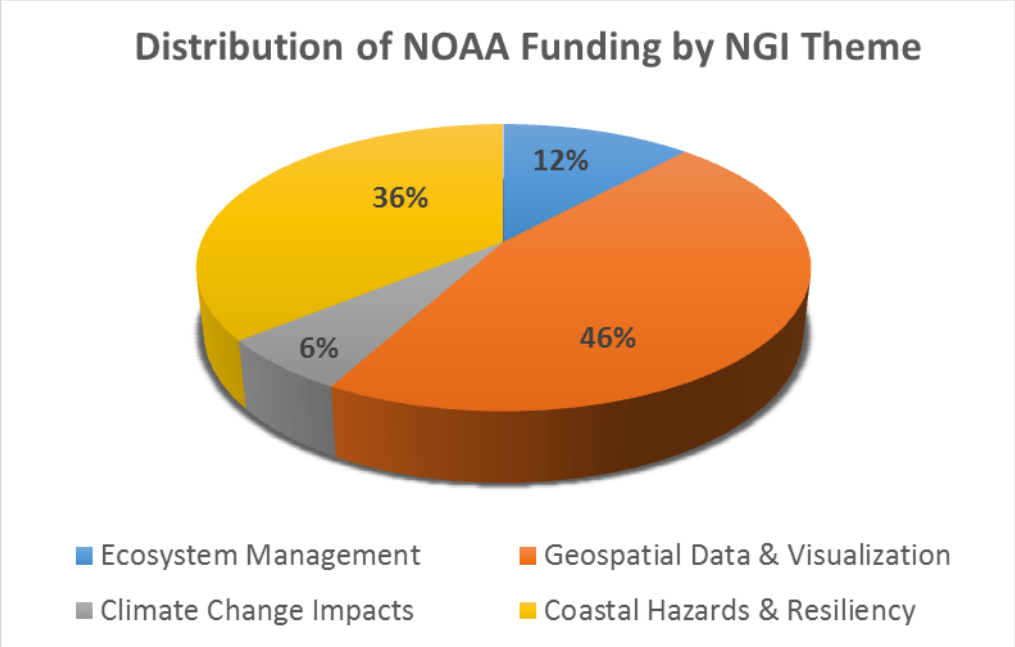

Figure 3 Distribution of NOAA funding by the four NGI themes.

Task I Activities

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

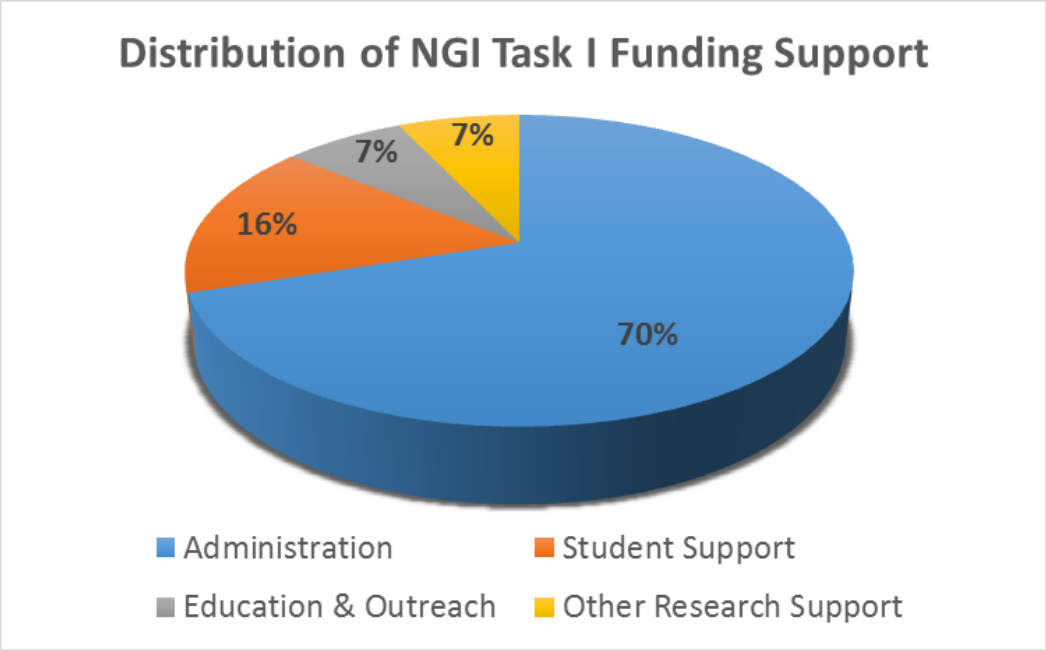

Figure 4 Distribution of NGI Task I funding.

NGI File #14-NGI2-70: Examining Microplastic Occurrence in Gut Contents of Sargassum-Associated 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

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; and

3. Determine the "natural" diet composition in the guts of Sargassum-associated fishes.

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

Our sponsor (NOAA Marine Debris Program) supported our efforts for a pilot project to examine possible ingestion of microplastics by Sargassum-associated fishes. During the past project year, we completed one additional cruise (in June 2015) off the coast of Alabama on board the R/V EO Wilson. In total, we have completed five research cruises (including earlier cruises in May, June and July 2014). A variety of sampling gear (e.g., neuston net, plankton purse seine, dip nets, hook-and-line sampling) was used to sample Sargassum algae, fishes, and marine debris. From these collections, all larger fishes (> 10 mm) were identified to the lowest possible taxonomic level and measured (standard length, in mm). Stomachs were then removed and dissected for gut contents which were imaged and identified, if possible. In addition, stomachs were removed from fishes collected in surveys from previous Sargassum projects (unrelated to marine debris) in 2010 and 2011. To date, gut contents have been dissected and examined from all 2010 samples. We requested a no-cost extension in April 2016 to complete the analyses for the 2011 samples (approximately 100 fishes). The location of the 2014 and 2015 sampling stations are depicted in Figure 5, along with those sampled in 2010 as part of an NSF RAPID project.

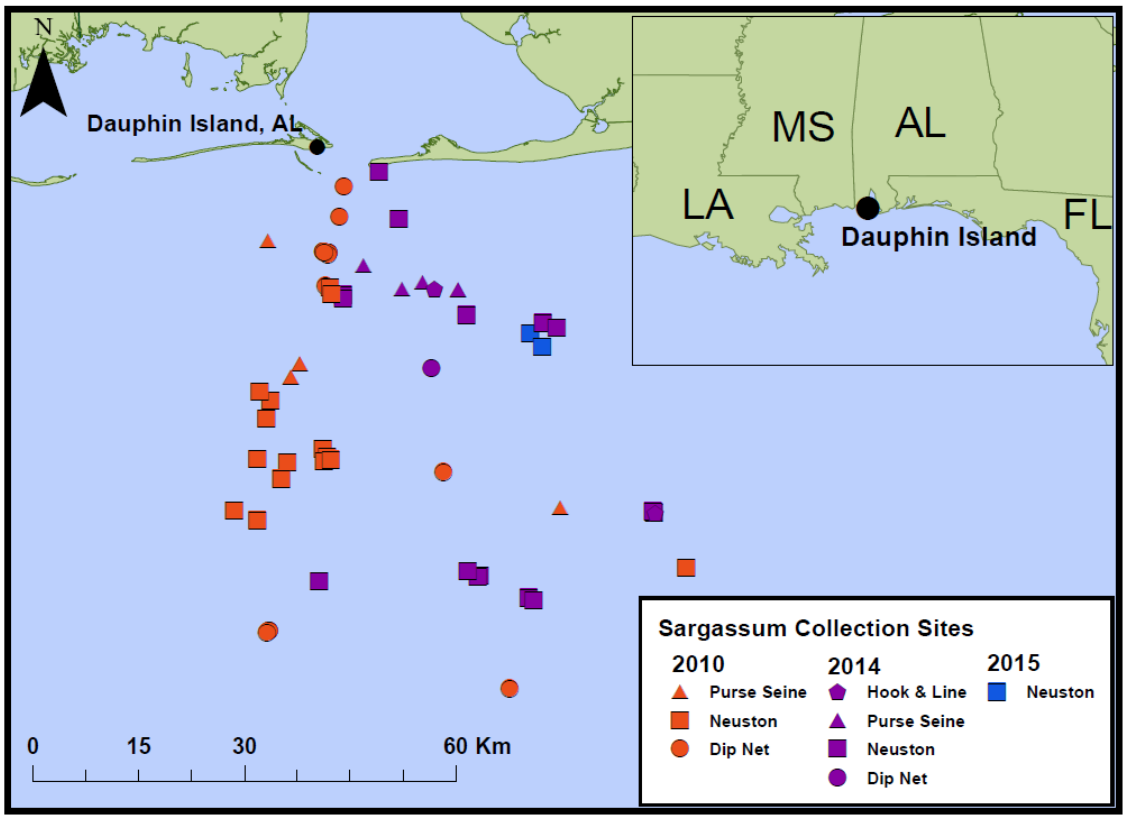

Figure 5 Sargassum sampling locations in 2010 (orange), 2014 (purple) and 2015 (blue). Gear types used at each site are denoted by shapes. Sampling locations for 2011 are not depicted, as these are still being processed.

Description of significant results, protocols developed, and research transitions

Marine debris was present in all Sargassum collections to various degrees, and ranged from large items (e.g., soda bottles, large plastic containers) to smaller particles (e.g., small plastic particles; small filaments, possibly monofilaments or nylon threads). We are currently reviewing the literature to examine means of quantifying debris collected in samples--for instance, by volume, size, weight, surface area, or some other metric. To date, a total of 751 fishes have been dissected and analyzed for gut contents (2010, n=420; 2014, n=286; 2015, n=45). Dominant taxa included Planehead Filefish (Stephanolepis hispidus; 27.7%), pipefishes (Syngnathus spp.; 14.6%), Blue Runner (Caranx crysos; 11.3%) and Sargassumfish (Histrio histrio; 11.2%) (Figure 6). Gut contents contained mostly natural prey items, including copepods, other zooplankton, Sargassum shrimp, hydroids, and fishes, depending on predator size. However, 7.6% of the fishes examined (all species) had microdebris in their stomachs (Figure 7). The taxa with the highest frequency of microdebris occurrence were Pygmy Filefish (Stephanolepis setifer; 22%), Bermuda Chub (Kyphosus sectatrix; 12%), Planehead Filefish (Stephanolepis hispidus; 9%), and pipefishes (Syngnathus spp.; 9%) (Figure 8). Notably, no microdebris was found in the stomachs of Sargassumfish, Tripletail and Grey Triggerfish specimens.

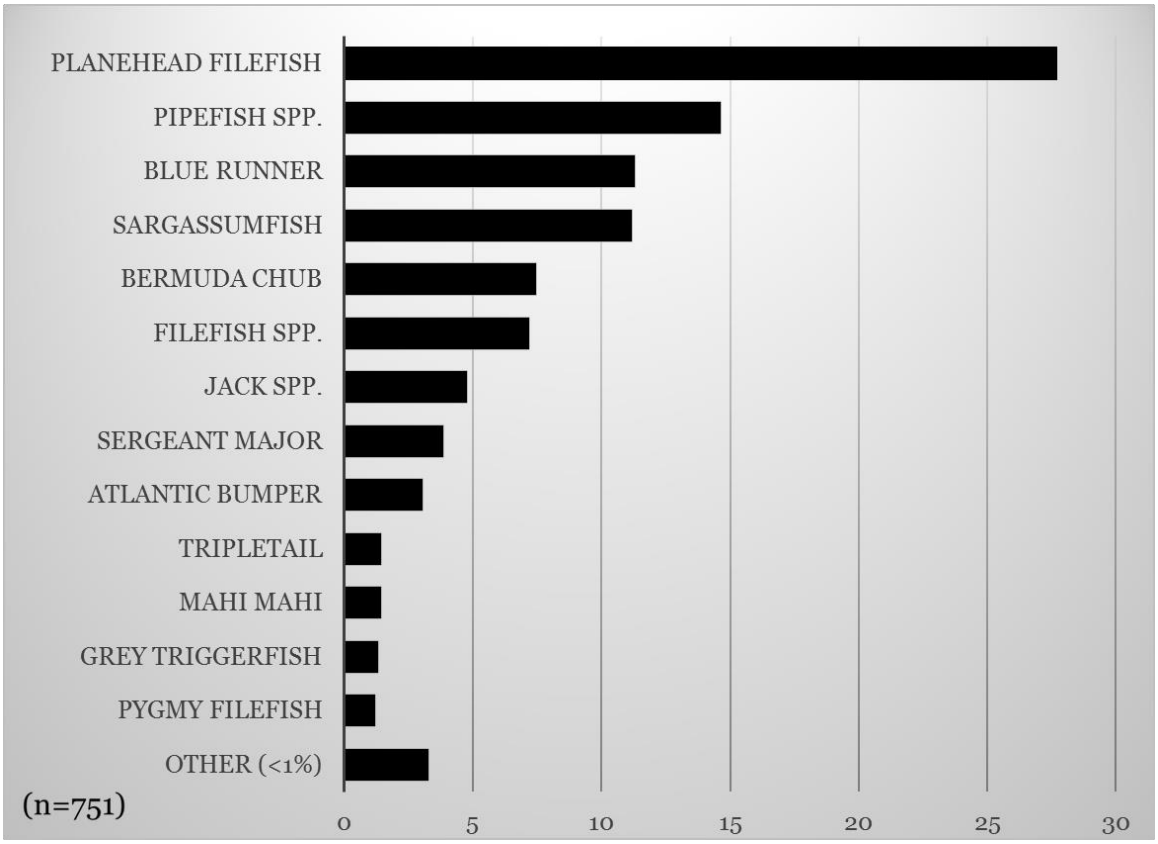

Figure 6 Summary of fishes dissected and analyzed for evidence of microplastic ingestion. Values are percentages of the total catch (n=751).

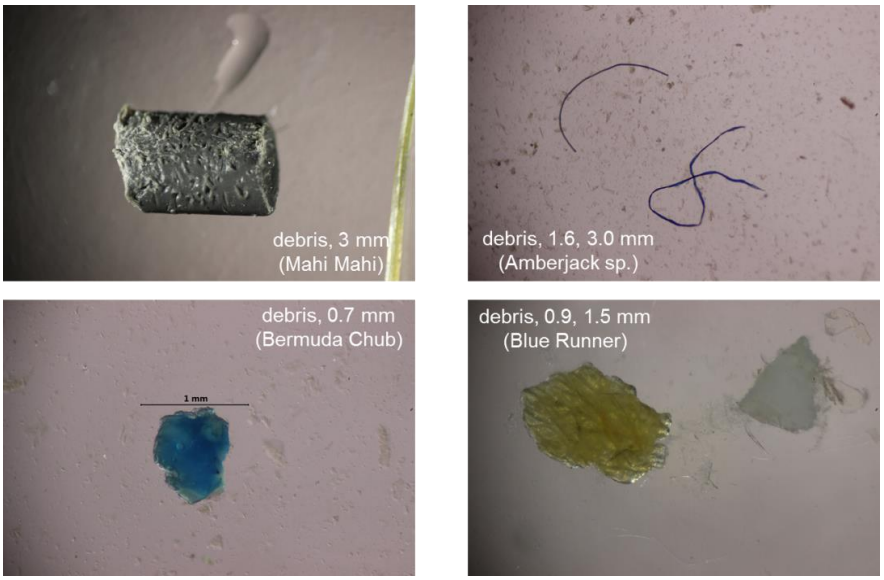

Figure 7 Examples of microdebris removed from the stomachs of fishes dissected in this study.

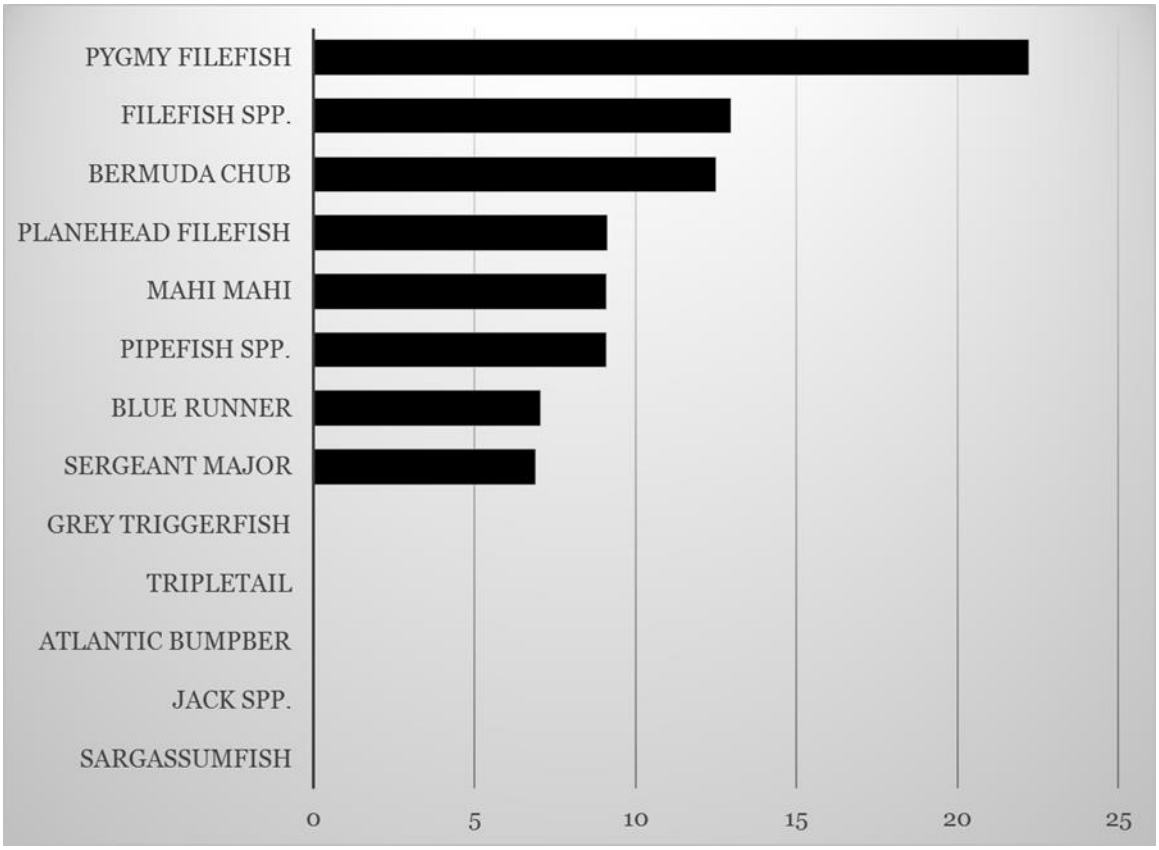

Figure 8 Microplastic frequency of occurrence for dominant taxa examined in this study.

Information on collaborators / partners: Not applicable

Information on any outreach activities: A M.S. graduate student's stipend was funded by project for much of the past project year. This student participated on field trips, and has devoted 20 hours per week on the project sorting through Sargassum, measuring and identifying fishes, and has completed nearly all of the diet analyses to date. The student presented her findings at an international conference in February 2016 (see next section below). In addition to this student, numerous other interns, graduate students, research technicians and a postdoc have participated in the field and lab components of the project, including several interns supported by the NOAA NGI Diversity Internship program. Further, the PI has incorporated findings from this project into several outreach and education presentations, including a (Sea Grant-supported) teacher workshop, "Fin, Fish, and Fisheries" sponsored by the Dauphin Island Sea Lab.

Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology

NGI File #14-NGI2-71: Diagnosing Atlantic Basin Tropical Cyclone Rapid Intensification with Artificial Intelligence and Composite Techniques

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

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

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 uses a mixture of large-scale and local-scale predictors in a purely statistical framework to predict the onset of RI. 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:

- 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

- 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.

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

The timeline below (Table 1) shows the anticipated progress on the project through the end of year 1. A brief summary of the activities up to this point is provided as well. *Tasks 1-4 are complete, tasks 5 and 6 are ongoing. Note a 1 year no-cost extension was requested so the remaining tasks in year 2 will be completed during the no-cost extended year 3 period.*

Table 1 Project timeline of anticapated progress through year 1.

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		■				■		

Individual milestones:

1. National Hurricane Center's hurricane database (HURDAT) was used to obtain all tropical cyclone cases between 1985-present. GEFS reforecast data was obtained for a 24 hour lead time before tropical cyclone rapid intensification. Additional lead times will be used after the framework is completed for 24-hours lead time. Each composite was formulated on a storm-centric domain based on the minimum sea level pressure (mslp) in the GEFS reforecast fields and compared and adjusted to the "best track" mslp as established in the HURDAT. Rapid intensification (RI) was defined initially as an increase in wind of 25 kts in 24 hours, and using this definition the data were classified into RI and non-RI case lists. This work was completed in 2015.
2. Rotated principal component analysis (RPCA) was performed on 3-dimensional atmospheric output from the GEFS reforecast fields including height, specific humidity, temperature, u and v wind components as well as calculated fields including divergence, relative vorticity, potential temperature, equivalent potential temperature, static stability, speed shear, and vertical shear. One-dimensional variables were also considered from the GEFS reforecast fields including CAPE, latent heat flux, sensible heat flux, and vertical velocity at 850 mb. Cluster analyses were performed on the RPC loading fields to show how the events grouped together. These similar fields were averaged to yield composite map types for variables mentioned in step 2, which could then be subjectively analyzed. The individual variables from separate RPCA T-mode loadings (step 2) were also clustered to evaluate whether a specific pattern dominated between RI and non-RI storm types. This work was completed in 2015.
3. S-mode and T-mode rotated PCA results were formulated on all storms in which RI occurred at least once in its life cycle, as well as all storms in which no RI occurrence was observed. The S-mode results formalized the non-linear separability between RI and non-RI events, as seen through analyses of the S-mode RPC score results from recent work (Figure 9). While S-mode

results were not as useful other than demonstrating the non-linear separability issues discussed previously, T-mode results revealed several key findings regarding important discriminatory variables, both in terms of space and magnitude. The results showed that equivalent potential temperature maxima were located near the storm center in RI cyclones, while the maxima were generally weaker and displaced northeast of the storm center in storms that never underwent RI (Figure 10). Additionally, relative vorticity maxima were larger and centered on the cyclone more effectively in RIs vs non-RIs. Finally, static stability in the mid and upper levels in the center of the cyclone was generally higher in RIs vs. non-RIs, revealing the area of strong subsidence in the cyclone center that was notably absent from non-RI storms. This work was completed in spring 2016.

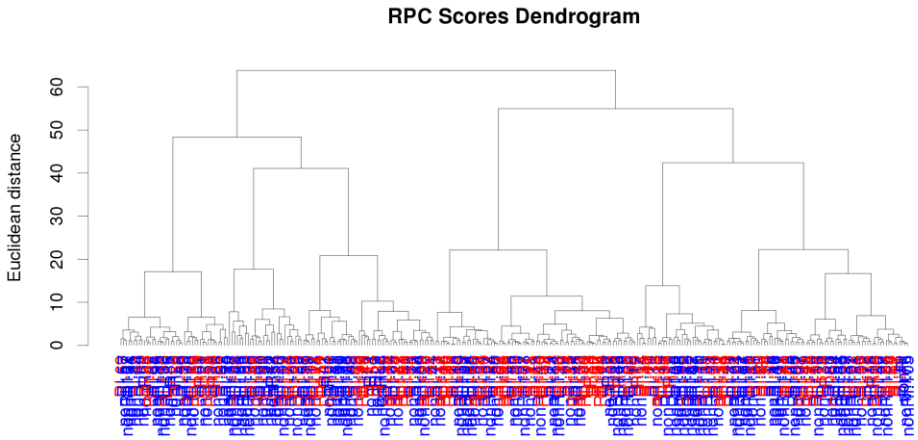

Figure 9. RPC S-mode score clustering, revealing significant overlap between RI RPC scores (red labels in the dendrogram) and non-RI RPC scores (blue labels).

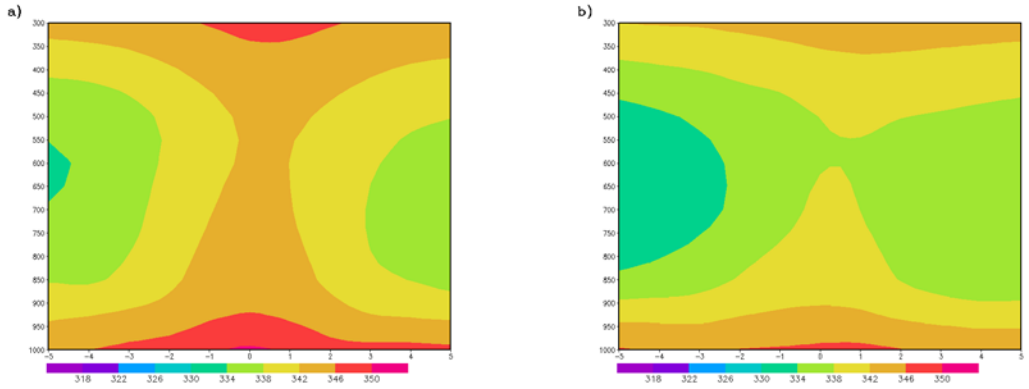

Figure 10 T-mode composite equivalent potential temperature fields for an RI cluster (a) and a non-RI cluster (b). The greater values in the storm center in the RI storms reveal the additional available energy for RI to occur.

4. With a finalization of spatial location and variables which are significantly different between RI and non-RI environments, AI development has begun. Initial development utilized numerical

weather prediction model output of varying resolution (54 km, 18 km, 6 km) to determine the importance of higher-resolution simulations in improving AI classification ability. The findings were counter to expectation, as 54 km model simulations gave the best discrimination capability (highest HSS) relative to the other model resolutions. Of particular note, the 6 km resolution data were too noisy, and the high degree of noise hindered classification ability such that a notable skill drop-off of 10-20% was observed. Interestingly, HSS results were considerably better than current operational implementations of the SHIPS-RII, as median bootstrap skill scores with the SVM (AI) were roughly 0.6, vs the current standard of 0.3 (Figure 11). These results have motivated the next phase of this research that is going to formalize simulations of all cases at the coarser resolution. Ideally, future simulations initialized with GFS at the 54 km resolution for the north Atlantic study domain will continue to yield improved discrimination capability, ideally leading to an operational implementation.

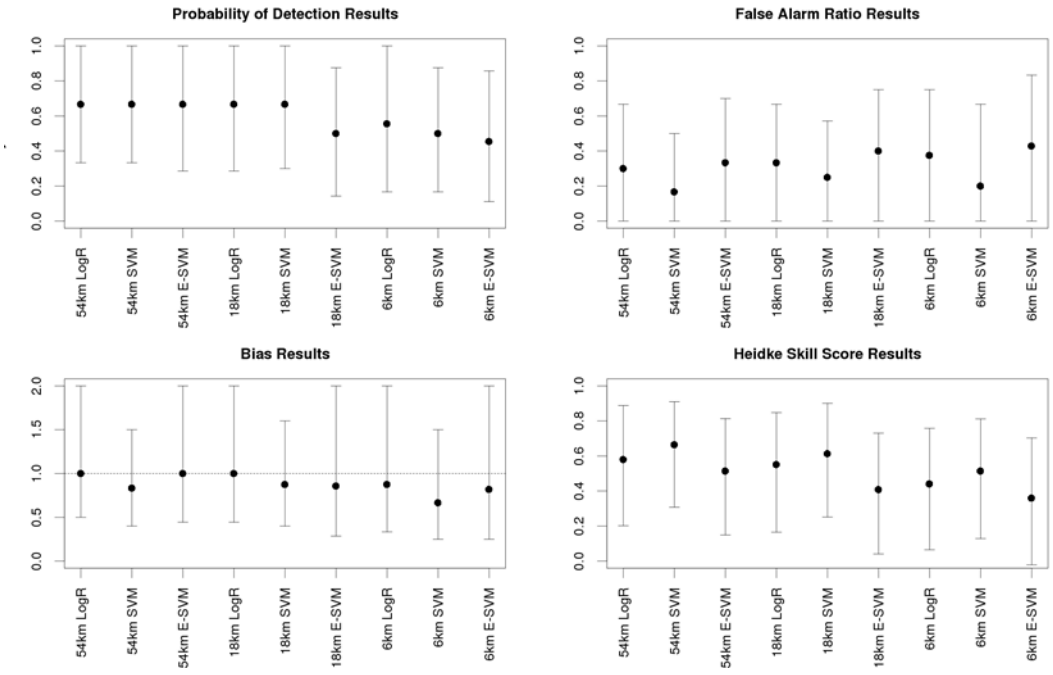

Figure 11 Contingency statistics results for the simulated RI/non-RI cases used to train the AI. Of particular note is the drop-off in HSS (bottom right panel) observed with increasing spatial resolution within the model. Coarser resolutions yielded improved classification performance by the AI.

Description of significant results, protocols developed, and research transitions:
Preliminary work regarding the AI model development is completed and has yielded promising results. Additionally, the results from the S-Mode composite analysis work (task 4 above) have revealed a suite of important variables and gridpoints that are relevant for distinguishing intensification patterns within cyclones. Some of the major findings include:

1. Low-level thermodynamics, characterized by vertical equivalent potential temperature lapse rates near the center of the tropical cyclone, seem to be important for discriminating RI and non-RI storms. There does not seem to be a favorable quadrant for these differences, but storms

with warmer equivalent potential temperatures and/or slower lapse rates seem to be more likely to undergo RI.

2. Symmetric upper-level vorticity fields were commonly seen in RI tropical cyclones and notably absent from most non-RI tropical cyclones. This physical characteristic reveals the vertical stacking in the center of the storm that is needed for RI to occur
3. Vertical shear profiles are important discriminators, particularly near the storm center, with lower horizontal shear leading to a greater chance for RI.
4. Low resolution model simulations of 20 storms in which RI occurred (at least once) and 20 storms in which no RI occurred at any point in the cyclone's life cycle were formulated. Varying model resolutions were considered (6 km, 18 km, and 54 km). Despite the additional information gained from the 6 km results, AI discrimination worked best in the 54 km simulations, suggesting the synoptic scale contains important discrimination capability that needs to be further explored.
5. The resulting model skill results from the low-resolution model simulations revealed improvements over current operational implementations within the SHIPS-RII of up to 100% (Heidke skill scores of 0.6 vs the operational current peak best of roughly 0.3).

Information on collaborators / partners:
Name of collaborating organization: NOAA/AOML
Date collaborating established: Not reported
Does partner provide monetary support to project? Not reported. Amount of support? N/A
Does partner provide non-monetary (in-kind) support? Not reported
Short description of collaboration/partnership relationship: This proposal was developed under the advisement of the AOML. Trips to the AOML will occur in the next month or two to discuss future work and obtain relevant feedback on the work completed up to this point.

Information on any outreach activities: None reported

Related NOAA Strategic Goals: Weather-Ready Nation

Related NOAA Enterprise Objectives: Science and Technology

NGI File #14-NGI2-74: Occurrence and Accumulation of Marine Debris on barrier Islands in the Northern Gulf of Mexico

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

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

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

Project objectives and goals

The overall goal of this research will be 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, we will investigate these 5 questions-

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:

Table 2 shows the milestones for this project. Shoreline marine debris monitoring has occurred for 5 monthly periods during this reporting period.

Initial clean-ups- February 9-13
Month 1- March 7-15
Month 2- April 4-9
Month 3- May 2-9
Month 4- June 1-4
Month 5- will be completed week of June 28

Table 2 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	**In progress**
February 2017	Manuscript(s), Report(s)	

Description of significant results, protocols developed, and research transitions

Protocols

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

Results

We have completed four months of sampling for this two year project and preliminary results from the first four months show a large jump (> 2x) in the number of pieces of plastic debris collected in May with the start of tourist season, this increasing trend continues into June (Figure 12).

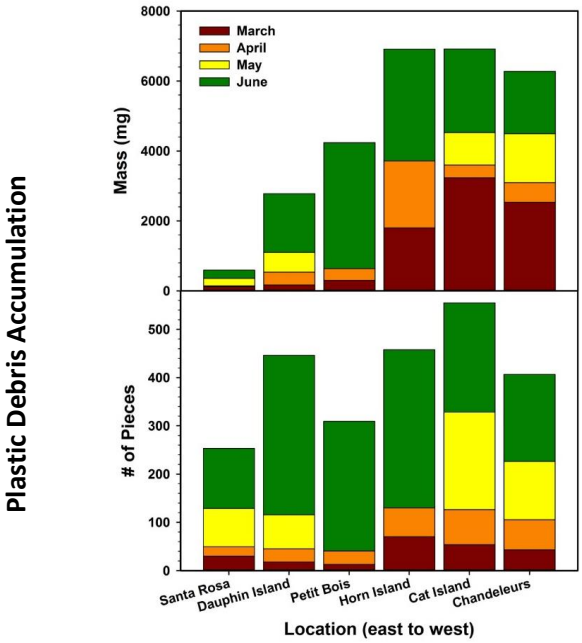

Figure 12 Preliminary results of the amount of plastic debris collected from the ocean side of barrier islands during March, April, May, and June 2015.

Information on collaborators / partners: None reported

Information on any outreach activities: None reported

Related NOAA Strategic Goals: Resilient Coastal Communities and Economies

Related NOAA Enterprise Objectives: Science and Technology

NGI File #14-NGI2-75: Trace Element and Isotopic Analysis of Gulf Sturgeon Fin Rays to Assess Habitat Use

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

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

Project objectives and goals
The goal of this project is to determine past habitat use of juvenile to adult Gulf sturgeon through trace element and isotopic analyses. This goal will be accomplished through the following objectives:

1. Quantify water chemistry changes within the Choctawhatchee River Basin;

2. Analyze fin ray samples for trace element changes corresponding to different ages of the fish; and

3. Analyze fin ray samples for isotopic changes corresponding to natal reach of river.

Description of research conducted during the reporting period and milestones accomplished and/or completed
Objective 1 research underway: Water samples are being collected throughout the Choctawhatchee River Basin, ranging from the limits of accessibility to sturgeons in the upper reaches to its confluence with the ocean. Initial water samples are currently being evaluated for trace elements using solution inductively coupled plasma mass spectrometry (ICPMS).

Objective 2 research underway: Fin ray cross-sections have been analyzed for changes in trace elements using laser ablation ICPMS. Fin rays are in the process of ageing, with the trace element changes to be overlaid to understand approximate ages when habitat based movements are taking place.

Milestones:
Initial water samples collected throughout the Choctawhatchee River Basin. Water samples have been analyzed.

Pectoral fin spines have been collected from wild Gulf sturgeon and are currently being analyzed using LA-ICPMS.

Pectoral fin spines from reference sturgeon held at known salinities have been collected. These are currently being analyzed using LA-ICPMS.

Description of significant research results, protocols developed, and research transitions
Only preliminary results are available at this time. More comprehensive results for both water samples and fin ray samples will be developed as the analyses continue. Additional water samples for trace element concentrations are scheduled to be collected in the near future. Analyses of isotopic concentrations in fin spines and water samples are also scheduled. Results from both types of analyses will be compared to reconstruct habitat use at different life history stages in Gulf sturgeon.

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

Information on any outreach activities: None reported

Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology

NGI File #14-NGI2-79: Increasing our understanding of the interaction between physical and ecological processes in the Gulf of Mexico and Caribbean

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

Co-PI: Steven Morey, Florida State University, smorey@fsu.edu

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

Project objectives and goals:
The overall goal of this project is to gain an understanding of environmental factors that impact fish populations of certain species in the Gulf of Mexico. This project is intended also to train a student in biophysical modeling and to develop a collaborative research program between FSU and NOAA scientists. The project objectives are to (1) Develop and apply a model of the Gulf of Mexico to simulate spatio-temporal variability of circulation and biochemistry that may impact fish larvae; and (2) Apply an individual-based methodology, coupled with the physical-biogeochemical model, to simulate variability in larval recruitment for key species.

Description of research conducted during the reporting period and milestones accomplished and/or completed:
A Ph.D. student appropriate for this project, Taylor Shropshire, was identified and admitted to the Oceanography program at Florida State University in January. Mr. Shropshire is co-advised by Dr. Chassignet and biological oceanography assistant professor Dr. Mike Stukel, and is being mentored by Dr. Steve Morey. Taylor spent the first semester taking a full load of classes chosen to prepare him for beginning the model development work. He has since been developing and running HYCOM simulations, and is also developing an NPZD model coupled to the HYCOM. We have identified a team of NOAA collaborators, Dr. Sang-Ki Lee from AOML and Dr. Mandy Karnauskas from SFSC, and have had teleconferences with them to begin refining the research project. We have a scheduled face-to-face two-day meeting with them next month.

Milestone: Two papers resulting from student work previously funded under this project were accepted and appeared.

Description of significant research results, protocols developed, and research transitions:
Previous student research projects involving circulation in the Big Bend region of the northeastern Gulf of Mexico driving larval transport and upwelling in the DeSoto Canyon region have been completed and published. A new student has started and has been training for the model development phase of the project. This work will commence following next month's meeting with the NOAA collaborators.

I**nformation on collaborators / partners:**
Dr. Sang-Ki Lee (NOAA-AOML) and Dr. Mandy Karnauskas (NOAA-SFSC) will be collaborating on this project. The team of collaborators was established in May 2015. They will lend their expertise to guide the refinement of the research project objectives, including selection of key study species, development of hypotheses, and design of numerical experiments to test the hypotheses.

Information on any outreach activities: Not applicable

Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology

NGI File #14-NGI2-80: Time-Series and Underway Assessments of Ocean Acidification and Carbon System Properties in Coastal Waters

Project Lead (PI): Stephan Howden, USM, stephan.howden@usm.edu

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

Project objectives and goals: None reported

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

Reporting Period: April 1, 2016- June 30, 2016
At the beginning of the reporting period buoy USM3m02 was deployed and USM3m01 was undergoing refurbishment. The condition of USM3m01 at recovery is shown in Figure 13. In order to modify the instrument wells in buoy USM3m01 for the redesigned MAPCO2 system, we contracted with Mechelen Fabrication and Development at the Stennis Space Center. Among other things, Mechelen has built buoy hulls for NDBC. This was necessitated by our inability to have NDBC make the modifications and other work that had stacked up with the CenGOOS team. They were also contracted to repair the broken and missing buoy masts (Figure 13), and sandblast and paint the hull. Although Mechelen was supposed to have completed the buoy refurbishment before the end of the reporting period, they had not done so. It should be completed in early July and then it will deployed in late July or August. Once buoy USM3m02 is recovered we will have to modify that hull as well.

The MapCO2 data were collected over the entire reporting time period (Figure 14). The SAMI pH sensor stopped working on August 13, 2015 (prior to the reporting period), but PMEL did not have a replacement available for us.

Water Samples
Water samples are to be taken on an approximately quarterly basis for DIC, TAlk and pH. Table 3 shows the most recent water sample times at the buoy. Another sampling cruise is scheduled in mid-July. Appropriate sample bottles are received before each cruise from the lab of Wei-Jun Cai at the University of Delaware (UDEL). The samples are spiked with $HgCl_2$ and chilled for shipping back to UDEL for analyses.

Table 3 Recent water samples collected at buoy U8M3m02

Date	Vessel	Location	Sample Depths	Number Samples
08/05/2015	R/V Pt Sur	CenGOOS Buoy	Surface Mid-depth Bottom	3 3 3
12/1/2015	R/V Wilson	CenGOOS Buoy	Surface	3
03/16/2016	R/V Pt Sur	CenGOOS Buoy	Surface Bottom	3 3

Figure 13 Buoy USM3m01 photo taken on December 11, 2015. One of the two anemometer masts and the antenna mast are gone. One of the NOAA/NDBC modules used for testing new components for their SCOOP system is seen dangling in the water. Although one anemometer mast remains, the anemometer is missing.

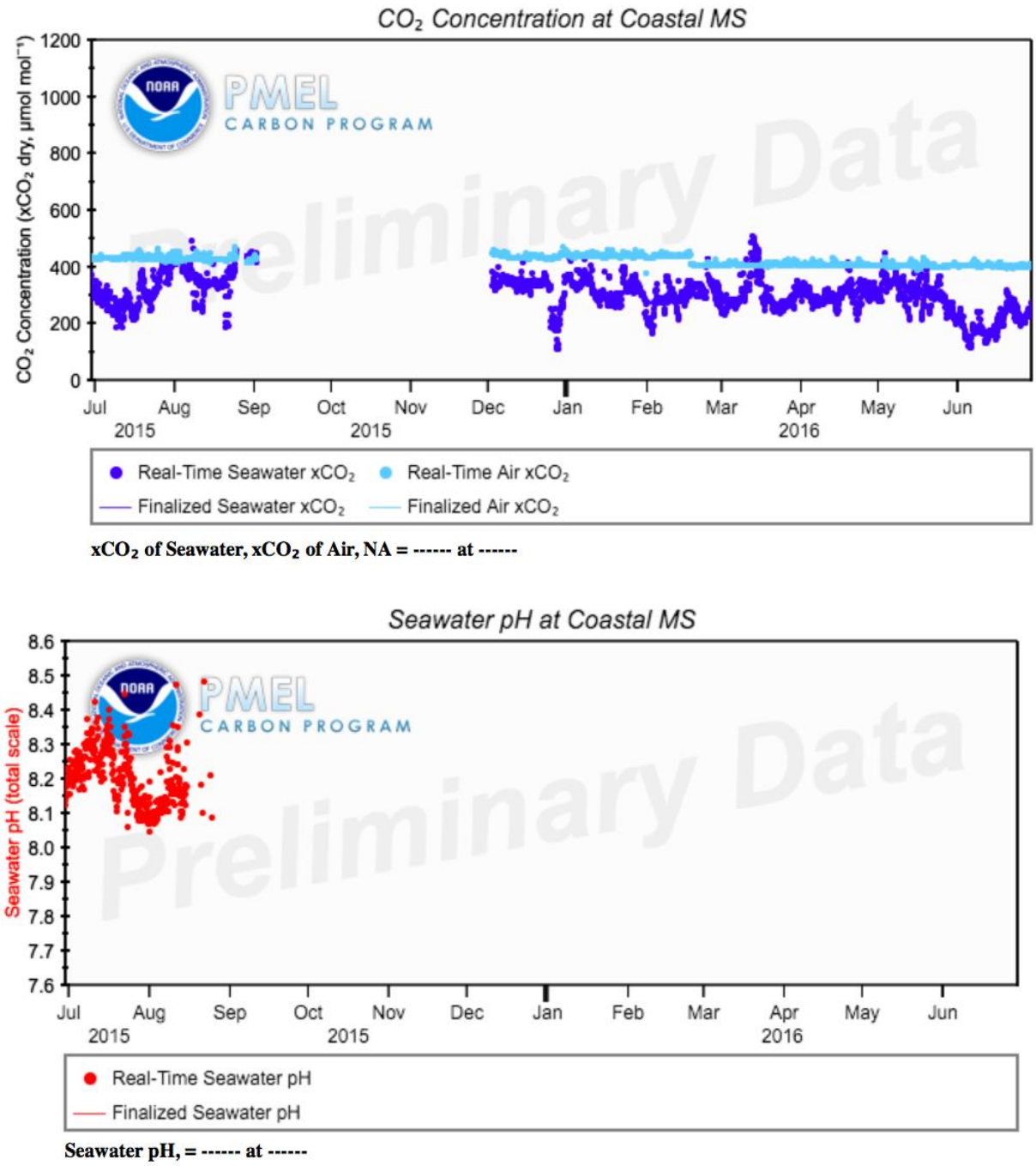

Figure 14 MAPCO2 data for the reporting period.

Description of significant research results, protocols developed, and research transitions:
The time series of xCO_{2air}, xCO_{2sw}, pH, wind speed, C, T and S has continued to be collected. This time series will help determine the seasonal and long-term trends of ocean acidification, and air-sea exchanges of CO_2 in the northern Gulf of Mexico.

Information on collaborators / partners:
Name of collaborating organization: NOAA/PMEL , NOAA/AOML & NOAA OAP; Dr. Rik Wanninkhof (NOAA/AOML), Dr. Anne Michelle Wood (NOAA/AOML), Dr. Jeremy Mathis (NOAA/PMEL), Dr. Christopher Sabine (NOAA/PMEL), Dr. Richard Feely (NOAA/PMEL) and Dr. Jon Hare (NOAA/NMFS/NEFSC).
Date collaborating established: 2011
Does partner provide monetary support to project? No Amount of support? N/A
Does partner provide non-monetary (in-kind) support? Yes
Short description of collaboration/partnership relationship: The CenGOOS buoys serve as a platform for the PMEL MAPCO2 system (including attached CTDs, dO and pH sensors). NOAA collaborators participate in data analysis and writing of presentations and publications. PMEL ships USM the components of the extended MAPCO2 system and USM ships equipment back for repair and calibration.

Information on any outreach activities: None reported

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

Related NOAA Enterprise Objectives: Science and Technology

References:

Dickson, A.G., Sabine, C.L. and Christian, J.R. (Eds.), 2007. *Guide to best practices for ocean CO_2 measurements.* PICES Special Publican 3, 191 pp.

Riebesell U., Fabry V. J., Hansson L. & Gattuso J.-P. (Eds.), 2010. *Guide to best practices for ocean acidification research and data reporting*, 260 p. Luxembourg: Publications Office of the European Union.

NGI File #14-NGI2-83: 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: Russ Beard, NCDDC

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 are 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:

Goals:

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).

2. Plan and implement improvements to the geospatial mapping technology currently in place.
   Progress: **ON-GOING**, with continued dedication to adapt to changes in geospatial mapping technology and to implement improvements to the OER meta/data products in response to those changes.

3. Assess needs regarding continuing GIS operations support and implementation of mapping technology currently in place.
   Progress: **ON-GOING**, with continued dedication to enhanced GIS capabilities, enabling data visualization and integration. This on-going work also supports maintenance of core human resource support for end-user planning and decision support.

Milestones: Goal 1 accomplished in a previous reporting year. For the current reporting year (July 1, 2014 –June 30, 2015), the on-going nature of NOAA GIS workflow requires maintenance of Goals 2-3.

Progress: **ALL MILESTONES MET** by preferred completion date(s). Milestones for Goals 2-3 are ongoing.

Description of significant results, protocols developed, and research transitions

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 GeoTIFF 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 GeoTIFF 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

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.

Production of Bathymetric Data Layers

Bathymetric mapping utilizes a suite of swath-mapping echosounder systems and visualization software to reveal fine scale detail of seafloor topography. To support the mission of NOAA-sponsored explorations, new bathymetric products are added daily to the *Digital Atlas* during *Okeanos Explorer* missions that provide mapping products which are updated in near real-time. During these missions, processed multibeam data (GeoTIFFs) are downloaded daily via FileTransfer Protocol (FTP) and ingested into ESRI® ArcMap® software, a component of ArcGIS®. These GeoTIFFs are added to an

existing map document (.mxd), which is a file extension for a map document used by ArcMap® and contain a map description, layout, and embedded objects saved in the map. Raster pyramids are then created from the GeoTIFFs to improve the display performance of each pixel, and are then copied to the staging server to be reviewed by mapping experts for quality assurance and quality control (QA/QC).

Data Processing for the Gulf of Mexico Hypoxia Watch
Dissolved oxygen (DO) measurements and the associated CTD data which are collected from annual Southeast Area Monitoring and Assessment (SEAMAP) summer groundfish surveys, as part of the NCEI Gulf of Mexico Hypoxia Watch, are processed and visualized as DO contour maps which identify areas of hypoxia in near real-time. Shapefiles are generated from text files using the Geostatistical Analyst in ArcMAP®, utilizing a suite of advanced mapping techniques (*e.g.* kriging and point data interpolation), in order to create contoured shapefiles and polygon graphics from DO measurements. Once these map products clear QA/QC procedures, they are added to a final map as Bottom DO contours, and serve as a primary source of information for summertime advisories on anoxic and hypoxic conditions within the northern Gulf of Mexico region.

Digital Atlas Reachback
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*.

Information on collaborators / partners:
None beyond the NGI/NOAA collaboration with the University of Southern Mississippi (USM), as the grantee.

Information on any outreach activities:
Technical Operator for the Exploration Command Center (ECC)
As a Technical Operator at the ECC, primary responsibilities are to provide communication tools and assist shoreside scientists participating in OER-sponsored research. These duties include Polycom™ voice conferencing to communicate with the science team, simultaneous video display of three high resolution dive feeds on HD telescreens, and logging into the EX dashboard, instant messaging (IM) and Eventlog chatroom, as well as the EX FTP server for data access. Upon arrival, shore-based scientists are briefed on ECC amenities, including wireless access and facilities, the dive plan for that day, the various websites and available collaboration tools, and ship-to-shore science meetings. The shore-based science personnel are provided copies of the latest ROV dive plan, the plan of the day, and an *Okeanos* Data and Products Overview document. This tasking also requires service as an Educational Liaison to engage student groups (ranging from middle school to graduate levels) in all aspects of ocean exploration and current research technologies used by the *Okeanos Explorer*.

Storymapping

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.

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

Information on any outreach activities: None reported

Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology

NGI File #15-NGI2-105: Climate Variability in Ocean Surface Turbulent Fluxes

Project Lead (PI) name, affiliation, email address: Mark A. Bourassa, Center for Ocean-Atmospheric Prediction Studies, Florida State University, bourassa@coaps.fsu.edu

Co-PI(s) name, affiliation, email address: Shawn R. Smith, Center for Ocean-Atmospheric Prediction Studies, Florida State University, smith@coaps.fsu.edu

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

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, for testing coupled ocean/atmospheric models, ENSO forecasts, and for understanding some aspects of climate related variability.

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

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

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

1. Continue operation production of the 2˚ Tropical Pacific and 1˚ 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; and

6. Continue interaction with national and international flux groups.

Progress on these deliverables specifically target the program deliverables related to sea surface temperature, surface currents (via wind observations), and the air-sea exchanges of heat, momentum, and freshwater. The DAC strives to make high-quality fields of surface turbulent fluxes readily available to the research and operational marine climate community. We produced the Pacific and Indian Ocean FSU Winds products, with 100% success in meeting our timeliness goal. However, we are deeply concerned that deterioration of the TOA/TRITON array adversely impacted the quality of the tropical Pacific Ocean product, particularly in the eastern Pacific Ocean where data from this array is a very important component of the *in situ* observing system. The data-related problem in Indian Ocean remains a lack of sampling in the northwestern Indian Ocean due to fears of piracy. Our prior examination of this problem found an enormous impact on the accuracy of *in situ*-based products in this region (Smith et al. 2011).

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).

Our satellite winds are currently undergoing a vast improvement. They were not released during this funding cycle; however, they are expected to be released in at least a beta testing mode during the next funding year. Pending improvements based on this beta testing (and based on a first round of beta testing), the wind product will be released in near real time for oceanographic applications (we are aiming for release within two days of acquisition of the satellite data, which is typically within 12 hours for satellite data). Two years ago our satellite wind product suffered from the limitation that the technique worked only poleward of 20° (e.g. the benefits of that model on fluxes are shown in Figure 15). Last year we improved the physics and can produce the winds poleward of 15°; however, the general approach was found to be a dead end. In the last year, 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. The satellite sensible and latent heat fluxes will continue to be in a development phase, pending implementation of the above model as a hard constraint in our objective analysis.

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 for very carefully intercalibrated data to avoid spurious small scale variability;

3. Satellite observations for near surface air temperature and humidity have vastly improved in the last five years; however, they are not yet planned for near real time production; and

4. An appropriate mechanism for assimilating the observations and retaining the small scale features in a realistic fashion.

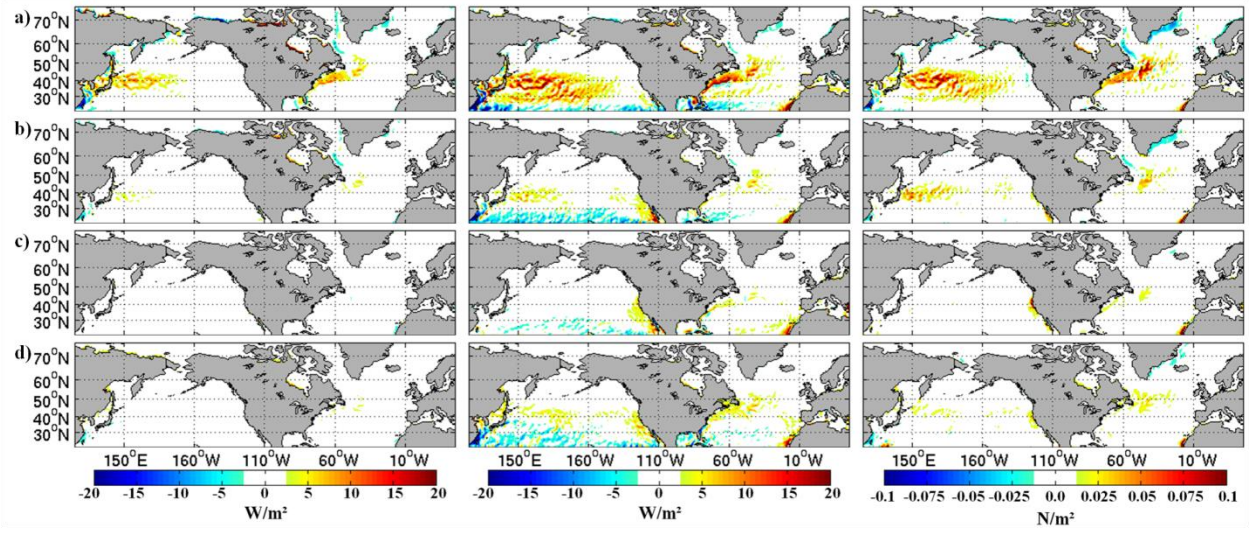

Figure 15 Seasonal biases in sensible heat flux (left), latent heat flux (center) and stress (right). From top to bottom seasons are winter, spring, summer and fall. On daily or six-hourly time scales the changes can by roughly a factor of ten greater.

We strongly suspect that we have greatly reduced problems related to (1) and (4). In the last year, there has been tremendous progress on (2), and remaining differences are being investigated. We are working with NOAA researchers to obtain timely observations of near surface temperature and humidity.

One other critical issue is identifying an appropriate sea surface product to use in our product. This is a controversial topic, with many issues related to the diurnal cycle. Figure 16 shows the comparisons of the GOES geostationary and modeled SST daytime and nighttime data compared to the MUR foundation temperature The MUR foundation data were expected to show a cold bias compared to the geostationary data because the SSTs do not contain any diurnal variability. However, the nighttime comparison shows that MUR is actually warmer on average. This nighttime bias is, on average, 0.17°C. As mentioned previously, the ZB algorithm includes estimations of the cool-skin layer; the evaporation and conduction on the molecular level account for a cooling of the skin temperature that is between 0.1 – 0.3°C. It appears that the MUR foundation temperature may not be accounting for the cool-skin variability for this particular region. This is especially important for users who need to verify nighttime-based algorithms of future satellite missions, for example.

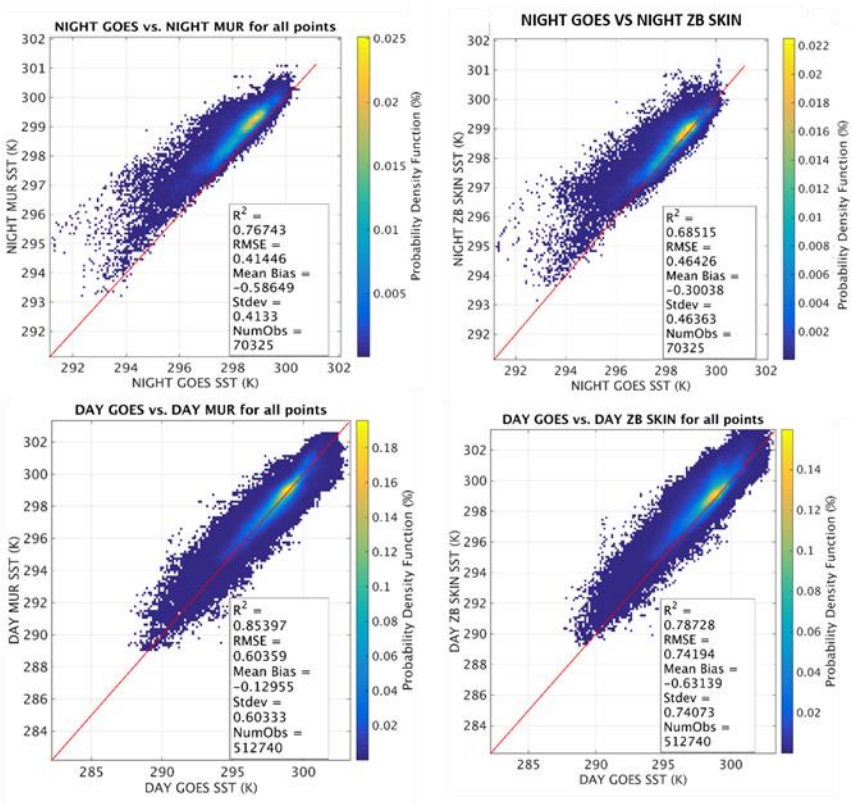

Figure 16 Comparisons of (top left) nighttime only data from GOES and MUR foundation SSTs (K), (top right) nighttime only data from GOES and ZB modeled SSTs (K), (bottom left) daytime only data from GOES and MUR foundation SSTs (K), and (bottom right) daytime only

We have also used WRF simulations to show that considering the diurnal cycle improves the model fit to satellite wind data. Therefore we will continue to examine the use of better representation of the sea surface temperature in our flux products, as these considerations will have substantial regional and seasonal impacts on the calculated fluxes, and consequently there will be a substantial impact of budgets of energy, freshwater, and momentum, as well as transports of nutrients and tracers.

Website:
http://coaps.fsu.edu/RVSMDC/FSUFluxes/index.php

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

Information on collaborators / partners:
FSU collaborates with the NASA Ocean Vector Winds Science Team to develop and eventually produce the gridded winds fields, which are used as part of the technique to create gridded fields of fluxes. We have worked with developers of boundary-layer models to test them for consistency with observations and to utilize them as a hard constraint in the objective method for our gridding technique.

Information on any outreach activities:
Activities related to the Ocean Observing System:

- 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 pushing 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.

- NASA Ocean Vector Winds Science Team Leader (funded through NASA):
  Activities most closely tied to the Climate Observing System are pushing forward the RapidSCAT mission, which is extremely well suited to address calibration differences between North American and Asian instruments with European instruments, which operate at different frequencies and resolve different spatial scales. Another NASA funded activity that is relevant to COD is the development of a global over-ocean gridded fields for surface vector winds.
- Co-chair or organizer of meetings and session on topics closely tied to the observing system.

Work with students and schools

I have advised two graduate students, Rachel Weihs (Ph. D, ongoing) and Qi Shi (Ph.D. ongoing) on projects that are tied to gridded flux products

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

References:

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

NGI FILE #15-NGI2-108: Analysis of Fisheries Acoustic Data

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

Co-PI: Valerie Samedy, Northern Gulf Institute, valerie@ngi.msstate.edu

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

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

Overall biomass, abundance, and distribution of small nekton fish and larger invertebrates are relevant to defining the ecological status of aquatic ecosystems. However, determining the exact community composition and biomass of fishes particularly for mixed species as in the Gulf of Mexico is difficult due to the size and diversity of this ecosystem. Acoustic surveys produce large volumes of data but partitioning the acoustic biomass into particular trophic categories is still problematic.

The National Marine Fisheries Service - Mississippi Laboratories carries out several routine surveys of fishery resources in the Northern Gulf of Mexico each year. The cruises target several components of the ecosystem and aim at monitoring the abundance and distribution of organisms occurring within the

study area using a broad array of measurements (water currents, water properties, and phytoplankton). The acoustic data come from demersal and plankton surveys established from 2010 to 2015. In the database, height surveys have been selected based on the quality of data, with almost 400 GB of data (Table 4) with more than 60,000 km of acoustic data. A systematic grid with sampling stations approximately 30 nautical miles apart is used for plankton surveys (GU1101, PC1305, GU1501, PC1504) whereas groundfish surveys (PC1006, PC1108, PC1306, GU1406) are located randomly at different stations (Figure 17). These cruises take place in spring, summer or fall onboard different NOAA Ship (Pisces-PC or Gordon Gunter-GU). The fishing strategy is to collect samples with high-opening fish trawls to determine the information of small fish species and to estimate size structure of sampled populations. Simultaneously, various samplers provide complementary data on ichthyoplankton and environmental information from abiotic data to sediment quality.

For all cruises, the collection of acoustic data was incidental to other survey operations. Acoustic data were collected continuously and the EK60 was recording data from the start to the end of the cruise, along the entire cruise track to provide data that could subsequently be used to characterize the horizontal and vertical biomass of the ecosystem. Four echosounders with one frequency for each split-beam (18, 38, 120 and 200 kHz) provided real-time information on the spatial patterns and abundance of nekton ranging from plankton to fish. The advantages of acoustic methods relative to capture netting are well known: instruments can be deployed on autonomous or cabled platforms that are suited for short or long-term monitoring at high spatial and temporal resolution and at low cost. However, the major challenge in hydroacosutics is still the identification of studied targets to some taxonomic levels, although many studies worked on this issue through the threshold and the multi-frequency. The recording quality is dependent on the ambient environment and could affect the data. The noise could come from different sources of noise, as physical (weather, wind friction, waves), biological (animals sounds, behavior), or artificial (electrical noise, bubbles).

Table 4 Summary of surveys information conducted in the Gulf of Mexico by the NOAA ships (PC = Pisces, GU = Gordon Gunter).

Survey designation	Year	Date	Season	Distance (km)	Ship	Files	Size (GB)	Frequency	Cruise purpose
PC1006	2010	10/12 - 11/23	Autumn	10200	PC	4380	71.3	18/38/120/200	Demersal organisms
GU1101	2011	05/02 - 05/28	Spring	6958	GU	2049	66.7	18/38/120/200	Spring Plankton
PC1108	2011	10/13 - 11/16	Autumn	7508	PC	6070	98.8	18/38/120/200	Groundfish
PC1305	2013	08/25 - 09/24	Summer	7453	PC	5748	187.1	18/38/120/200	Plankton
PC1306	2013	10/22 - 12/06	Autumn	8737	PC	3973	125	18/38/120/200	Groundfish
GU1406	2014	10/31 - 12/03	Autumn	4945	GU	772	31.1	18/38/200/120	Groundfish
GU1501	2015	03/17 - 04/01	Spring	8452	GU	1337	65.9	18/38/200/120	Spring Plankton
PC1504	2015	08/24 -09/10	Summer	5811	PC	562	27.2	18/38/120/200	Fall Plankton

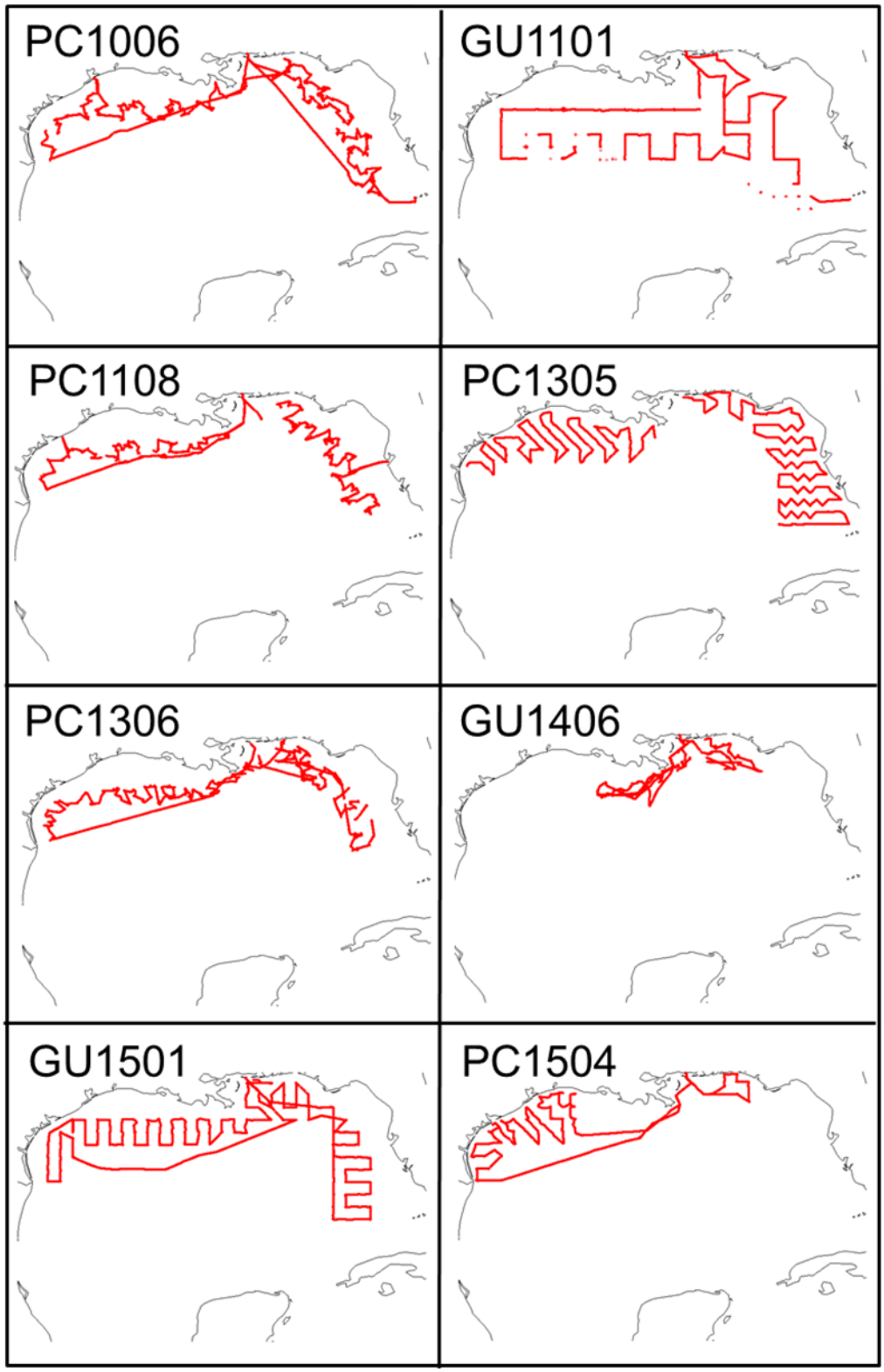

Figure 17 Cruise tracks for each survey during which EK60 data was collected in the Gulf of Mexico.

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

Software management

Digitized hydroacoustic data collected at each survey were processed with Myraix Echoview software (version 6.1 and 7.0). It is a program developed by the Australian company Sonar Data, which allows the collection and analysis of acoustic data, performs echo-integration for estimating abundance, and also interactively allows identification and classification of different species. This software requires a dongle USB or parallel port. The dongle is a physical hardware device against software piracy which allows functionality under license.

Each echogram is a "variable", and each variable has specific properties that are common for all variables. Each variable was used to visualize process and characterize the data. Several adjustments in the Echoview programming were necessary for proper handling and analysis of data (Figure 18).

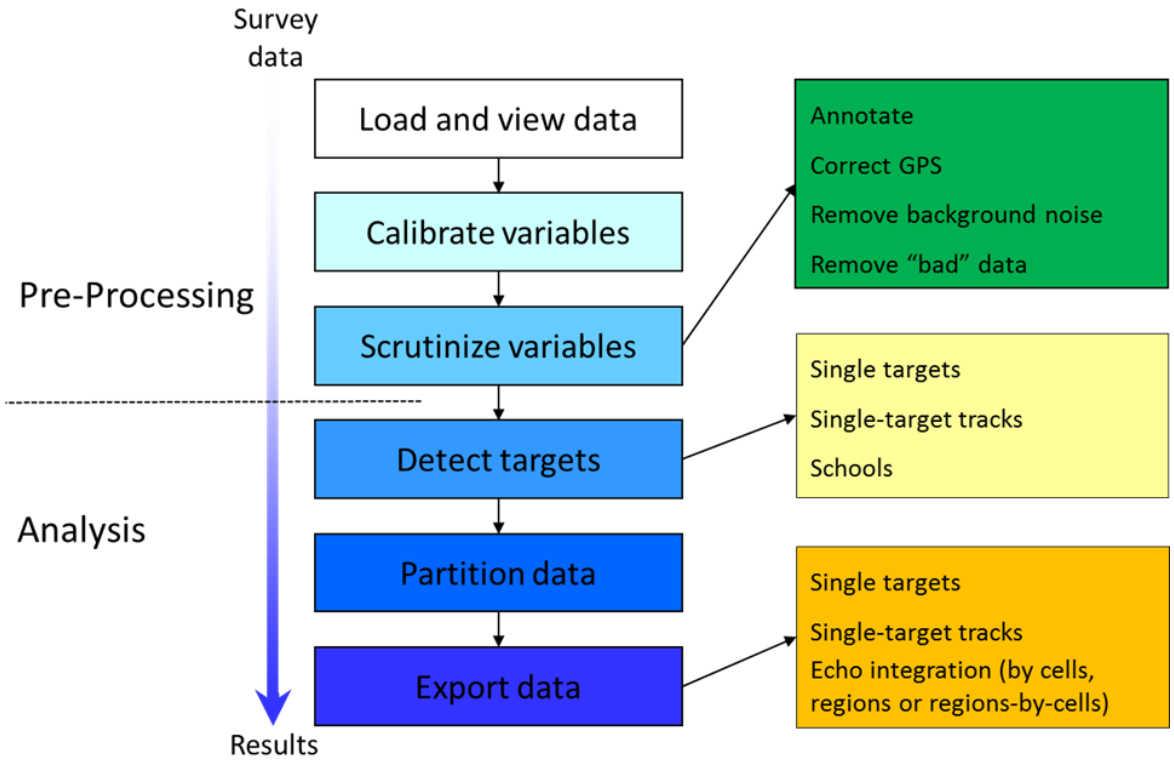

Figure 18 Different steps to process acoustic data (Echoview, 2015)

Data pre-processing

Acoustic data, recorded in a Simrad specific format (.raw), required some important pre-processing work before in order to be analyzed (displaying the preliminary data, converting and filtering echograms, removing the noise or the bad data), particularly in this case, as opportunity data.

The first step was to update data in the software and make them exploitable. Each EV file is archived in the folder named as the same designation of the cruise name and can be used any number of times.

The Dataflow window is used to manage all variables and geometry objects. It displays relationships between transducers and the platform, their inputs and outputs, as well as the data flow relationships between raw acoustic and virtual variables (Figure 19). In this processing, each unit had to be connected at the correct transducer or objects. For each frequency, a new transducer unit was created and connected to the different variable icons (Sv, TS, raw line variables, Angular position). Each single beam acoustic variable should be recognized by frequency as T1, T2, T3 and T4 respectively (18, 38, 120 and 200 kHz excepted for GU1406 & GU1501, the order is 18, 38, 200 and 120 kHz).

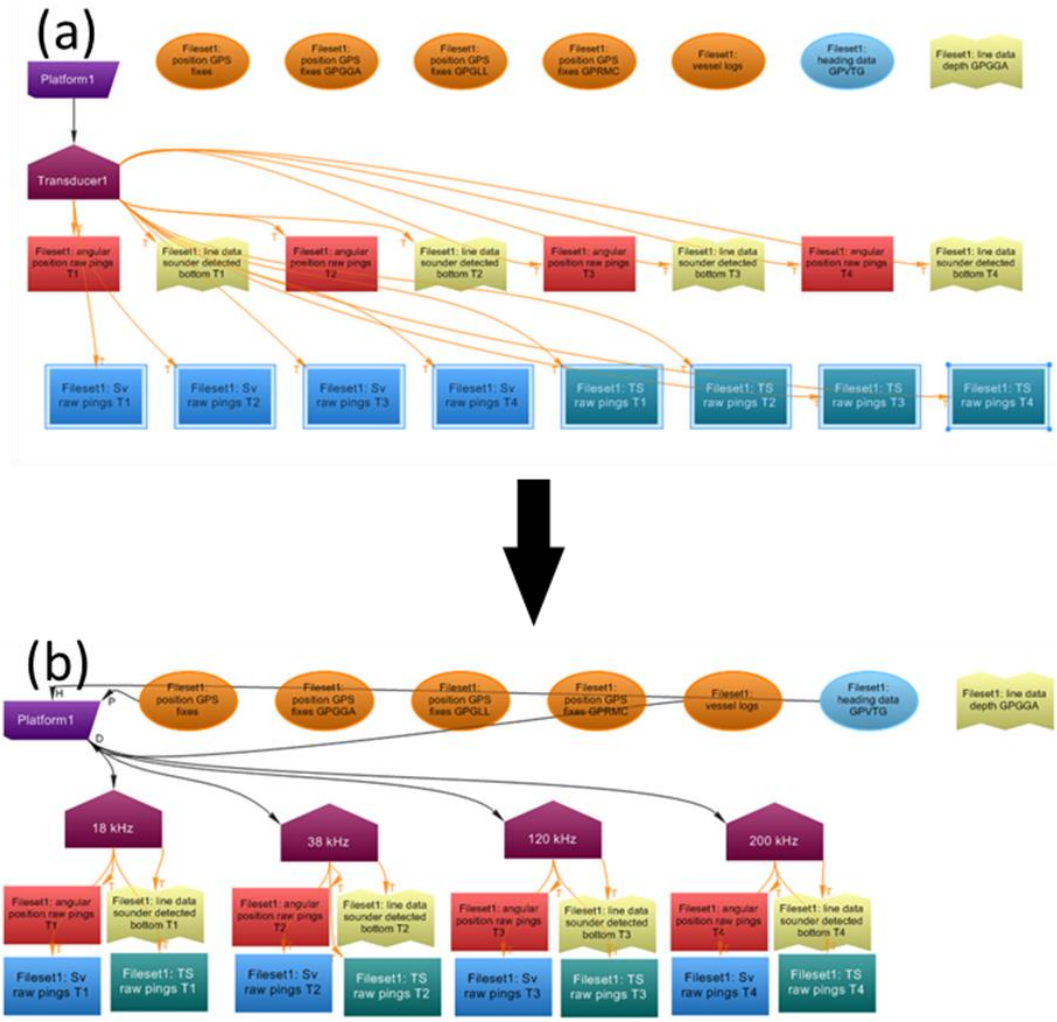

Figure 19 Manage the data flow after to upload the data (a) upload structure (b) corrected structure

The transducer draft, which is the vertical distance between the water surface and the center of the transducer face, has to be correctly translated the range to depth. The draft is defined as the Z-vertical offset in Echoview (Figure 20). The maximum recorded depth and the transducer draft for each survey are summarized in Table 5.

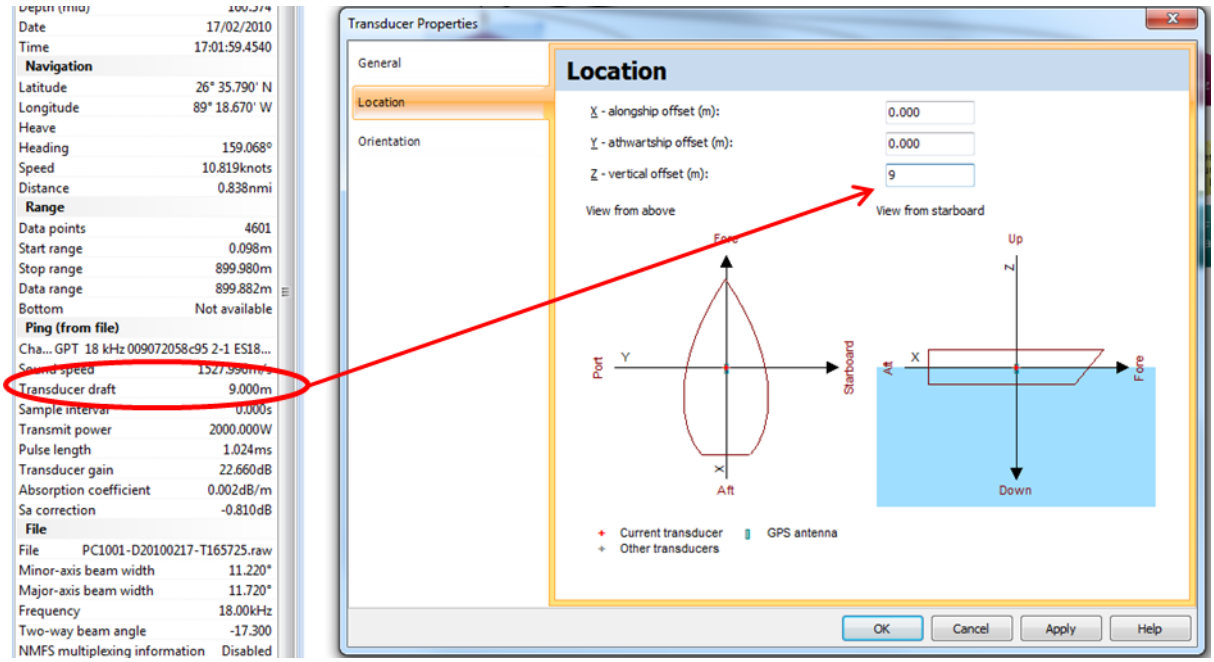

Figure 20 Transducer properties to correct the transducer draft

Table 5 Information about the recorded data

Surveys	Depth limit record	Transducer draft
PC1006	1000 m	6m - 9m
GU1101	2200 m	5m
PC1108	600 m - 1000 m	9m
PC1305	1500 m	6m – 7.5m - 6 m - 9m
PC1306	1500 m	9m
GU1406	600 m	4.6 m
GU1501	1000 m	4.6 m
GU1501	1000 m	4.6 m
PC1504	600 m	6 m

Data interpretation

Interpretation of acoustic data involves verification of the echogram in scrutinizing data before to generate volume backscattering strengths (mean Sv), i.e., process of visually interpreting (Jech and Michaels 2006) and selecting data as good data, then checking the data quality. Echograms need to be checked and manually corrected to clean data, particularly to remove bad data or noise, with particular attention paid to finding an appropriate treatment. Scrutiny and replay of echograms was a hard task because manual examination was needed. The process of scrutinization is a largely subjective process that should be at the very least carried out in the presence of someone who is experienced or familiar with the acoustic data.

In acoustics, there are two areas where the target cannot be detected: near the surface and near the bottom. Variables lines provide access to creating, modifying baselines with the surface line delimiting

the area near the transducer and on the bottom to prevent their integration. For these data, a 10 m line was defined to eliminate near-field transducer effect and to reduce backscatter from surface bubbles (Figure 21a). The depth of seabed was estimated using the best bottom algorithm but the bottom line was manually checked and corrected if necessary and data within 1m of and below the estimated bottom depth were removed to ensure any pixel from the bottom did not interfere or integrate the echo-integration values. Minor bottom integrations can cause a huge amount of unwanted biomass. The bottom depth was combined with the data from all frequencies. A new bottom line was edited (green line) based on the existing raw line (=line data sounder detected bottom, yellow line). Even with the safety margin, sometimes, the bottom line needs to be adjusted particularly when the data were recorded during inclement weather (Figure 21b).

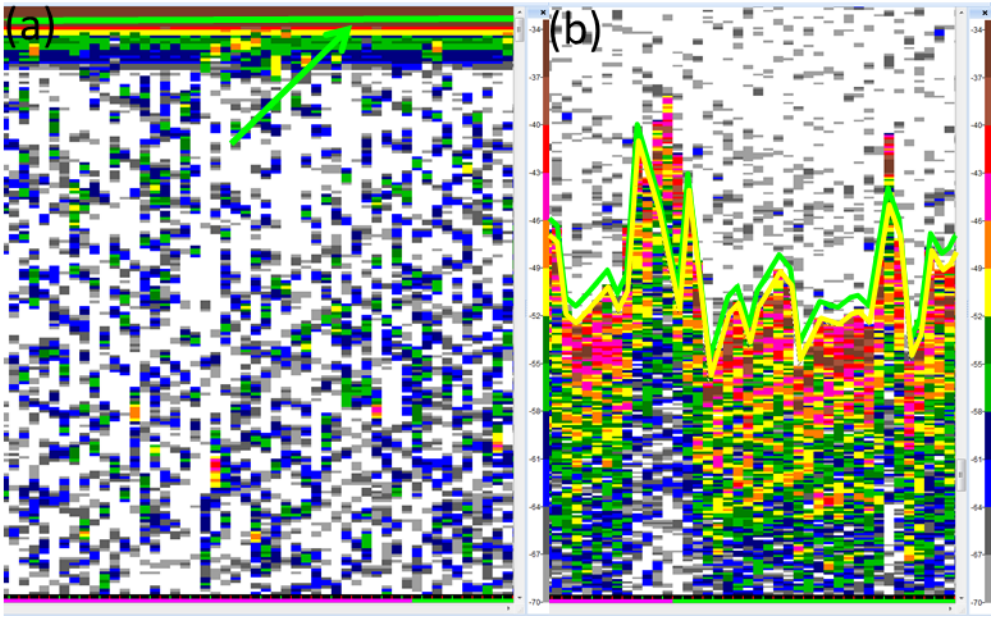

Figure 21 Variables lines in Echoview (a) created fixed depth line at 10 m in green (b) raw bottom line in yellow and picked bottom line in green with 1.5 m added.

During the survey, the acoustic data methods require paying attention upon acquisition because that will be the raw data. However, as there are opportunistic acoustic surveys, the data seem to have a lot of interferences. Indeed, transducers are sensitive to echoes from all elements in the water column. Each element could create noise like turbidity, bubbles in surface, etc. Weak unwanted signals (noise echoes) were very numerous, particularly and probably due to the electrical interferences during the surveys when they used other samplers. This could be seriously biased abundance estimates.

Initial inspection of all data revealed that high levels of background noise, usually flow noise or other shipboard sound sources (Impulse Noise Removal Filter), or dripping (process of Drop out) from excessive attenuation in surface bubble plumes during inclement weather, resulted in spurious high levels of backscatter. Our major challenge was to test and find the better process to overcome this problem (Figure 22).

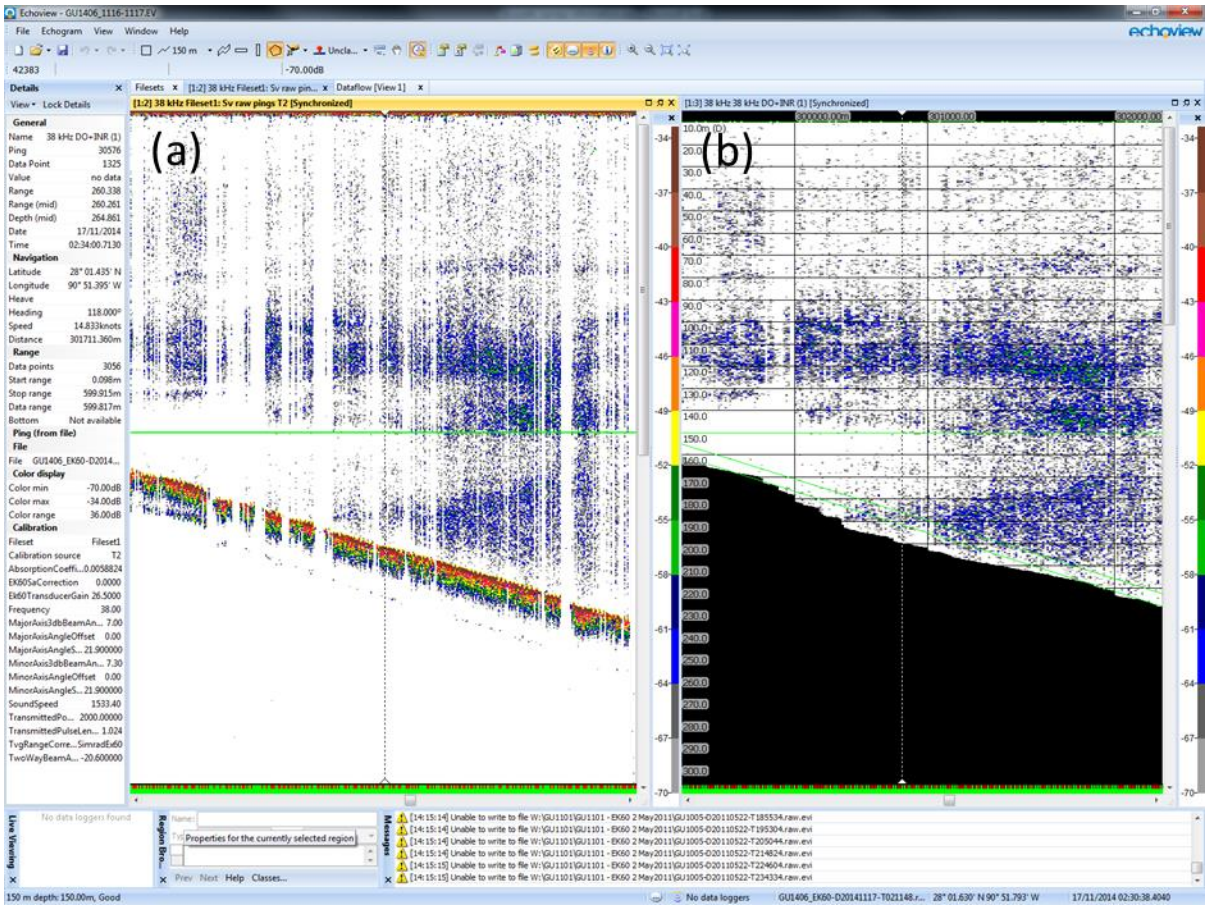

Figure 22 Comparison between (a) the raw echogram and (b) the echogram after different operations applied to remove the drop out.

Each echogram was replayed again and scrutinized another time for “bad data”. In Echoview, two types of bad data region are available: Bad data (no data) and Bad data (empty water). The first one (no data region) was chosen because its values have known or suspected problems or and any other non-biological returns (Figure 23). The second one (empty water) was useful to assign a value of -999 dB (effectively zero backscatter) but to include volume in the analysis domain (Figure 24). All of these areas were manually identified, designated as “bad data” regions, and excluded from data analysis and echo integration.

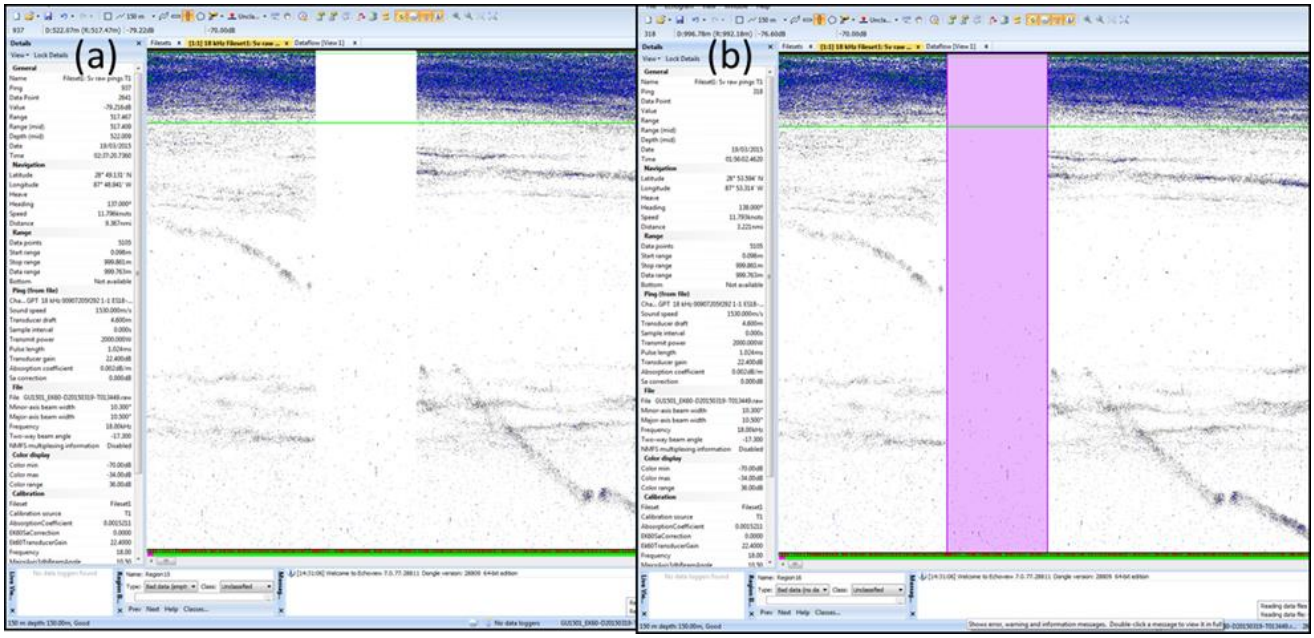

Figure 23 Example of echogram with bad data (a) before and (b) after the exclusion of bad data (no data) in purple color

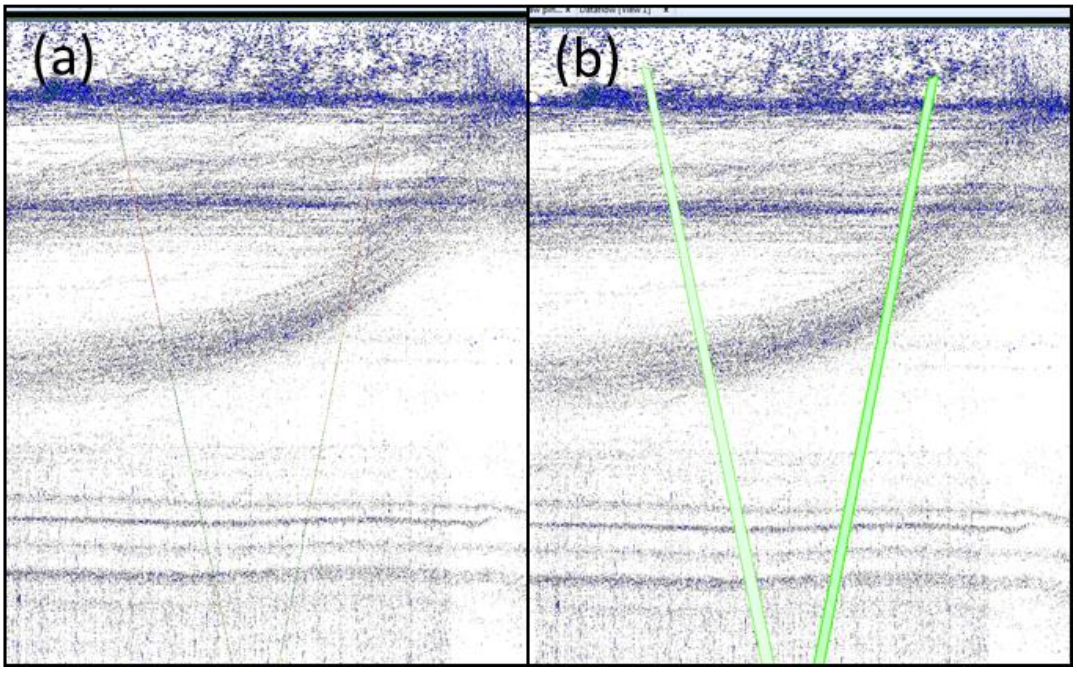

Figure 24 Example of echogram with bad data (a) before and (b) after the exclusion of bad data (empty water) in green color

Acoustic metrics

The many output variables could be generated in Echoview but these two primary outputs are routinely used for statistical analysis: (1) target strength (TS), an acoustic measure (in dB) of target size, generally used to derive estimates of fish length; and (2) Mean Volume Backscatter (Sv), in dB.m-3, commonly used as an approximation of fish biomass. Both TS and Sv are logarithmic in their scales and as such are not directly amenable to the calculation of mean values. Thus each is converted to anarithmetic, or linear, form prior to such manipulation. In this study, we used the echo-integration approach.

In this study, the echo-integration with mean volume backscattering (Sv) was used and echoinA grid had been defined: each cell is edited as 1 km by 10 m. The analysis domain had been considered between (Figure 25):

- above the 10 m line and below the bottom line for 18 kHz and 38 kHz,
- above the 10 m line and below the 200 m line for 120 kHz,
- above the 10 m line and below the 150 m line for 200 kHz.

No threshold was set during the analysis but different minimum and maximum analysis thresholds were tested to see if the choices of thresholds have an impact on the backscattering values.

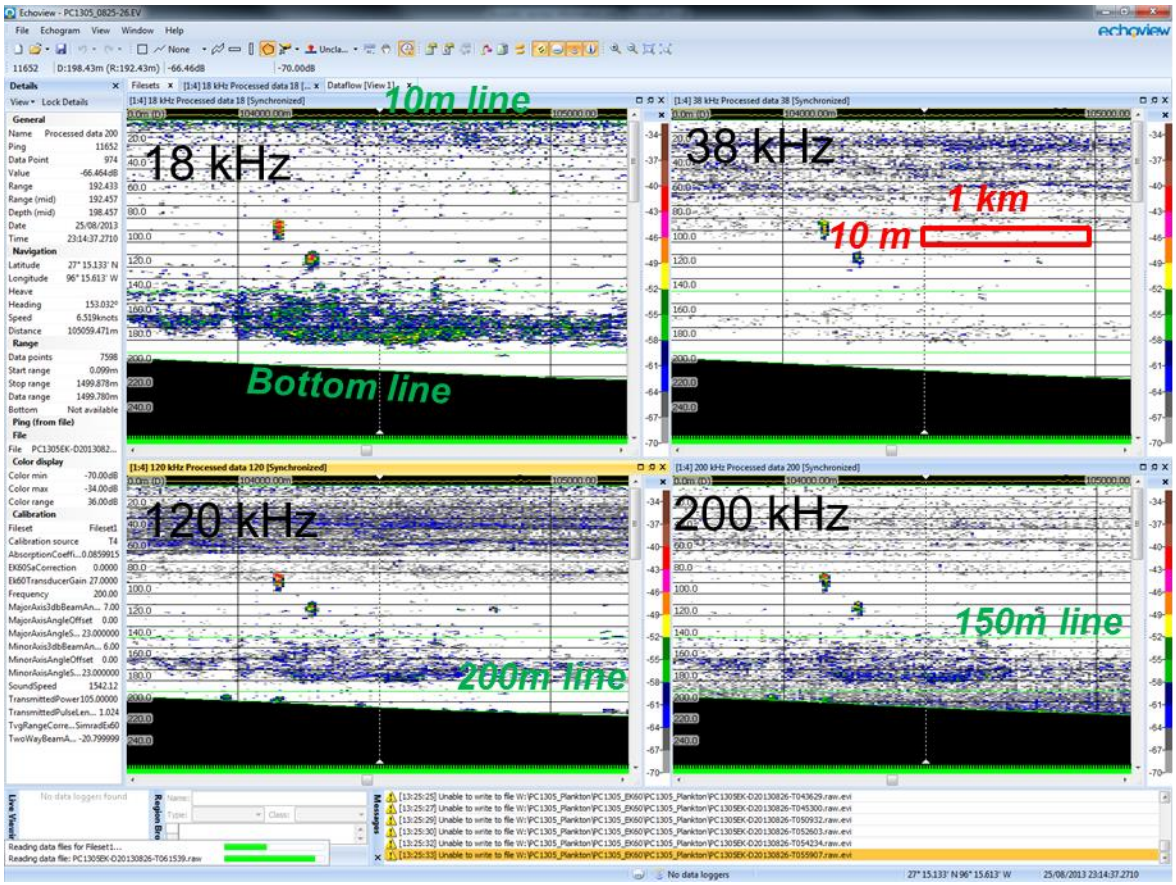

Figure 25 Echograms at 4 frequencies (18, 38, 120 and 200 kHz) with grid (black grid), surface line exclusion and bottom line exclusion.

Significant results

The choice of this threshold was arbitrary and one of the difficulties of the acoustic approach lies in the choice of this threshold, which is a filter (such as the size of the mesh of a net) to retain only that fish compartment. We tested the influence of minimum or maximum threshold for 2 surveys (PC1006 and GU1501). In the literature, the choice of thresholds varied among users and among surveys for similar target species. In addition, there was no consensus on how an *in situ* TS threshold relates to a Sv threshold.

For the minimum threshold, the results showed that the backscattering value changed from -70 dB (Figure 26). In the aquatic literature, a -60 dB threshold is often used as the best compromise between removing the noise and integrating sufficient fish density (for the Sv domain). This result is really interesting for the future of this work if the focus will be on the fish compartment only. For the maximum threshold, any significant difference showed.

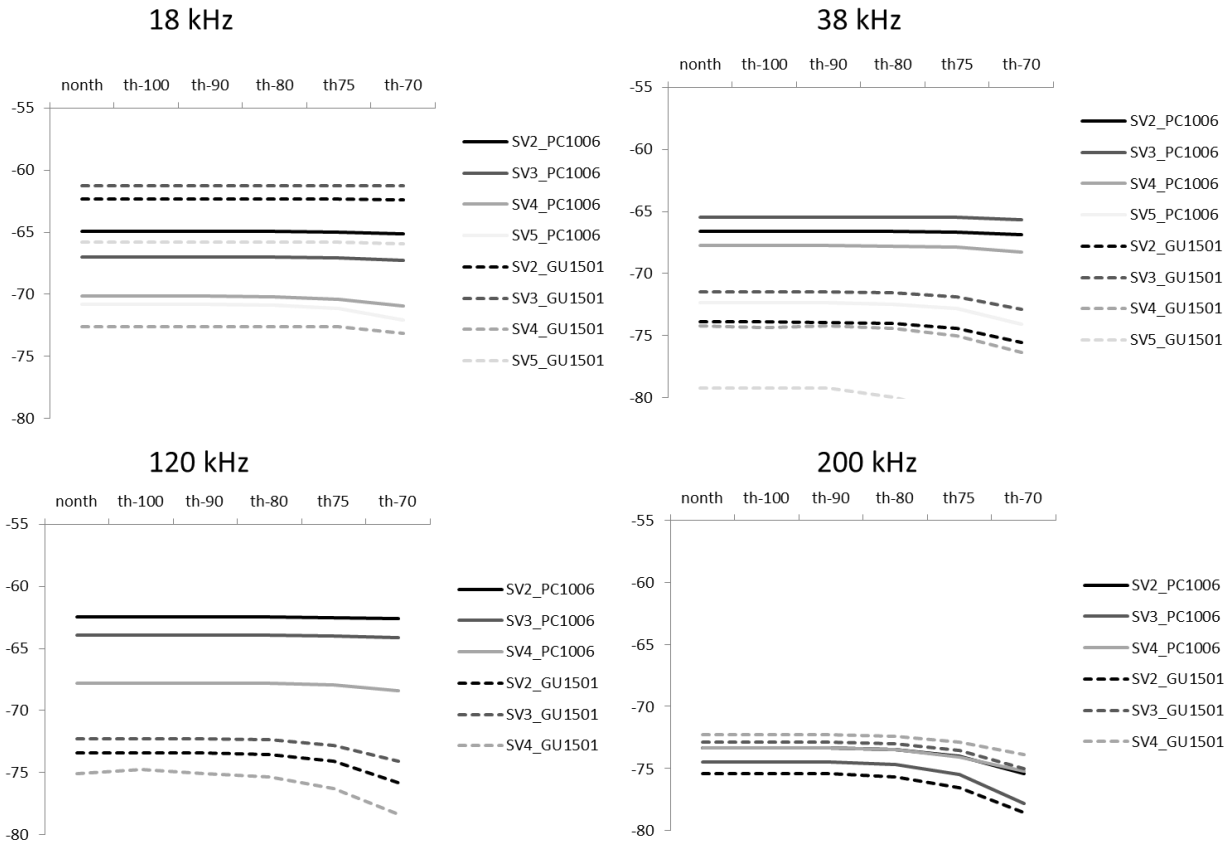

Figure 26 Minimum threshold effect

All data are being integrated in MatLab software in order to create acoustic assessment “biomass” maps and to analyze the acoustic data set. The measured backscattering level for the whole water column has a mean of -50 dB (Figure 27).

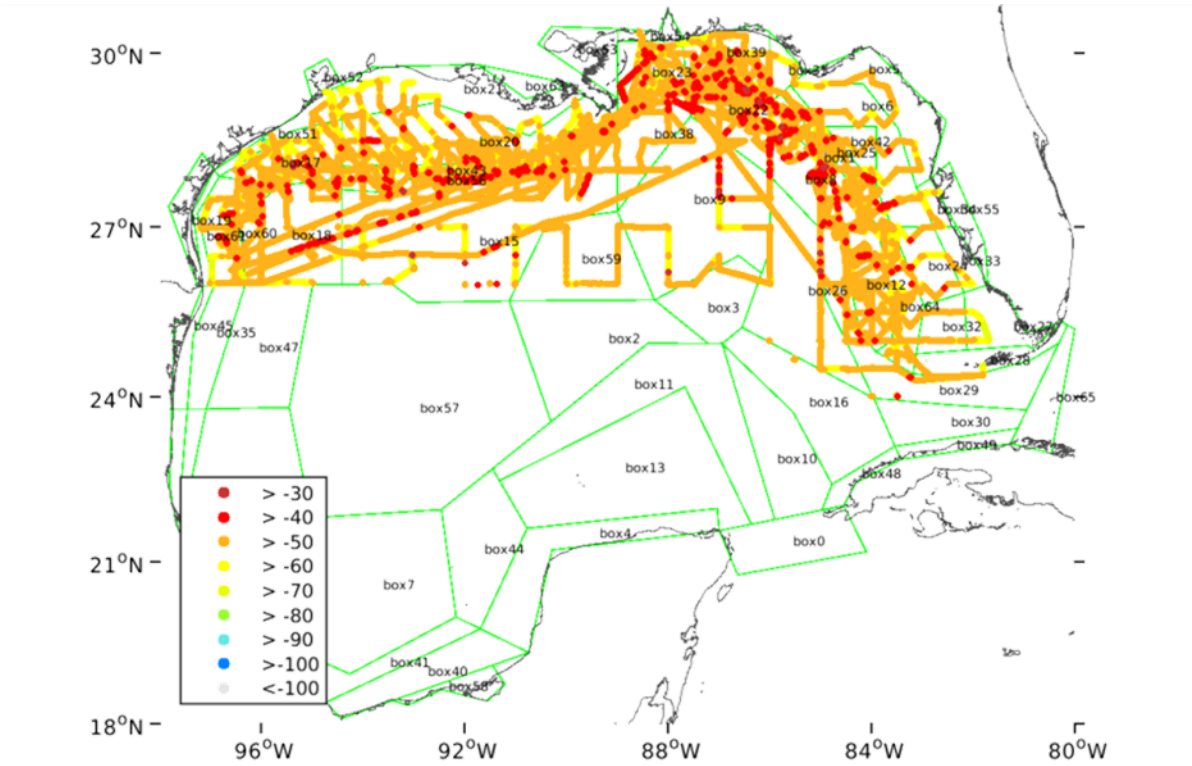

Figure 27 Map of measured total column strength (in dB0 from echo sum from the water column for all surveys.

The ecosystem modeling efforts are more often used in the Gulf of Mexico, but an effort needs to be made to provide ground truth in order to improve the knowledge. The purpose of this project is to provide overall total biomass levels: measured levels of SV and SL from echo-integration were compared with the expected theoretical backscatter predicted from simple approximate acoustic models (bent cylinders and bladders, sensu) (Love 1978; Stanton 1989), as applied to the densities of “pelagic” species from within an initial stable run of the GOM Atlantis Model.

The measured acoustic data were integrated and compared with the Atlantis model runs to calculate the theoretical backscattering strengths. Even if the SL provides an absolute limit on the possible sum of backscattering from all possible mixtures of organisms in the water column, it can be directly measured by the acoustic data based on acoustic models applied to density of "pelagic" species from within Atlantis. Our initial assessment suggests a disagreement in equilibrium biomass concentrations of the nekton. The model showed 20 to 30 dB more scattering (100x-1000x) on the outer shelf and in the deep water (Figure 28). This gap could be come from the effect of mesopelagic fish or the nekton-zooplankton or from some pelagic groups which are unstable in the model.

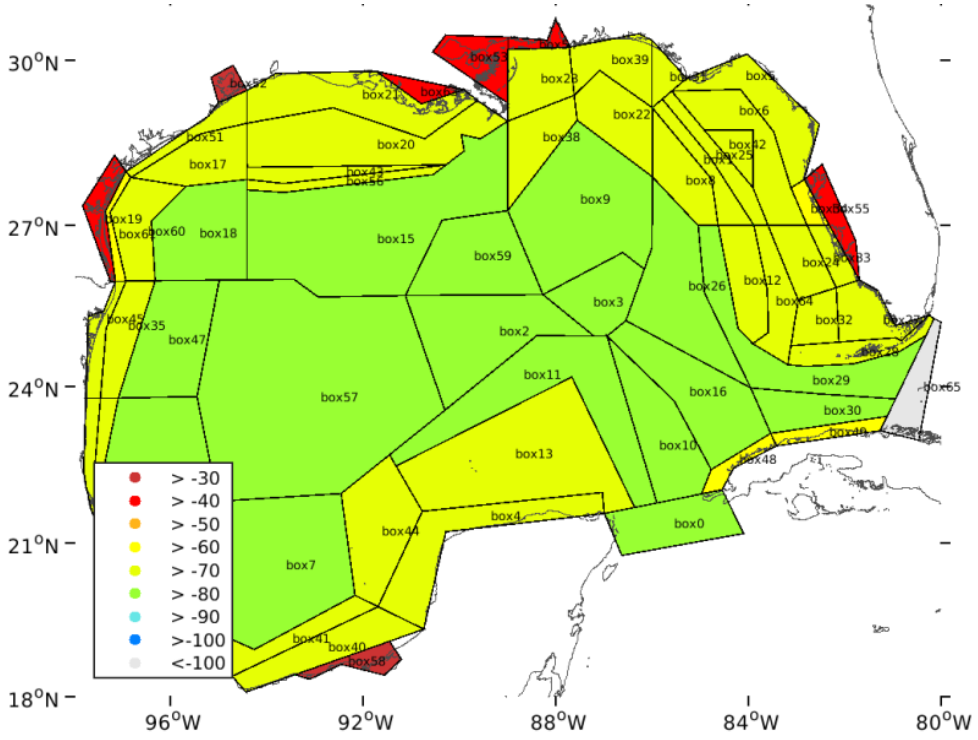

Figure 28 GOM Atlantis Model estimate of total column strength

Some descriptive analyses are done to interpret the evolution of biomass (per survey, per month). The evolution of backscattering (all frequencies together) varied from one survey to another (Figure 29) and varied from one month to another (Figure 30).

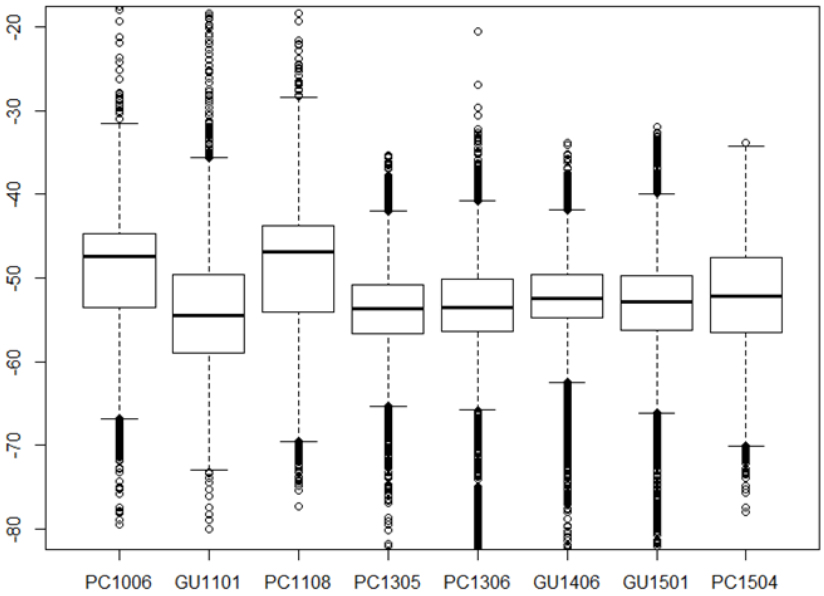

Figure 29 Evolution of backscattering values per survey

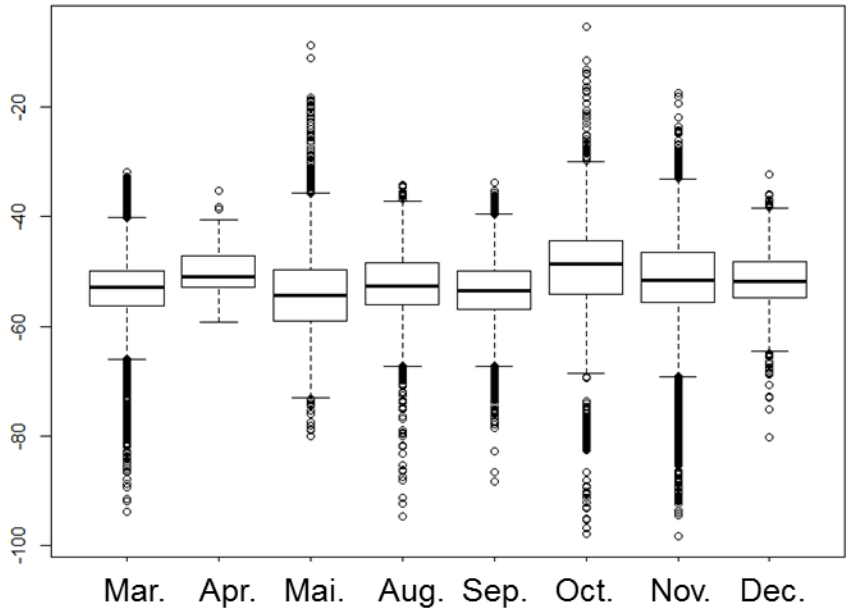

Figure 30 Evolution of backscattering values per month

Another way to study the distribution of biomass in the Gulf of Mexico was to have a vertical approach. Based on the GOM Atlantis model, 6 depth strata were defined. In the same way, the evolution of backscattering (all frequencies and per survey together) varied from one layer to another (Figure 31).

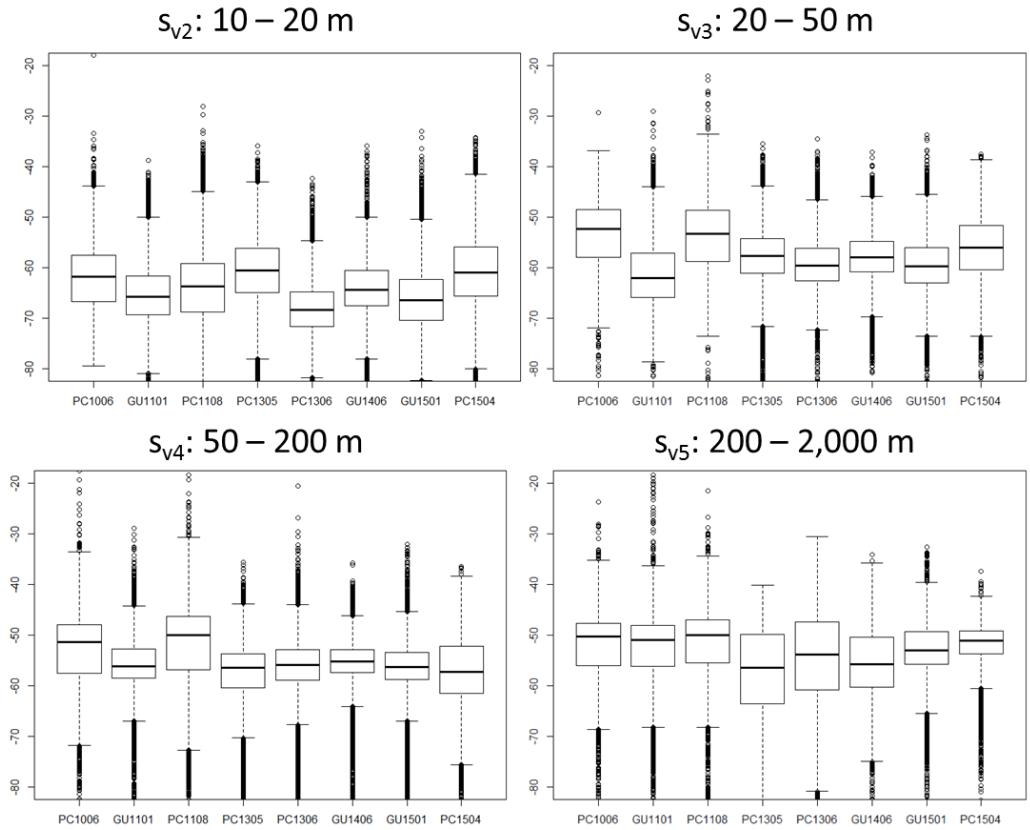

Figure 31 Evolution of backscattering (all frequencies together and per survey) per layers.

However, this kind of descriptive analysis is not robust enough to interpret the evolution of biomass due to the autocorrelation of different parameters: variation in time, season, and space. Other rigorous statistical technique should be attempted to document significant changes in the distribution of acoustically determined biomass in space and time. Presently, the kriging approach seems to be a good way to study the data series and is attempting.

The fish distribution is not a coincidence but largely responds to environmental forcing. Indeed, the natural rhythms induce the complexity and variety at different special and temporal scales. The question of circadian behavior is often underlined and well recognized. The evolution between the backscattering values between the day and the night were compared (Figure 32). The echograms showed that during the daytime, the distribution is more organized in schools, and during the nighttime, the biomass spreads in the water column. Acoustically, the backscattering values are a little bit higher during the nighttime.

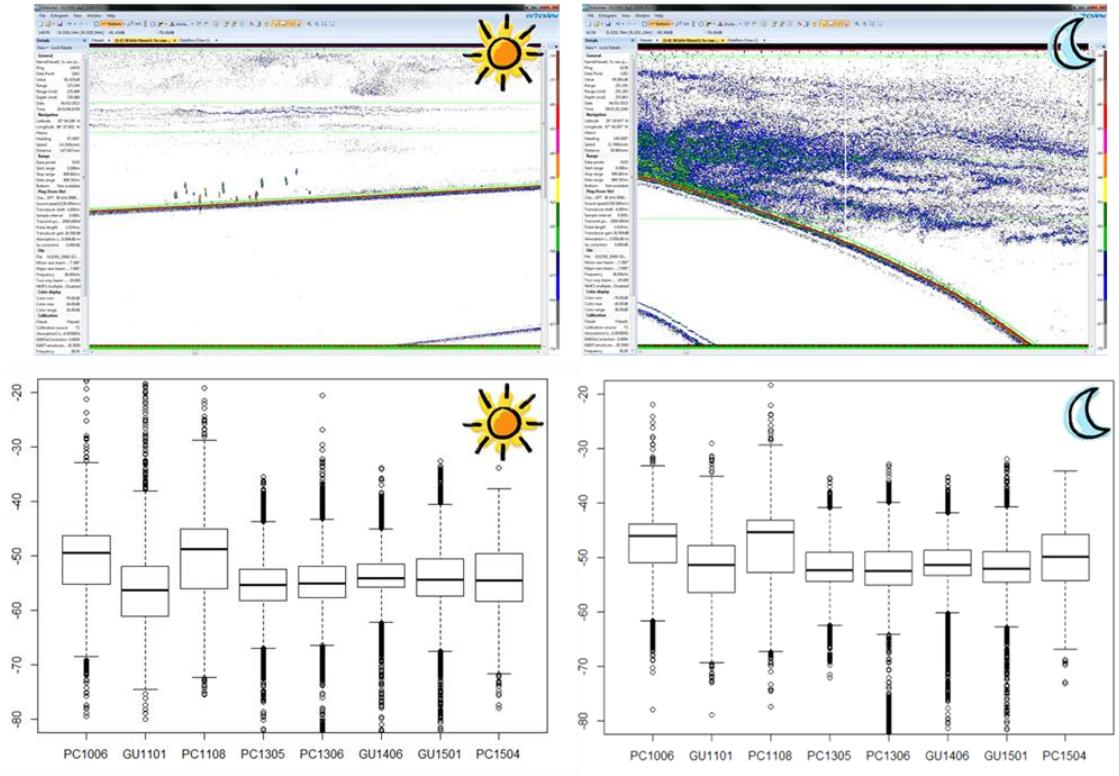

Figure 32 Backscattering values compared between day and night

Perspectives

Scientific issues are attempting to improve the interpretation of the biomass distribution in the Gulf of Mexico. More data from other surveys (GU0903, PC1001 and surveys conducted in 2016) are being analyzed and should be integrated to the database. Different analyses such as kriging or other statistical approaches are being conducted.

Also acoustic surveys produce large volumes of data but partitioning the acoustic biomass into particular trophic categories is still problematic. As the acoustics have no abilities to discriminate the variety of organisms, studying the frequency response from different targets can give important information about what the targets are. The intensity of echoes from targets depends on the targets acoustic density relative to the water, size, orientation, and echo-sounder frequency. The multiple echograms can be set up to show the echoes from the different frequencies simultaneously. It will be necessary to 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.

Information on collaborators/partners None reported

Information on any outreach activities

Dr. Samedy participated in the Third Biennial Southeast Acoustic Consortium) which was held in Saint Petersburg, FL, USA from March 22-25, 2016. The primary aim of this symposium was to inventory the activities, interest, expertise, gaps, and assets related to active acoustics across government, industry, and academia and to inform users of emerging technologies and research opportunities. The *Southeast Regional Acoustics Consortium* is conceived as a working group that would bring together academic

institutions, federal and regional fisheries and environmental management agencies, and private industry that conduct acoustics research in the coastal ocean of the US from North Carolina to Texas and the US Caribbean.

Dr. Samedy's presentation was entitled "Multi-year analysis of acoustic data in the Gulf of Mexico: comparison between acoustic survey data and ecosystem models ", Valérie Samedy, Redwood Nero and Cameron Ainsworth.

Dr. Samedy also made similar presentations at the NMFS Pascagoula Laboratory in May 2016. She had also participated to the plankton survey for the first leg from April 29 to May 13, 2016.

Dr. Samedy is writing a technical report to explain the processing and the inventory of fisheries acoustics data from NMFS surveys in the Gulf of Mexico (2010-2015).

Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology

NGI File #15-NGI2-109: Evaluation of VIIRS AOP/IOP Products

Project Lead (PI) name, affiliation, email address: Haibo Yao, Geosystems Research Institute, Mississippi State University, haibo@gri.msstate.edu

Co-PI(s) name, affiliation, email address: Zhongping Lee, University of Massachusetts Boston, Zhongping.Lee@umb.edu

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

Project objectives and goals
The objective was to characterize and evaluate the ocean color data quality of VIIRS in both turbid waters and oligotrophic ocean through match-up comparisons between satellite and *in situ* measurements.

Description of research conducted during the reporting period and milestones accomplished and/or completed
Evaluating VIIRS-derived ocean products over blue waters

Studies were implemented to evaluate VIIRS AOPs and IOPs for offshore oligotrophic waters. Two data sources were used as references: one is measurements of remote sensing reflectance (RRS) made on May 5, 2014 over blue waters offshore Puerto Rico (Figure 33), and another source is climatology data obtained from MODIS Aqua for gyre waters (Figure 34).

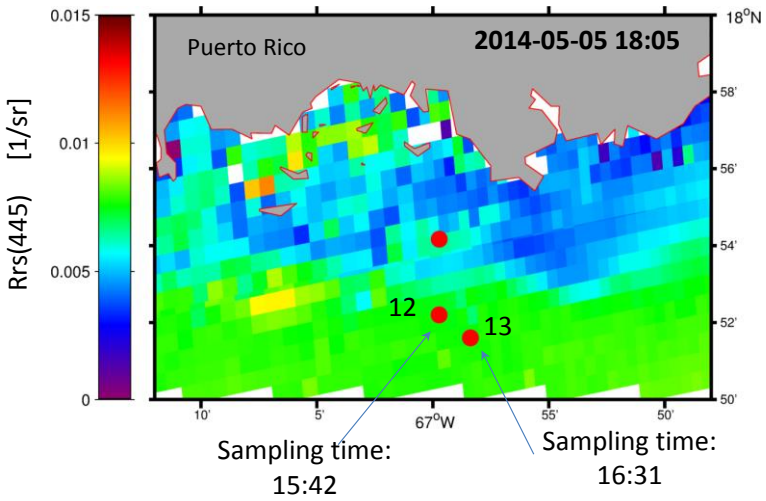

Figure 33 Matchup stations between VIIRS and in situ measurements.

For the Puerto Rico offshore water (Figure 33), there are two stations (#12 and #13) with matching VIIRS data, and Figure 35 shows VIIRS RRS (from CLASS) vs field-measured RRS (with our SBA system). For these two stations, apparently the waters were quite homogeneous where there was almost no difference in the measured RRS (either from SBA or from VIIRS). However, there are quite large differences between VIIRS RRS and SBA RRS, with VIIRS RRS systematically lower than that from SBA. And, VIIRS RRS at the 672 nm band is negative (not showing). We also compared the day-

to-days VIIRS RRS, and apparently there is quite large variation of VIIRS RRS for this location (Figure 36).

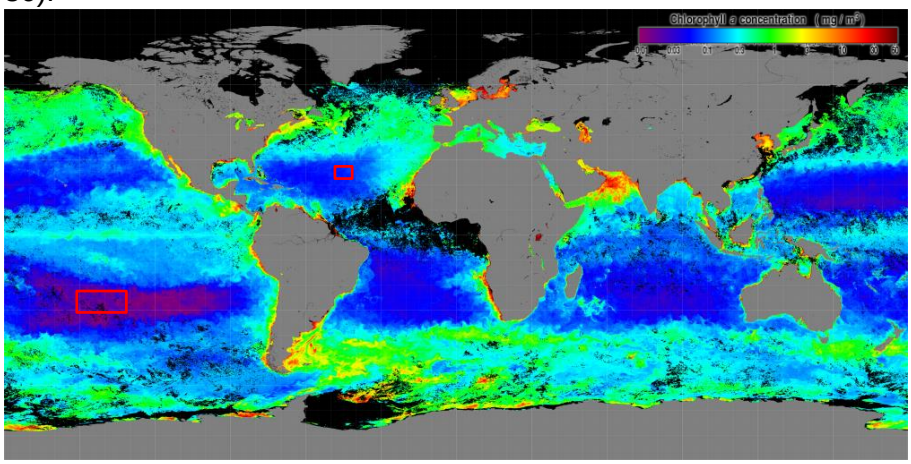

Figure 34 Gyre locations used for comparison between VIIRS EDR with MODIS climatology.

It is found that generally VIIRS RRS match MODIS RRS very well for these super clear waters, but, similarly as the location at offshore Puerto Rico, there is clear day-to-day variations in VIIRS RRS. The VIIRS IOP (absorption coefficient) also matches MODIS climatology very well. Again, there are some day-to-day spikes resulting from the variation of VIIRS RRS.

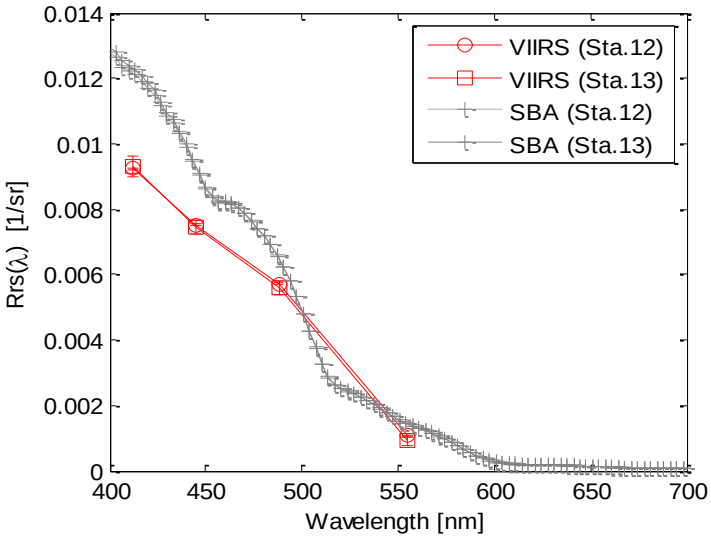

Figure 35 Comparison between VIIRS RRS and in situ RRS.

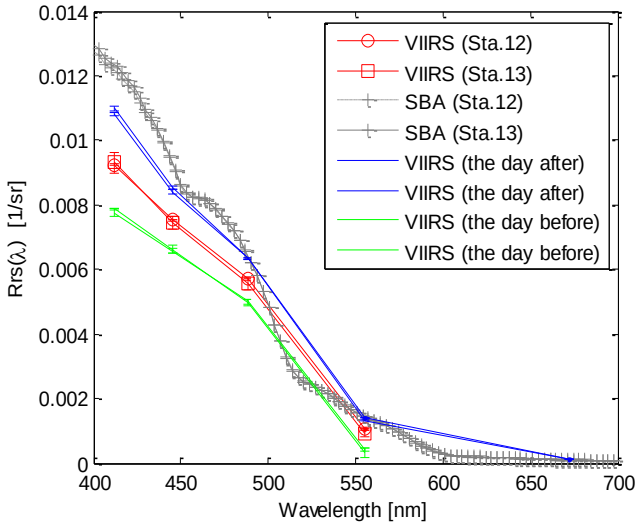

Figure 36 *Day-to-day change of VIIRS RRS.*

Evaluating VIIRS-derived ocean products over green waters

Field measurements to matchup VIIRS were carried out on September 7 and September 17, 2014, with Figure 37 showing the measurement locations. Field measured properties include hyperspectral remote-sensing reflectance (RRS) by our SBA system and absorption/backscattering coefficients by the ac-s and bb-7 systems (Wetlabs). Both were clear-sky days and a total of 10 matchups were obtained (within ±2 hours). The close-to-show station is excluded for this assessment due to the likely high adjacency effect from the land.

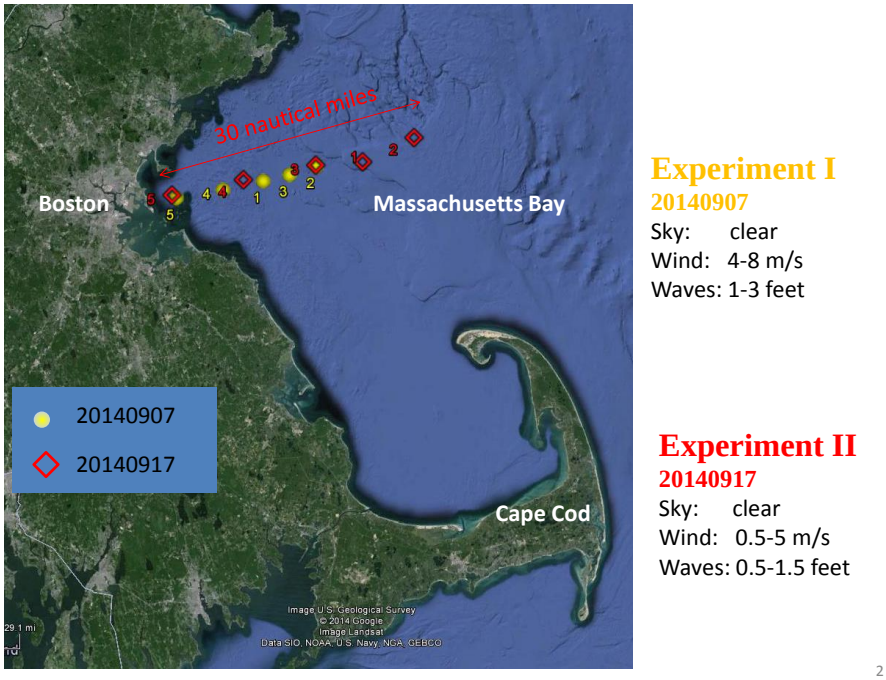

Figure 37 *Matchup stations between VIIRS and in situ measurements.*

Figure 38 compares satellite (both VIIRS and MODIS) RRS with *in situ* RRS for measurements on September 7, 2014. Apparently satellite RRS (both VIIRS and MODIS) values are substantially (~30-40%) lower than *in situ* RRS for all the bands. This discrepancy is likely a result of the fact that the aerosol models used in the processing system do not cover the encountered aerosol type, so the ATMWARN flag showed up for this image.

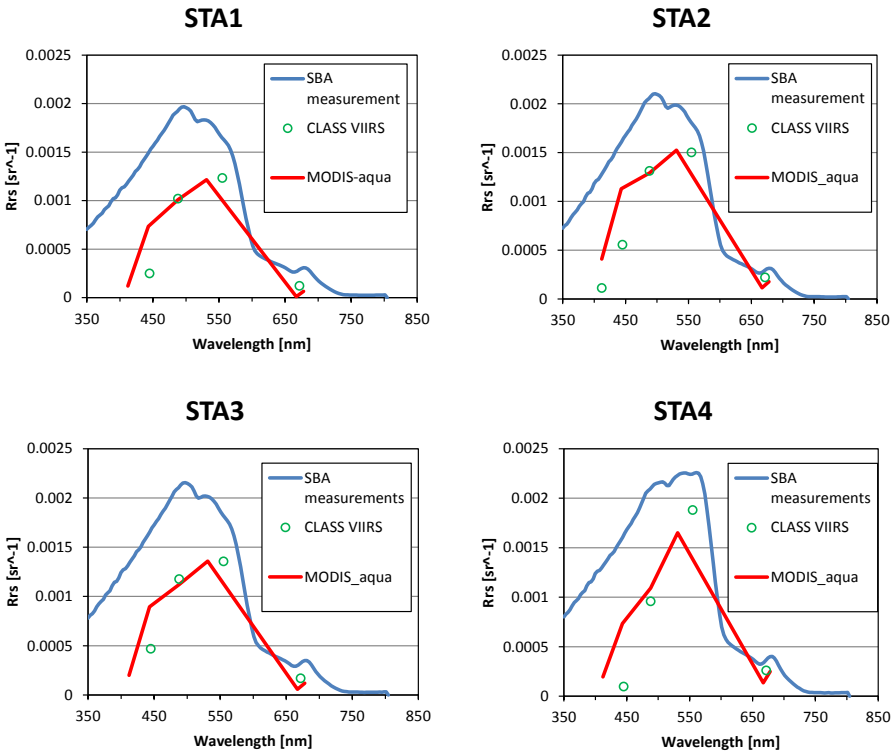

Figure 38 Comparison of RRS between satellite product and in situ measurements for September 7, 2014.

As for satellite RRS and *in situ* measurements on September 17, 2014 (not shown here), the VIIRS RRS values match better for Station 1 and Station 2 (the most offshore station) except Bands M1 (412 nm) and M2 (443 nm). But, again, VIIRS RRS are substantially lower (~40%) than *in situ* RRS for the inshore station (Station 4). On the other hand, MODIS RRS show significant underestimation for this day.

Because of such large discrepancies between satellite RRS and *in situ* RRS, there are also large differences between VIIRS-retrieved IOPs products and in-situ-measured IOPs. This could also in part be due to uncertainties in the measured IOPs though, which we are still trying to reduce and minimize.

More field measurements were carried out in the North Atlantic Ocean in November 2014, organized by NOAA to validate VIIRS products, with our unique SBA system deployed to measure RRS of both coastal and offshore waters (Figure 39, left). Also measured were IOPs (absorption/backscattering coefficients) with the ac-s and bb-7 systems (Wetlabs, Inc.). These measurements covered a total of 22 stations, with 4 stations having VIIRS match up (within ±2 hours). The measured RRS spectra with our system are presented in the right side of Figure 39.

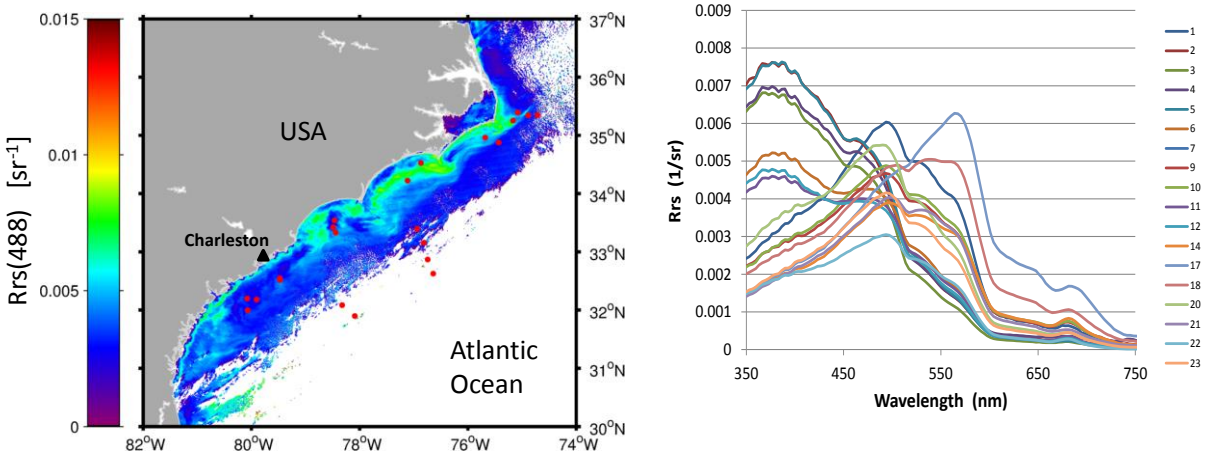

Figure 39 Locations of the stations during the November 2014 cruise (left) and RRS spectra of these waters (right).

As an example, Figure 40 shows a comparison between VIIRS RRS (acquired from CLASS) and *in situ* measurements, where VIIRS in the blue is significantly smaller than *in situ* RRS, even for a time difference of 20 min (Station 21). This is consistent with the general pattern that VIIRS in the shorter wavelengths are lower than that from field measurements.

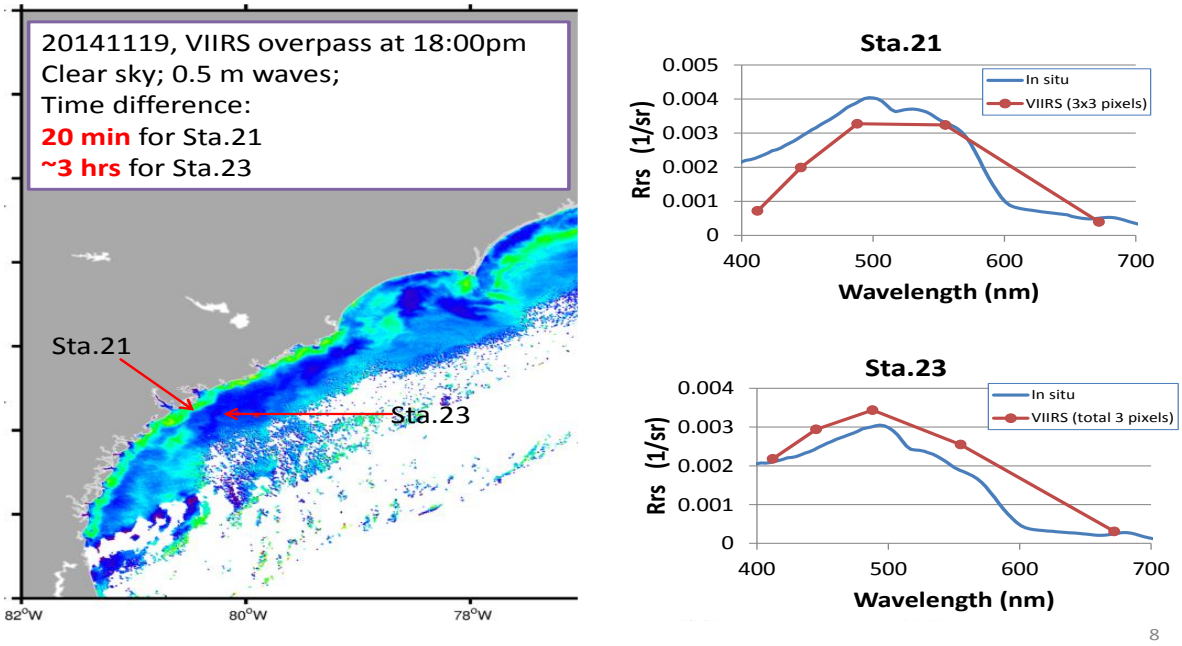

Figure 40 An example of matchup comparison of RRS between VIIRS (from CLASS) and in situ measurements.

Description of significant results, protocols developed, and research transitions

Derived and refined absorption coefficient of "pure" seawater in the UV-Vis bands (Lee, Z. P., J. Wei, K. Voss, M. Lewis, A. Bricaud, Y. Huot, 2015, "Hyperspectral absorption coefficient of "pure" seawater in the 350-550 nm range inverted from remote-sensing reflectance," Appl. Opt., Vol. 54, 546-558).

Obtained improved closure between remotely derived and *in situ* measurement of particle backscattering coefficient (Lee, Z. P., Y. Huot, 2014, "On the non-closure of particle backscattering coefficient in oligotrophic oceans," Opt. Exp., Vol. 22, 29223-29233).

Information on collaborators / partners: None reported

Information on any outreach activities: None reported

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

Related NOAA Enterprise Objectives: Science and Technology

NGI File #15-NGI2-110: 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

Co-PI(s) name, affiliation, email address: Fuzhong Weng, NESDIS

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

Project objectives and goals
In order to achieve quality weather forecasts accurately and to extract climate signals and climate change from satellite data, which remains 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

1. Impact of satellite orbital drift on AMSU-A derived climate trend from NOAA-15, -18, -19 and MetOp-A using diurnal correction and double differencing methods;

2. Development and test of ATMS de-striping optimal filters for both brightness temperatures and ATMS calibration counts;

3. Impacts of model top on satellite data assimilation and forecast results using HWRF system;

4. Impact of NOAA-15 AMSU-A data on quantitative precipitation forecasts and its implications for three-orbit constellation; and

5. Uses of Allan deviation for characterizing Advanced Technology Microwave Sounder (ATMS) noise equivalent differential temperature (NEDT).

Description of significant results, protocols developed, and research transitions
Higher Model Top is Required for Hurricane Data Assimilation of ATMS Temperature Sounding Channels

Assimilation of satellite sounder data into numerical weather prediction (NWP) models typically requires accurate radiative transfer calculations of brightness temperatures at the top of the atmosphere. The total radiation received by the satellite is contributed by different levels of atmosphere, and thus the accuracy of radiative transfer simulations for upper sounding channels depends on the NWP model top altitude. This study investigates the impacts of the Hurricane Weather Research and Forecasting (HWRF) model top altitude on satellite radiance assimilation and on tropical cyclone (TC) forecasts. A pair of satellite data assimilation and forecasting experiments with two different model tops (i.e., 50 hPa and 0.5 hPa) are carried out for tropical storm Debby that occurred in 2012 in the Gulf of Mexico.

Satellite radiance data from the Advance Microwave Sounding Unit-A (AMSU-A) on board the National Oceanic and Atmospheric Administration (NOAA) satellites NOAA-18 and NOAA-19, and European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) MetOp-A, the hyperspectral Atmospheric Infrared Sounder (AIRS) onboard Aqua, the High Resolution Infrared Sounder (HIRS) onboard NOAA-19 and MetOp-A, and the Advanced Technology Microwave Sounder (ATMS) onboard Suomi National Polar-Orbiting Partnership (NPP) satellite are assimilated. It was shown that a higher model top allows more upper-level microwave and infrared sounding channel data to be assimilated into HWRF. Extending the model top to a higher level allowed a more accurate depiction of the upper-level background profile and upper-level sounding channels to be incorporated into the HWRF model to generate an improved atmospheric steering flow and thus better model the movement of tropical cyclones. As a result, the track prediction for the tropical cyclone Debby with a higher HWRF model top (0.5 hPa) is more accurate than that with a lower model top (50 hPa).

An Improved Quantification of ATMS NEDT Using Allan Deviation

Currently, noise magnitudes of the operational satellite instruments are mostly quantified by computing the standard deviation of the measurements from their calibration targets. The standard deviation is valid for describing the spread of a statistical distribution of the measured values around its mean that is stable. However, the measurements of a warm calibration target such as Advanced Microwave Technology Sounder (ATMS) blackbody can exhibit a considerable variation in each orbit. In this study, we propose to use Allan deviation to characterize the ATMS noise. It is found that in the overlapping Allan deviation formula, the averaging window size has to be set to one in order to accurately assess the noises for both stationary and non-stationary time series. From the ATMS on-orbit data, the noise magnitudes at several channels show a large discrepancy between the Allan deviation and the current operational Noise Equivalent Differential Temperature (NEDT). Thus, the Allan deviation method is recommended for the noise characterization of all the ATMS channels and other similar instruments.

ATMS Striping Noise Mitigation

Advanced Technology Microwave Sounder (ATMS) on board Suomi National Polar-orbiting Partnership (NPP) satellite provides global distributions of microwave brightness temperature measurements at 22 temperature and humidity sounding channels twice daily. However, the differences between observations and brightness temperature simulations exhibit a systematic along-track striping noise for all channels. In this study, a set of 22 “optimal” filters is designed to remove the striping noise in different channels. It is shown that the original method for ATMS striping noise mitigation developed by Qin et al. (2013) can be simplified and made suitable for use in an operational context. Impacts of striping noise mitigation on small-scale weather features are investigated by comparing ATMS cloud liquid water path (LWP) retrieved before and after striping noise mitigation. It is shown that the “optimal” filters do not affect small-scale cloud features while smoothing out striping noise in brightness temperatures. It is also shown that the striping noise is present in the LWP retrievals if the striping noise in brightness temperatures of ATMS channels 1 and 2 is not removed. The amplitude of the striping noise in LWP is linearly related to the magnitude of striping noise in ATMS brightness temperature observations.

Calibration noise is often smoothed out at the calibration counts level. The optimal filters are also designed for smoothing out the striping noise in warm counts, cold counts, warm load temperatures, and scene counts. Using the two-point algorithm, antenna temperatures are then calculated with warm counts, cold counts, warm load temperatures, and scene counts before and after applying the optimal filters. The patterns and magnitudes of the striping noise removed are very close to those from the

results obtained by applying optimal filters directly to ATMS brightness temperatures. It is confirmed that the striping noise is present in the scene counts and must be smoothed out in order to eliminate the striping noise in antenna temperatures. It is also shown that the optimal filters are superior to the conventional boxcar filters in terms of being able to effectively remove the striping noise in the high frequency range but not to alter the lower frequency weather signals.

The Importance of Having Three Orbits to Coastal QPF near Gulf of Mexico

An effort was made to demonstrate the importance of an early morning orbit satellite for improved coastal precipitation forecasts (QPFs) near the Gulf of Mexico. The Advanced Microwave Sounding Unit-A (AMSU-A) radiance observations from the early morning satellite NOAA-15, the mid-morning satellite MetOp-A and the afternoon satellite NOAA-18 are assimilated using the National Centers for Environmental Prediction (NCEP) and Gridpoint Statistical Interpolation (GSI). For a Gulf coast precipitation case selected in this study, two pairs of data assimilation and forecasting experiments are carried out to compare the differences in QPFs with and without assimilating AMSU-A data from NOAA-15. It is shown that the two orbits provided by NOAA-18 and MetOp-A render both the Gulf of Mexico and the western continent of United States two data-void areas at 0000 UTC and 1200 UTC. The NOAA-15 orbit fills these data gaps. Adding NOAA-15 AMSU-A data into GSI data assimilation results in a consistently positive impact on the QPFs near the Gulf coast. It is thus suggested to have a continuing availability of an early morning orbit satellite with AMSU-A or AMSU-A like instrument onboard. A partial solution is a sustained effort to maintain the NOAA-15 AMSU-A for a longer-lived operation.

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

Information on any outreach activities:
Hosted speakers, workshops and/or any training: Yes
Type: Speaker
Name of event: (1) EUMESTSTAT Meteorological Satellite Conference; (2) 2014 The Joint International Geoscience and Remote Sensing Symposium (IGARSS); and (3) The Fifth Asian/Oceania Meteorological Satellite Users' Conference.
Date: (1) September 22-26, 2014; (2) July 13-18, 2014; and (3) November 19-21, 2014.
Location: (1) Geneva, Switzerland; (2) Quebec, Canada; and (3) Shanghai, China.
Description: (1) An oral presentation entitled "Suomi National Polar-Orbiting Partnership (NPP) Satellite Instrument Calibration, Validation and Applications;" (2) an oral presentation entitled "Cross-Calibration of ATMS and AMSU-A for Climate Change Studies;" and (3) an oral presentation entitled "ATMS Striping Mitigation and Data Assimilation."
Approximate Number of Participants: About 1,000 participants in Geneva and Quebec. About 60 participants in Shanghai.

Related NOAA Strategic Goals: Weather-Ready Nation

Related NOAA Enterprise Objectives: Science and Technology

NGI File #15-NGI2-111: Calibration and Validation of NPP VIIRS-Color and SST Ocean Products 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: Ryan Vandermeulen, University of Southern Mississippi, Ryan.Vandemeulen@usm.edu; Bill Gibson, Louisiana State University, bgibson@lsu.edu; Jean-Francois Cavula, Vencore Inc., Jean-Francois.Cayula@Vencore.com; and Sherwin Ladner, NRL, Sherwin.ladner@nrlssc.navy.mil

NOAA sponsor and NOAA office of primary technical contact: Lihang Zhou, NESDIS/STAR

Project objectives and goals

This proposed activity is to establish the on-orbit calibration and validation of satellite ocean products for the VIIRS (Visible Infrared Imaging Radiometer Suite) on NOAA's Suomi National Polar–orbiting Preparatory Project (S- NPP) satellite. The 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, to be launched in 2018, J2, etc.). The project is coordinating with NOAA, NASA, university, and Navy scientists and has demonstrated the capability for VIIRS ocean products to reach maturity within the JPSS program. As a member of NOAA's national JPSS calibration validation team for the United States, we coordinate with many team members for calibration of ocean satellite products.

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

NOAA Center for Satellite Applications and Research (STAR) has developed algorithms and processed VIIRS ocean products using MS12 for ocean color products and Advanced Clear-Sky Processor for Oceans (ACSPO) for SST. 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 goals of SST (Sea Surface Temperature) are to evaluate the accuracy of ACSPO SST products from the VIIRS satellite and to define methods for improvements.

The project goal is to support the NOAA – STAR and JPSS programs in identifying issues regarding the stability of the sensor and satellite products and provide guidance to the JPPS 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 included: (1) Participation in VIIRS ocean color science telecons; (2) Data analyses from ocean color cal/val cruise for characterizing *in situ* validation; (3) Maintaining WavCis platform, an *in situ* ocean color validation site; (4) Identifying diurnal changes in Ocean color; and (5) Sea Surface Temperature VIIRS validation.

A. Participation in NOAA's Ocean Color Calibration and Validation Telecons of SNPP-VIIRS
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. 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 represents approximately 28 scientists, from 10 universities, agencies, and organizations throughout the nation, who 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. There were six presentations per year consisting of a 30 – 40 minute presentation to the entire team followed by a write-up summary to the JPSS program office of the ocean color cal/val status. The major milestones that we achieved this year are listed below and are detailed in the publications.

Milestones were completed in delivering telecons to the cal/val team and in providing 6 detailed progress reports on work accomplished per year to NOAA.

Milestones were completed in attending the annual JPSS cal/val meeting in August and presenting over 8 (2015-2016) presentations and posters to the NOAA JPSS program. Presentation and posters were presented at the February ocean sciences meeting of SPIE, IOCCG, and NASA GEOCAPE in New Orleans.

B. Research in the East Coast Gulf Steam and Tongue of the Ocean Cruises and Gulf of Mexico Cruises
NOAA Cruise: The NOAA SNPP cal/val cruises for ocean color were a major focus. A major focus of the VIIRS cal/val effort is to determine the difference in *in situ* measurements (RRS- Remote sensing Reflectance) which are used for VIIRS cal/val. Our goal was to determine both the variability in *in situ* calibration measurements and how to improve them so that the VIIRS products can be improved.

Analyses of data from the 2014 cruise in the Gulf Stream characterized the variability of the optical properties which are used for VIIRS cal/val. A NOAA cruise report of this cruise was written with STAR and presented at several presentations. The results helped outline improvements and methods that were required for the December 2015 cruise to improve the cal/val process.

A major milestone this year was participation in a dedicated SNPP calibration validation cruise on the NOAA Nancy Foster research vessel for ocean color product validation. This is an annual NOAA cruise to develop *in situ* optical protocols for the calibration and validation of VIIRS ocean color products. Our Stennis team helped design the cruise plan for the Gulf Stream waters, extending it into the Tongue of the Ocean for the purpose of characterizing the optically shallow waters for VIIRS cal/val. The cruise track for the December collected 27 stations (Figure 41). A variety of water types were measured with multiple instruments used for VIIR calibration.

The research was conducted to determine the variability on *in situ* optical measurements of RRS from different instruments and to establish the accuracy in measurements to improve the calibration and validation of VIIRS sensors. The cruise left Charleston, NC on December 1 for a 13 day cruise with 10 groups including NOAA, NASA, NAVY, and 6 universities with experienced scientists in ocean color cal/val. The cruise was made of similar and extended measurements and instruments from the 2014 cal/val cruise (2014 NOAA cruise report). The cruise established new methods for collection and processing of (1) Above water ASD measurements; (2) Floating hyperpro water leaving radiances; and (3) Inherent optical properties. This cruise evaluated multiple instruments collecting the same water leaving radiance (nLw) (RRS) at the same stations and determined the variability on these instruments. The Stennis team processed many instruments the same way to determine the variability and accuracy between the instrument and how it matched with the VIIRS satellite products from NOAA, NASA, and Navy.

Optical measurements of RRS from several Floating Hyperpro from USM, NRL and UMB were used to determine instrument stability at each station. A protocol for the Floating Hyperpro was determined and is being evaluated. Additionally, RRS measurements from seven ASD spectral radiometers for above water radiation were used to determine the variability and accuracy of the instruments and methods for collection and processing. The ASD instrument collection protocols are being developed for detailing the instrument angles, ocean spot size, and processing procedures. The ASD research, which included data from a standard Blue tile plank provided by NIST, was used on the ship to test the methods and inter-sensor stability and variability. The Stennis team is working with NOAA, universities and NIST to process these data sets for developing protocols for *in situ* collection of optical data for calibration of VIIRS. (Planned papers.)

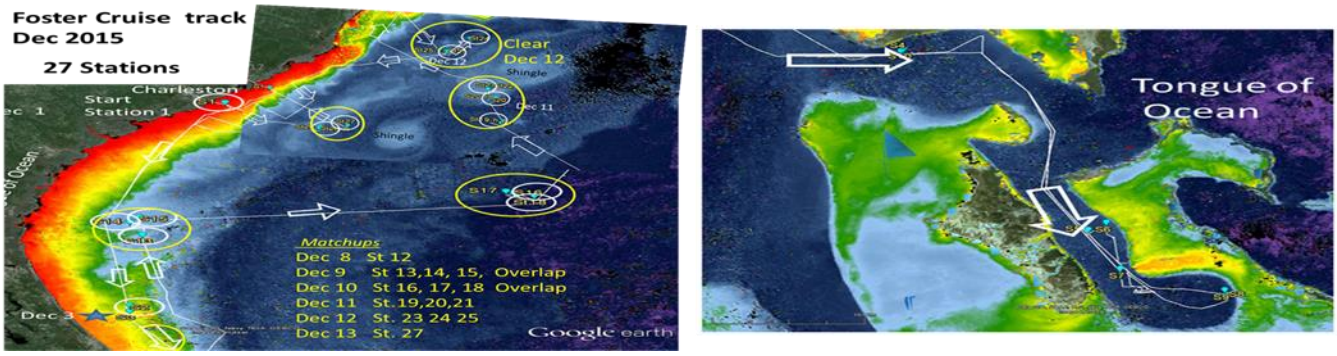

Figure 41 East Coast Cal/Val Cruise track December 2015 for Gulf Stream and Tongue of Ocean.

The *in situ* RRS from the Hyperpros, ASD's, and the VIIRS were compared at the stations. Data from VIIRS was obtained from the MSL12 Science Quality, NASA, and NRLVIIRS processing. Examples of the RRS data obtained for each station with VIIRS match up with December 8, 9, 10, 11, 12, and 13. On December 9 and 10 there were orbital overlaps with 2 VIIRS orbits with 100 minutes. The satellite imagery was screened for cloud flags so that some stations had a center pixel and others only had 3x3 or 5x5 pixel averages. For the differences in VIIRS RRS from the center, 3x3 and 5x5 clearly showed there are spatial changes in the pixels which lead to satellite matchup uncertainty for cal/val procedures. These satellite differences are related to the cloud cover threshold and flags that can influence the matchups (Figure 42).

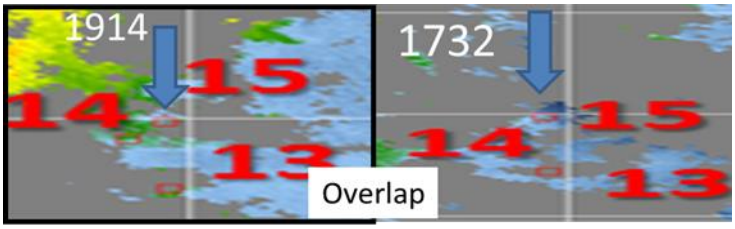

Figure 42 Station 15 shows the cloud cover on December 9 with the changes the 2 VIIRS orbital overlap from 1732-1942 GMT.

The VIIRS data used for matchup calibration can be contaminated by cloud shadows and sensor and solar angles. We recommend a protocol be established for VIIRS satellite data matchup which addresses spatial and temporal variability and the angles. This will improve the data set used for matchup with *in situ* data. An example of the uncertainty in VIIRS satellite RRS with *in situ* observations is observed in Figure 43.

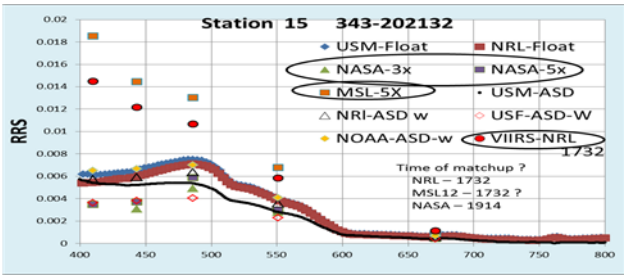

Figure 43 Station 15 shows the matchup of VIIRS products from NASA, NOAA MSL, NRL with different RRS pixel averaging (c, 3x3, 5x5). The RRS matchup between the in situ floating hyperpros (USM and NRL) and ASD's is relatively consistence for this station.

Another example of the December cruise matchup (Figure 44) for December 11, shows that VIIRS data protocols and *in situ* data protocols are required for calibration. These address spatial and temporal protocols, angles of satellite, the methods, and the processing of *in situ* data. A matchup example for Station 20, 21 represents a "cloud free" period with VIIRS MS12 product which are not cloud contaminated and are in open ocean conditions.

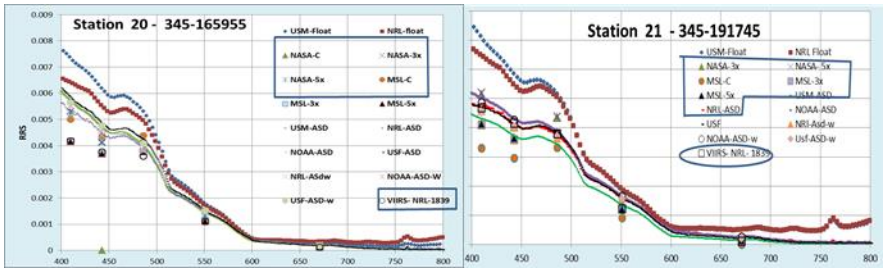

Figure 44 Open ocean water matchup December 11 for station 20 21 for satellite (MSl12, NASA) and in situ Floating HyperPro and ASD instruments.

Note that the values (Figure 45) for the VIIRS data represent the center, meaning 3x3 and 5x5 pixels. All values show a small amount of spatial variability in these open ocean waters. The time of VIIRS overpass was 18:35 which is within one hour of the two stations (16:59 and 19:17 GMT).

The results of all the 27 stations for the cal/val cruise show the differences and uncertainty between *in situ* instruments and satellite VIIRS. There is not a consistent offset between *in situ* instruments and VIIRS data that occurs for all stations. The results confirm this; the differences at each station change and suggest that multiple *in situ* measurements are required to determine the outliers and optimum set for calibration.

Milestones completed: (1) Completed processing the 2014 and 2015 Cruse data for the ASD and Floating Hyperpro and the flowthrough IOP data and delivered to NOAA- STAR; (2) Delivered the cruise report to STAR from the cruises; and (3) Developed protocols for ASD and the Hyperpro which are under evaluation by the cal/val team.

Gulf of Mexico Cruise: Additional VIIRS cal/val matchups were performed in the Gulf of Mexico using spectral ASD on board cruises of opportunity. Results confirm the VIIRS spectral radiation - ocean color in open and coastal waters (Figure 45).

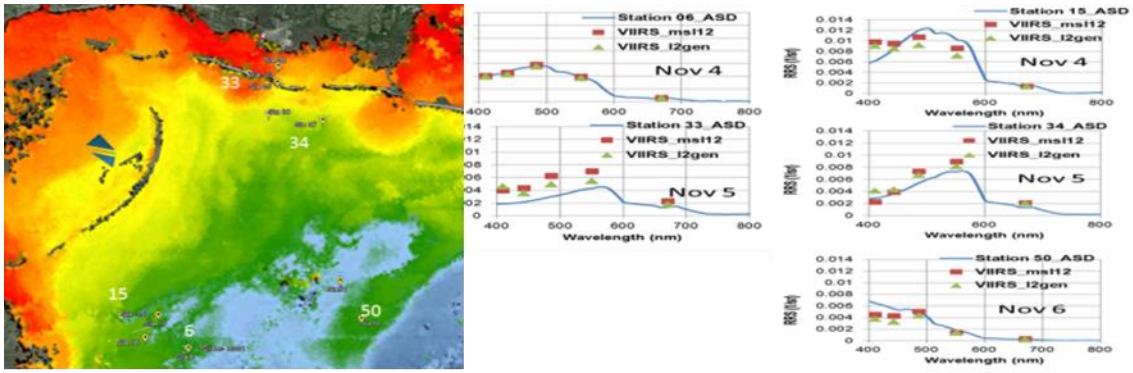

Figure 45 Gulf of Mexico Station on November 4- 6 and VIIRS matchup from MSL12 and NASA (l2gen) with in situ ASD RRS.

Additional ocean color cal/val research was presented at AGU Ocean Science to evaluate VIIRS products to determine euphotic depth (1% light) level on the Mississippi Shelf. Estimates from VIIRS indicate there are times in optically clear waters when the light levels reach the sea bottom and model mixed layer depth.

C. WavCIS – Coastal Calibration Site

The WavCis site (CSI) off Grand Island Louisiana is equipped with an *AErosol RObotic NETwork* (AERONET) SeaPrism instrument and is part of an international network for ocean color cal/val sites. http://aeronet.gsfc.nasa.gov/new_web/ocean_color.html. There are currently 4 SeaPrism sites in the US. The WavCis SeaPrism site is reporting daily water leaving radiance (nlw) and aerosol optical depth every 30 minutes during daytime operations. The platform is visited periodically and the 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 SeaPrism data to scientists. The WavCis site has been providing excellent highly accurate data stream for the ocean color community for the last 4 years. The NOAA–JPSS team has shown the matchups of VIIRS satellite to be quite good at the WavCIS site, compared to other sites on the east and west coast of US. The Stennis team are using the WavCIS to maintain a consistent and reliable data for monitoring the satellite performance in coastal water algorithms. Example of the WavCIS data used with the derived Chlorophyll Matchup with VIIRS and MODIS for 2014 and 2016 shows the consistency of the data sets (Figure 46).

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 and sent to NASA for calibration and a replacement was on WavCIS until the calibrated sensor was reinstalled. WavCis SeaPrism site was calibrated on yearly bases and the data remained a consistent data set.

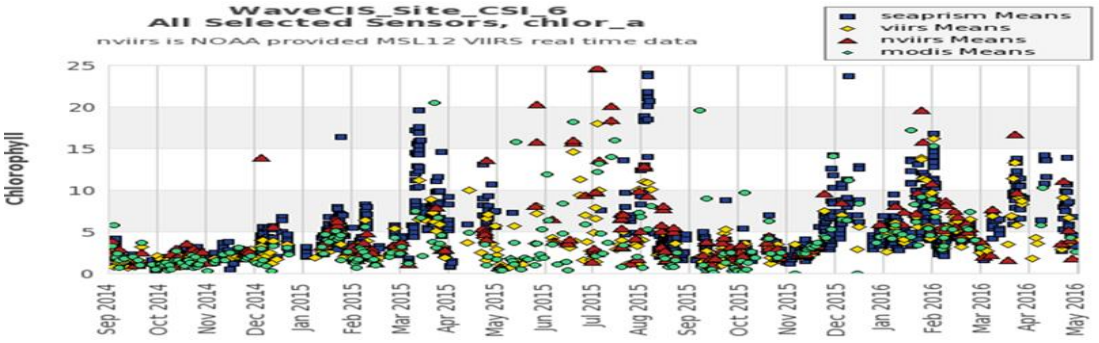

Figure 46 WavCIS derived chlorophyll from the RRS from 2014 – 2016 with chlorophyll matchup from VIIRS and MODIS.

D. Diurnal Changes in Ocean Color:

Research was performed on how rapidly ocean color can change in coastal waters. Coastal processes can change on hourly time scales in response to tides, winds and biological activity, which can influence the color of surface waters. These temporal and spatial ocean color changes require satellite validation for applications using bio-optical products to delineate diurnal processes. The diurnal color change and capability for satellite ocean color response were determined with *in situ* and satellite observations from the VIIRS orbital overlap. Hourly variations in satellite ocean color are dependent on several properties which include (1) sensor characterization; (2) advection of water masses; and (3) diurnal response of biological and optical water properties. The *in situ* diurnal changes in ocean color in a dynamic turbid coastal region in the northern Gulf of Mexico were characterized using above water spectral radiometry from an AERONET-WavCIS CSI-06 site that provides up to 8-10 observations per day (in 15-30 minute increments). These *in situ* diurnal changes were used to validate and quantify natural bio-optical fluctuations in satellite ocean color measurements. Satellite capability to detect diurnal changes in ocean color was characterized by using overlapping afternoon orbits of the VIIRS–NPP ocean color sensor within 100 minutes. Results show the capability of multiple satellite observations to monitor hourly color changes in dynamic coastal regions that are impacted by tides, re-suspension, and river plume dispersion. Hourly changes in satellite ocean color were validated with *in situ* observation on multiple occurrences during different times of the afternoon. Also, the spatial variability of VIIRS diurnal changes shows the occurrence and displacement of phytoplankton blooms and decay during the afternoon period. Results suggest that determining the temporal and spatial changes in a color/phytoplankton bloom from the morning to afternoon time period will require additional satellite coverage periods in the coastal zone besides the VIIRS afternoon polar orbiters. How rapidly ocean color can change is shown in Figure 47 for the WavCIS site for two channels: 442 and 551. The validation of VIIRS ability to track the variability of ocean color is shown in figure 47 in a 100 minute overlap. These changes in ocean color show the significance for future geostationary satellites to monitor diurnal changes.

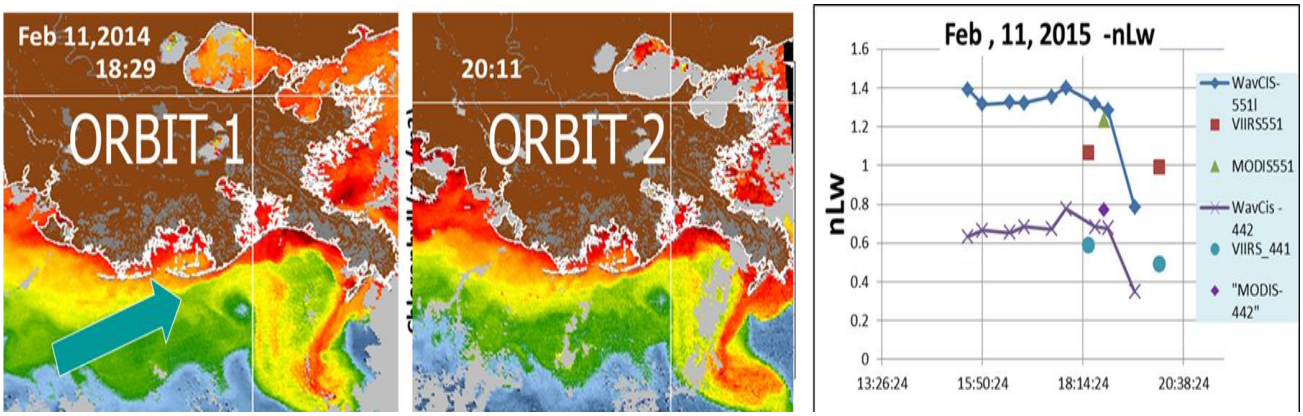

Figure 47 WavCIS AERONET site located at arrow. The overlap of VIIRS Orbit 1 and 2 for February 11 for each day shows the ocean color chlorophyll products within 100 minutes. Plots show WavCIS (blue 551 nLw and purple 442 nm) ocean color changes in the nLw throughout the day and the VIIRS (551 and 441) and MODIS (442) matchup.

E. Sea Surface Temperature (SST) –VIIRS – SNPP Research

The SST products were evaluated for the VIIRS sensor for the NOAA processing ACSPO and the NAVO processing. Research was performed to address the thermal uniformity analyses for SST data fields. The uniformity field defining the spatial difference in 2x2 and 3x3 pixel SST vary where the minimum-maximum difference exceed a threshold. The uniformity field is used to define the SST coherence and was applied to the SST equation for validation. The updated processing improved the coverage in frontal regions. The uniformity test performs better with brightness temperature than with SST. Replacing the standard correction term in the daytime SST equation by an nxn pixel average can reduce the effect of random noise and striping while keeping the strength of the fronts in the resulting SST field. The SST and uniformity field for ACSPO an NAVO shown in Figure 48 can enhance the ability of VIIRS products to define fronts.

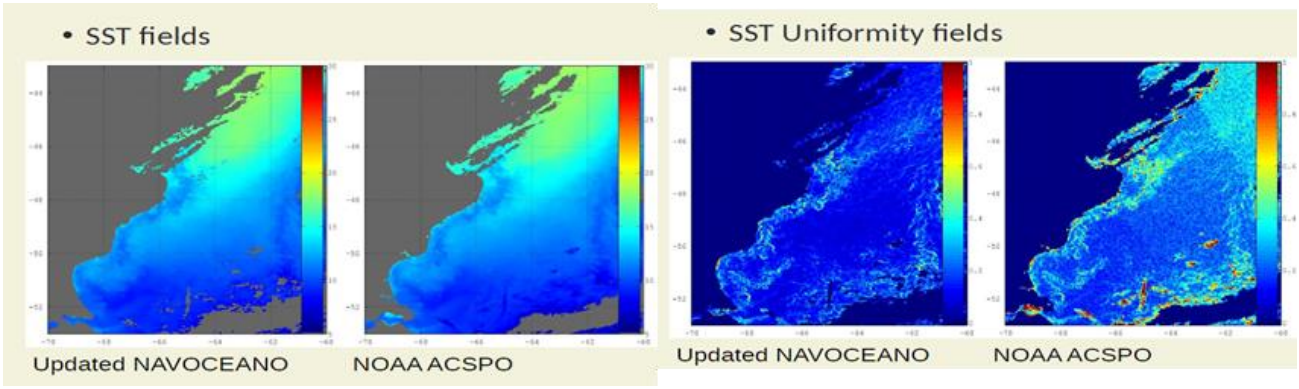

Figure 48 The uniformity filed for the ACSPO and NAVO SST and the updated SST fields.

Description of significant results, protocols developed, and research transitions

1. Protocols were developed for collection and processing of *in situ* optical data used for ocean color cal/val. These included the above water ASD and the floating hyperpro instruments. Protocols are under evaluation with the cal/val team for transition to operations.
2. 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 will address

methods to improve the cal/val processes so that improvements in calibration for satellite VIIRS products can be made.
3. The VIIRS ocean color products from NOAA MSL12 was shown to be similar to and often an improvement on the NASA ocean color products.
4. Results and data from the ocean color cruises were transitioned to NOAA and put into cruise reports and data.
5. Methods for establishing an advanced cal/val cruise for ocean color were established on the 2 cal/val cruise and these are being used as how *in situ* data should be collected for calibration. This is an interagency coordination (NOAA, NASA, NAVY) being coordinated with the 6 universities.

SST:
Methods for improving the SST using spatial uniformity are being tested and evaluated with positive results. This will improve the capability for VIIRS SST to determine frontal products.

Information on collaborators / partners:
Name of collaborating organizations: 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 Florida, UMB- University of Massachusetts, Boston, University of Miami, Oregon State University, Columbia 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.
Date collaborating established:

Collaborating with the cal/val team was part of the bi-weekly telecons
Collaborating with cal/val team on joint cruises February 2014 and December 2015.
GOMRI coordination on cruise in July 2015, fall 2015 – spring 2016

Do partners provide monetary support to project? Amount of support? Received support from the GOMRI CONCORD- Several months' salary and post doc.
Do partners provide non-monetary (in-kind) support? Received some ship opportunity and glider for data collection in Gulf of Mexico.
Short description of collaboration/partnership relationship:

1. There are many collaborators that are involved in the 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.
2. 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.
3. Collaboration with the NOAA NMFS and restore project involved using the VIIRS products to define a database and anomalies of ocean conditions in the Gulf of Mexico. There will be used to identify the potential hotspots for fisheries.

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 and SST products provide a daily validation for the circulation models and a better understanding of the ship and glider observations. The ocean weather lab is used for adaptive sampling and is presented to students and teachers to show the daily changing ocean conditions in the Gulf of Mexico. The lab hosts webinars, classes, and walk-through visits of conditions in the Gulf of Mexico. We have been visited by the Coast Guard, Navy, State Department of Marine Research, and periodic visitors.

Hosted speakers, workshops and/or any training: Yes
Type: Workshop and training of ocean conditions with adaptive sampling.
Name of event: "AUV – Jubilee"
Date: July 2015
Location: Entire Gulf of Mexico
Description: USM hosted the Glider jubilee using the USM Ocean Weather Labs (OWX) where teachers and multiple universities (Rutgers, USF, TAMU, Skidaway, OSU, USM) and NOAA agencies in the Gulf of Mexico used daily VIIRS satellite products combined with several circulation model products to determine where to fly their sea gliders and AUV. The weather lab provides the capability to provide forecast of ocean properties such as locations of fronts, river plumes, eddies, chlorophyll blooms, currents, and fresh water filaments which were used to optimally fly gliders for collection. This was critical for informing glider operations where they can send gliders and where they would not fail. The jubilee was coordinated with the GOMRI multiple consortium led by Concorde and NOAA GCOOS programs. The OWX hosted a series of daily webinars from July 13-17 to display the locations of 5 gliders being flowing in the Gulf with real-time ocean color and model (HYCOM/NCOM) products, as well as spatial uncertainty estimates. Visiting teachers were part of the OWX telecon where they were involved with seeing real time ocean weather and decision making process on flying ocean gliders. Teachers used the jubilee outreach for developing teaching guidelines for their classes on oceanography and the use of satellites for ocean products. The OWX lab provided the origin and date of river plumes, quantified biomass and physical volume transport, tracked the movement of bio-optical features, characterized water masses, resolved spatial and temporal variance, and linked the bio-physical coupling that ultimately drives ecosystem variability on global scales. These tools both enabled the display of up-to-date locations of various glider and ship/aerial operations while they were deployed and facilitated near real-time data exchanges in order to further assist in adaptive sampling. OWX provided collaborators with this data to expand the capacity and quality of data collection. See details at: http://www.con-corde.org/events/auv-jubilee/
and at: https://data.gulfresearchinitiative.org/node/84

Approximate Number of Participants:

1. 10 participating universities and agencies.
2. 25 teachers

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

Related NOAA Enterprise Objectives: Science and Technology

NGI FILE #15-NGI2-112: 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

Co-PI: Ariane Frappier, Northern Gulf Institute, Mississippi State University, ariane@ngi.msstate.edu

NOAA sponsor and NOAA office of primary technical contact: Matthew Campbell, NMFS

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 having 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 are performing 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

Results were presented at AFS Portland and manuscripts are currently under development from the two years of the project.

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 at AFS meeting in Portland Oregon.

Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology

NGI File #15-NGI2-113: Determination of Movement Patterns and Reproductive Status of Adult Smalltooth Sawfish

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

Co-PI(s) name, affiliation, email address: Shawn R. Smith, Center for Ocean-Atmospheric Prediction Studies, Florida State University, smith@coaps.fsu.edu

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

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. 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.

Methods: Bottom longlines consisting of nylon or 3.5 mm monofilament mainline and 50-100 gangions are deployed to capture sawfish. Gangions are terminated with non-offset, baited circle hooks (≥ 16/0) and longlines are anchored and marked with a buoy and/or highflier at each end. Soak times are typically one hour but do not exceed two hours. Once brought alongside the boat, each sawfish is restrained by placing a line around the rostrum and the caudal peduncle. Sex and length measurements are recorded. Fin clips are collected for population genetics studies and blood samples are collected to assess reproductive status. 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 Mini-PAT tags, which are 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, three research trips (20 total days, 12 days at sea) were completed and 66 total fishery independent longline sets were made (Figure 49), all aboard an FSU research vessel (a 26' Calcutta). Only two adult and one small juvenile sawfish were captured and tagged (Figure 49). The first trip was completed in September 2015. 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 and September 2015 to test these limits and also to search for sawfish in other areas, including 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. Based on information from a member of the public, 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.

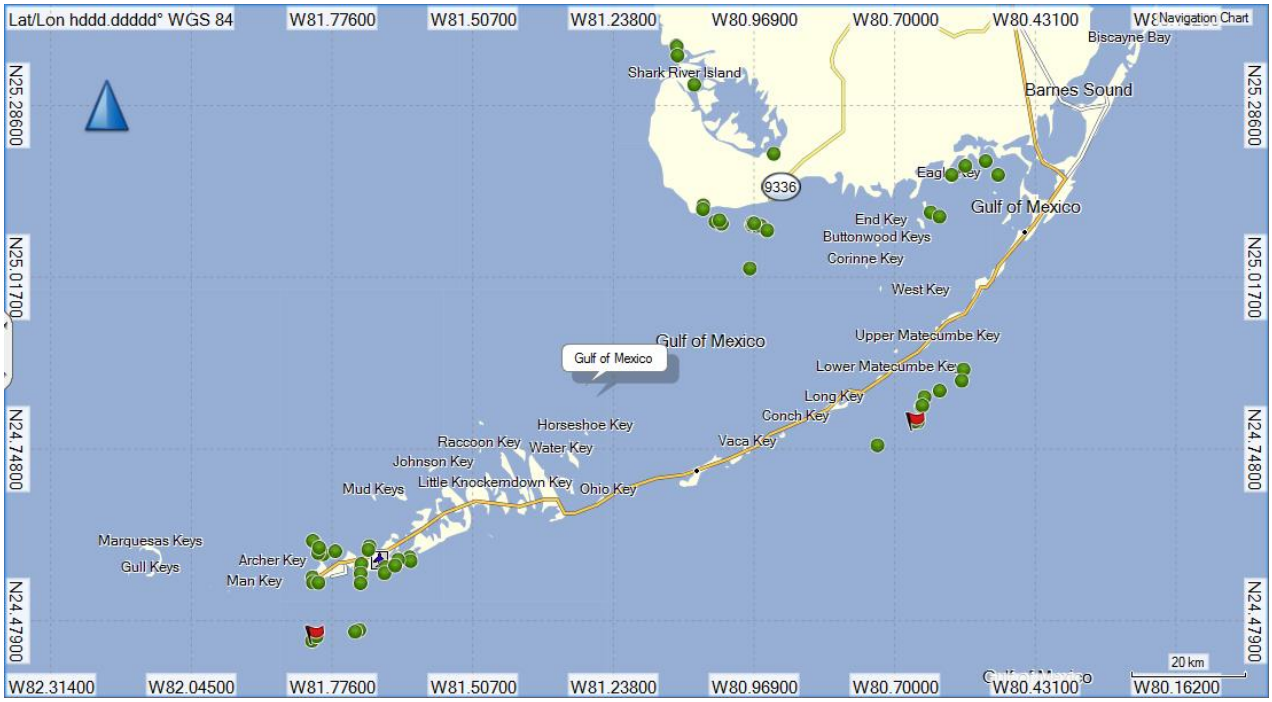

Figure 49 Distribution of fishery-independent longline stations (N=66) sampled during the 2015-2016 reporting period to capture and tag endangered smalltooth sawfish. Red flags = sawfish capture locations.

One trip was scheduled for December 2015 but was canceled due to inclement weather. The next trip was conducted in February 2015 on collaboration with NOAA colleagues conducting work on juvenile sawfish. The goal was to set areas where young-of-year sawfish were known to occur in hopes of capturing pregnant or post-partum female sawfish. Sampling took place throughout Florida Bay as well as Whitewater Bay and Shark River. No adult sawfish were captured

We conducted a third trip to the Florida Keys in May 2016. Most of the sampling during this trip took place around Key West, however, we did sample offshore areas where we captured adult male and female sawfish in July 2011. During the May 2016 trip we captured one adult female sawfish at a depth of 48 meters and successfully implanted the first 10-years transmitter to be implanted in a sawfish in the United States.

Description of significant 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 308 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 50). We captured 42 adult or large juvenile smalltooth sawfish on longlines and an additional 9 sawfish on rod and reel. Of the 42 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 21 were caught in the shallow waters of Florida Bay. Data to date suggest adult smalltooth sawfish do not leave U.S. waters and primarily remain in Florida waters (Figure 51). 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 15 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 spend the great majority of their time in waters less than 10 meters deep.

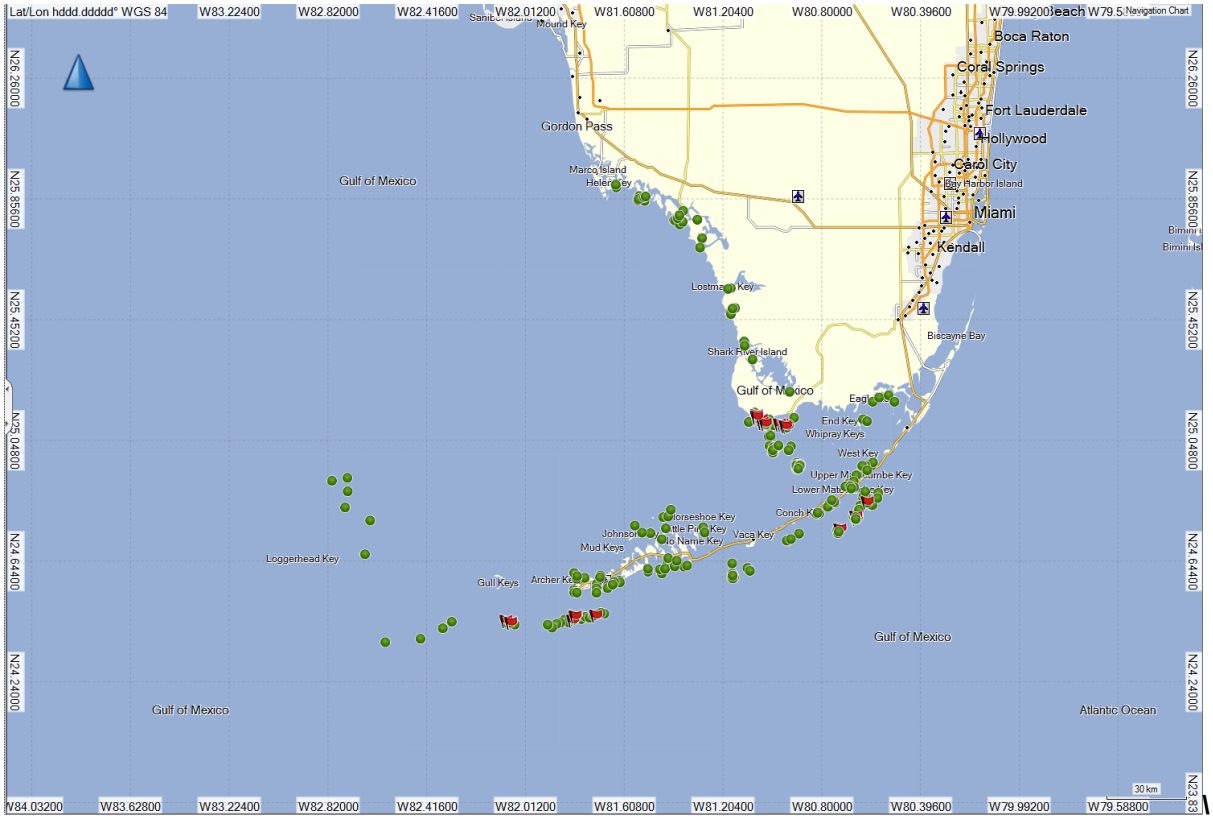

Figure 50 Distribution of fishery-independent longline stations (N=304) sampled during the 2011-2016 reporting period to capture and tag endangered smalltooth sawfish. Red flags = sawfish capture locations (N=42).

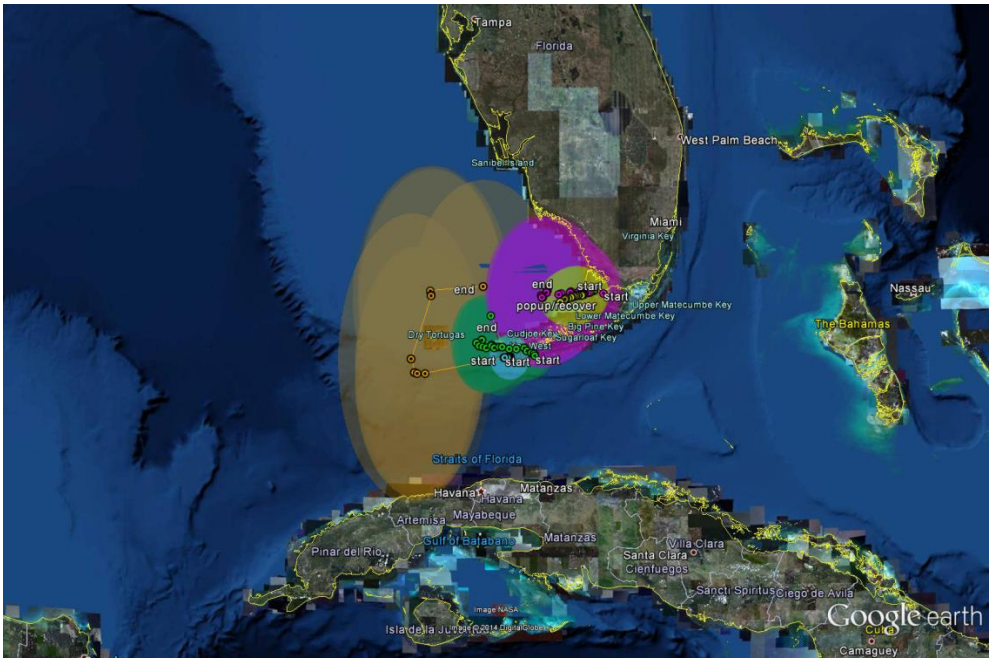

Figure 51 Most likely tracks of five satellite tagged sawfish tagged in Florida Bay and the Florida Keys following application of raw data to a Kalmin Filter. Ellipses represent 95% confidence around tracks.

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 that post-release survival in many fisheries is likely high (Figure 52). 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 53). Follicle development in females appears to occur from July through April, followed by mating and ovulation. Gestation is likely one year, and therefore, sawfish likely reproduce on a two year cycle. In addition to using blood for reproductive analyses, we are analyzing blood samples for physiological indicators of stress. Preliminary data suggest fishery-independent capture methods induce very low stress regardless if captured on deep longlines, shallow longlines, or rod and reel. These data will be useful as baselines to compare to sawfish captured using fishery-dependent methods.

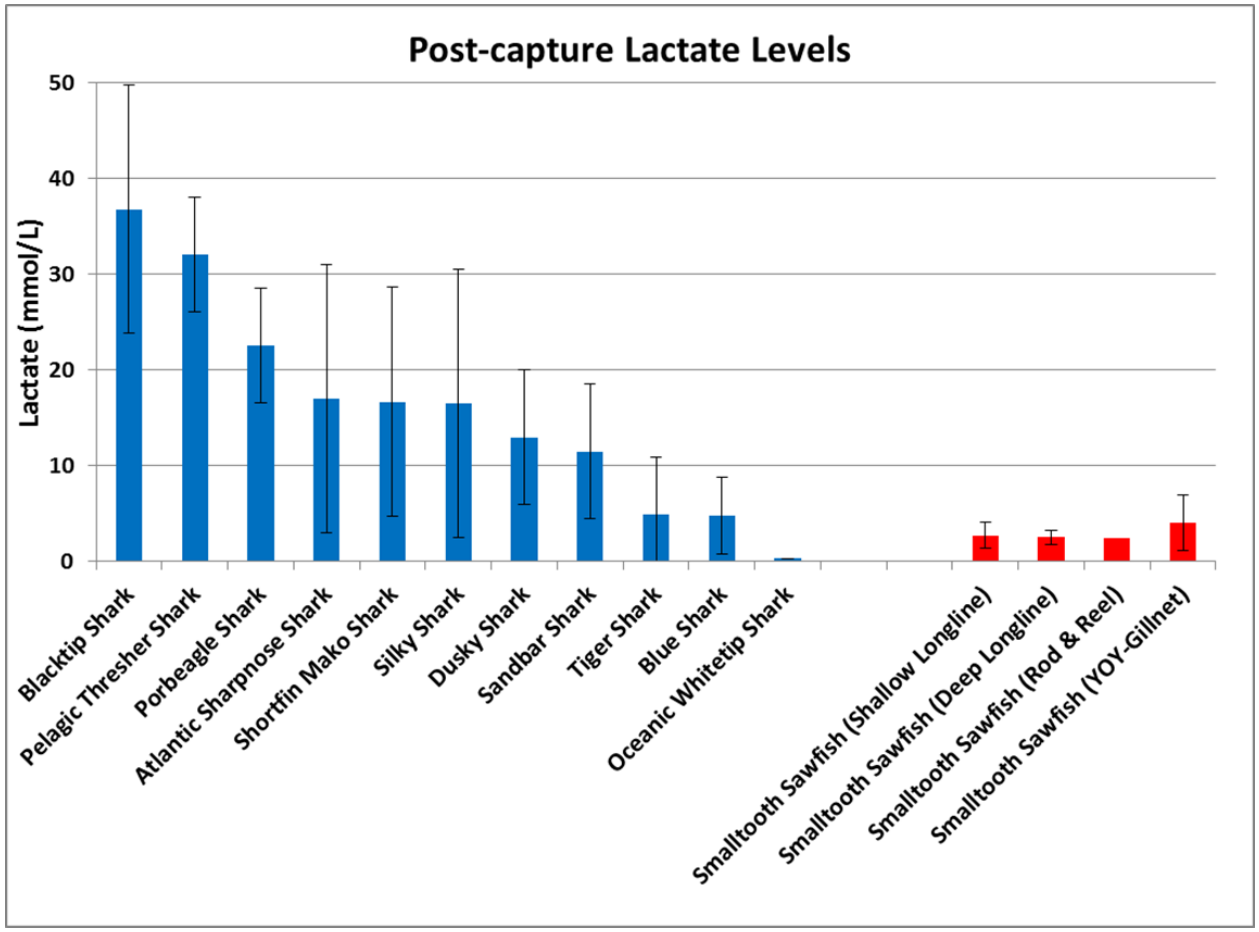

Figure 52 Blood lactate levels of smalltooth sawfish captured using deep longlines (45-70 m), shallow longlines (2-5 m), rod and reel, and gillnets during this study compared to lactate concentrations for coastal and pelagic sharks captured in longlines from Marshall et al. (2012). Rising lactate is 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.

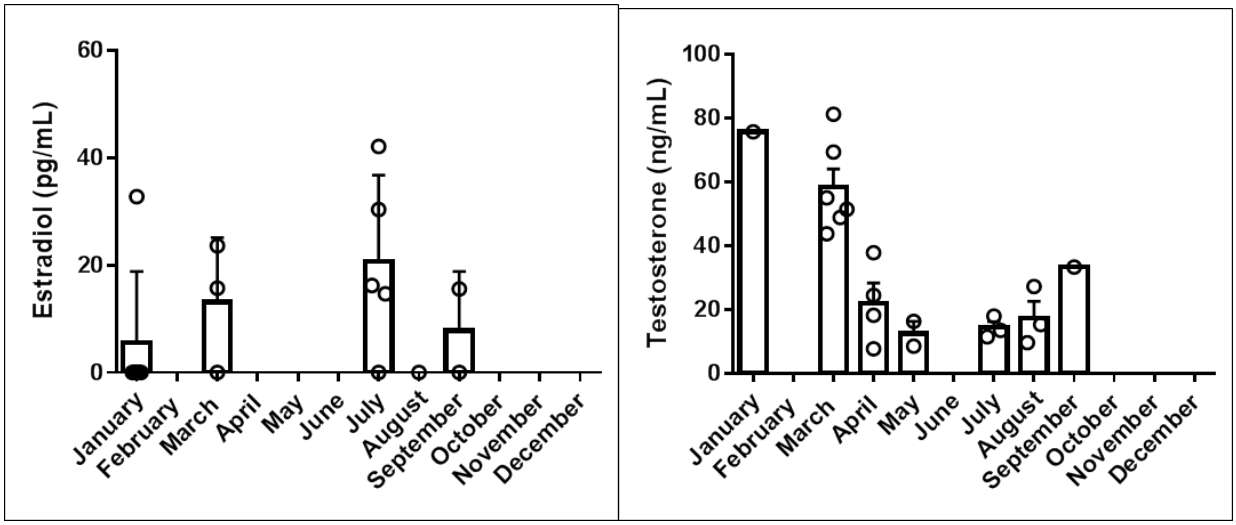

Figure 53 Preliminary results from plasma hormone analyses: Left – estradiol concentrations in large females exhibit no distinct pattern. Right - testosterone and 13, 14-dihydro-15-keto-prostaglandin F2α (PGFM) concentrations in mature males, demonstrating increased levels in March-April.

Information on collaborators / partners:

Name of collaborating organization: Dr. John Carlson, Shelley Norton, Adam Brame- NOAA Southeast Fisheries Science Center and Office of Protected Resources
Date collaborating established: 11/2009
Does partner provide monetary support to project? Amount of support? Monetary support through NGI
Does partner provide non-monetary (in-kind) support? Yes, satellite transmitters and satellite time
Short description of collaboration/partnership relationship: Our colleague from NOAA Fisheries supplies some the satellite transmitters that we deploy and the satellite time needed to download the data

Name of collaborating organization: Dr. Jim Gelsleichter- University of North Florida
Date collaborating established: 11/2009
Does partner provide monetary support to project? Amount of support? No previous monetary support, $5,000 subcontract requested for 2015
Does partner provide non-monetary (in-kind) support? No
Short description of collaboration/partnership relationship: Our colleague from UNF provides a field assistant to collect blood from sawfish in the field and analyzes blood samples for sex hormone concentrations.

Name of collaborating organization: Gregg Poulakis, Dr. Phil Stevens, Florida Fish and Wildlife Conservation Commission
Date collaborating established: 11/2009
Does partner provide monetary support to project? Amount of support? No current monetary support
Does partner provide non-monetary (in-kind) support? No
Short description of collaboration/partnership relationship: Our colleagues from FWC are conducting stable isotope analyses using samples we collected. 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

Name of collaborating organization: George Burgess, Florida Museum of Natural History, University of Florida
Date collaborating established: 11/2009
Does partner provide monetary support to project? Amount of support? No current monetary support
Does partner provide non-monetary (in-kind) support? No
Short description of collaboration/partnership relationship: Our colleagues from the FMNH have been collaborators on related work previously funded through the NOAA Section 6 program and the U.S. Department of the Navy.

Information on any outreach activities:
I gave a numerous invited presentations to public schools, the general public, and university groups that highlighted NGI supported research on smalltooth sawfish:

University of Trinidad and Tobago. 3 hour Invited Lecture (Online): Elasmobranch Fisheries and Conservation. March 30, 2016.

VIMS 75th Anniversary Symposium: Invited Speaker. From Sandbar Sharks to Sawfish: Application of the VIMS Tripartite Mission. October 8, 2015. Gloucester Point, Virginia

Bimini Biological Field Station. Endangered sawfish and deep-sea sixgill sharks: Using modern telemetry to study very large elasmobranch fishes. August 27, 2015 Carr Elementary and Middle School, Clarksville, FL. Research on coastal and deep-sea sharks and rays of the Gulf of Mexico. April 12, 2016. Lecture to 60 7th and 8th grade students

Pre-Veterinary Club at FSU. Research presentation to ~100 club members on deep sea shark and endangered sawfish research at FSU. March 23, 2016
Osher Lifelong Learning Institute - Florida State University. Research presentation to ~25 OLLI participants on Smalltooth Sawfish - the decline, listing, and potential recovery of the U.S.'s first native marine fish listed under the Endangered Species Act. March 23, 2016

Florida State University - Frontiers in Biology. Research into the ecology of coastal and deep-water sharks and bony fishes. Department of Biological Sciences. January 27, 2016

Flamingo Cay Rod & Gun Club, Andros, Bahamas. Lecture to patrons and staff on the biology and conservation of smalltooth sawfish in the Bahamas. November 27, 2015
Osher Lifelong Learning Institute - Florida State University Coastal and Marine Lab. Research presentation to ~25 OLLI participants on Sharks and Rays of Florida: From deep-sea sixgills to endangered sawfish. October 24, 2015

Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology

NGI File #15-NGI2-115: 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

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:

Fitzpatrick participated as a visiting scientist at the Hurricane Research Division. Using a combination of funding from this project as well as a Hurricane Sandy Supplemental project, and minimizing costs with mass transit and a hotel in the suburbs, Fitzpatrick traveled to Miami, FL on these dates: 2/28-3/3; 3/8-3/17; 3/22-3/30; 4/24-4/29; 5/8-5/13; and 6/20-6/24.

In addition, as preparation for HWRF and HRD interactions, Fitzpatrick participated in two Hurricane Forecast Improvement Project (HFIP) workshops and the Interdepartmental Hurricane Conference. Yee Lau and Fitzpatrick participated online for the HWRF python class 1/22, and Fitzpatrick and Lau attended the HWRF tutorial in 1/26-1/27 at College Park, MD. Fitzpatrick participated in three proposals with AOML.

Details on the interactions are in the next section.

Description of significant results, protocols developed, and research transitions

Research interactions are summarized below:

- Interactions and discussions with the majority of HRD scientists
- Discussions with George Halliwell and Gustavo Goni at the Physical Oceanography Division
- Attended weekly meetings, monthly meetings, and seminars at AOML and the University of Miami
- Attended HWRF training sessions, annual HFIP workshop, and the Interdepartmental Hurricane Conference
- Gave two presentations at HRD, including a joint presentation with Liquid Robotics
- One proposal to VORTEX-SE titled “Assessing tornado parameters in high-temporal output of meso-gamma HWRF tropical cyclone landfall simulations” based on HRD needs to evaluate Hurricane Isaac’s spiral bands at landfall and to initiate coastal wind studies at landfall. Collaborators included John Kaplan, Frank Marks, Sundararaman Gopalakrishnan, Hua Chen, Ghassan Alaka, Xuejin Zhang, Altug Aksoy, and Sim Aberson.
- One proposal to the Northern Gulf Institute titled “Examination and validation of reconnaissance field program data in multiple HWRF frameworks” which seeks a collaboration with NOAA’s HRD, Earth System Research Laboratory (ESRL), and NCEP/EMC Marine Modeling and

Analysis Branch (MMAB) to examine the representativeness of the environment and ocean-air interface in different HWRF frameworks compared to tropical cyclone (TC) reconnaissance field programs. The following scientists will have roles in HWRF studies — AOML: Frank Marks, George Halliwell, Gustavo Goni, Sundararaman Gopalakrishnan, Hua Chen, Ghassan Alaka, Xuejin Zhang, Altug Aksoy, Sim Aberson; ESRL: Joe Cione; and EMC: Hyun-Sook Kim.

- Proposal collaboration with Altug Atsoy to NASA Roses titled “Satellite observations to improve nowcasting of storm surge and its uncertainty using coupled hurricane and storm surge models and an ensemble-based data assimilation system.” Other co-PIs included Clint Dawson (University of Texas), Jeff Steward (NASA/JPL), and Troy Butler (University of Colorado – Denver).
- Meeting with Chris Landsea at the National Hurricane Center
- Meeting with Yuepeng Li at Florida International University

Specifics on the meetings are below:

- Attended the Hurricane Forecast Improvement Project (HFIP) Ensemble Workshop November 17, 2015, in Miami, FL.
- Participated remotely in the HFIP Annual Meeting November 18-19, 2015.
- Attended Hurricane Research Division monthly science meeting. Stan Goldenberg (AOML/HRD) presented "Update on the Basin-Scale HWRF Control Runs." Kelly Ryan presented "OSSE Evaluation of Aircraft Reconnaissance Observations and their Impact on Hurricane Analyses and Forecasts" Evan Kalina presented "The fall speeds and ice water paths on small and large ice species in Hurricane Arthur (2014)" March 15.
- Attended seminar “Tropical cyclone predictions from the Met Office Global Model: A brief history and recent developments" by Julian Henning, NOAA AOML, Miami, FL, March 17.
- Attended Interdepartmental Hurricane Conference, University of Miami, Miami, FL, March 14-15
- Attended seminar “ECMWF global ensemble weather forecasts for days to weeks ahead: progress, performance and products for tropical cyclone forecasting” by David Richardson, NOAA AOML, Miami, FL, March 14.
- Tour of NOAA AOML with Erica Rule, March 24.
- Attended Ph.D. defense “The tropical cyclone response to structural and temporal variability in the environmental wind profile” by Matt Onderlinde, University of Miami, Miami, FL, March 25.
- Attended seminar “Theoretically advanced, yet computationally efficient data assimilation and forecasting method” by Dusanka Zupanski, NOAA AOML, Miami, FL, March 28.
- Attended seminar “Object-based data assimilation: strategies and techniques” by Brad Beechler, NOAA AOML, Miami, FL, March 29.
- Attended seminar “The challenges in developing the operational HWRF DA system: What I've learned in 1.5 years at EMC” by Jason Sippel, NOAA AOML, Miami, FL, March 30.
- Attended seminar “Why is the tropical cyclone boundary layer not well mixed?” by Jeff Kepert, University of Miami, Miami, FL, April 27.
- Attended seminar “Eyewall replacement cycles and the tropical cyclone boundary layer” by Jeff Kepert, NOAA AOML, Miami, FL, April 28.
- Meeting with Yuepeng Li at Florida International University to discuss storm surge research, International Hurricane Research Center, Miami, FL, May 9.
- Meeting with Chris Landsea at National Hurricane Center to discuss storm surge research and Bill Gray legacy article in the Bulletin of the American Meteorological Society, National Hurricane Center, Miami, FL, May 9.

- Attended Hurricane Research Division monthly science meeting; Gustavo Goni (AOML/PhOD) presented “PHOD underwater glider operations.” Haiyan Jiang (FIU) presented “What is in the 37 GHz cyan+pink ring of rapidly intensifying tropical cyclones?” Cheng Tao (FIU) presented “The evolution of stratiform and convective rainfall in rapidly intensifying tropical cyclones using 16 years of TRMM PR Data”. Sim Aberson (AOML/HRD) presented “Recent HRD publications.” May 12.
- Participated in online Ocean Model Impact Tiger Team (OMITT) seminar “2016 TROPIC field plan” by E. F. Sanabia, United States Naval Academy, Annapolis, MD, June 24. [TROPIC is the Training and Research in Oceanic and Atmospheric Processes In Tropical Cyclones.]
- Participated in online Ocean Model Impact Tiger Team (OMITT) seminar “2016 HWRF V10.0.0 implementation: much improved operational forecast guidance for all global tropical cyclones” by Zhan Zhang, Environmental Modeling Center, College Park, MD, June 24.

The presentations were:

Carlon, R., and P. Fitzpatrick, 2016: An overview of recent Wave Glider® field programs. Invited seminar, NOAA’s Atlantic Oceanographic & Meteorological Laboratory. Miami, FL., May 12.

This seminar discussed recent Wave Glider programs, and also presented results from:

Fitzpatrick, P. J., Y. Lau, D. Merritt, R. Moorhead, A. Skarke, K. Kreider, C. Brown, R. Carlon, G. Hine, T. Lampoudi, and A. Leonardi, 2015: A review of the 2014 Gulf of Mexico Wave Glider® field program. Marine Technology Society Journal, 49, 64-71.

Fitzpatrick, P. J., Y. Lau, D. Merritt, R. Moorhead, A. Skarke, K. Kreider, R. Carlon, G. Hine, T. Lampoudi, and A. Leonardi, 2016: Further analysis of the 2014 Gulf of Mexico Wave Glider® field program. Marine Technology Society Journal, 50, 72-75.

Fitzpatrick, P. J., 2016: Mississippi State University research activities. Hurricane Research Division monthly science meeting, Miami, FL. March 10.

Information on collaborators / partners:
Discussions, interactions, and proposal collaborations were done with NOAA’s HRD, the Earth System Research Laboratory (ESRL), and NCEP/EMC Marine Modeling and Analysis Branch (MMAB).It includes AOML: Frank Marks, George Halliwell, John Kaplan,
Gustavo Goni, Sundararaman Gopalakrishnan, Hua Chen, Ghassan Alaka, Xuejin Zhang, Altug Aksoy, and Sim Aberson; ESRL: Joe Cione; and EMC: Hyun-Sook Kim.

Information on any 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 National Hurricane Conference Hurricane History Committee.

Fitzpatrick is a member of 12th Conference on Coastal Environment subcommittee, Northern Gulf of Mexico, as part of the 94th Annual American Meteorological Society Conference.

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

Fitzpatrick coordinated an American Meteorological Society short course: “Coastal Surge and Inundation Modeling”. I traveled to NOAA-MDL in Silver Spring, MD, and NOAA-EMC December 16-17. I met with SLOSH developer Arthur Taylor and ADCIRC/Wavewatch developer Andre Van der Westhuysen to prepare for the class. The class will provide lectures on surge physics, ADCIRC, SLOSH, joint probability methods, surrogate modeling, MEOW/MOMS, and ensemble modeling. Lecturers will be Fitzpatrick, SLOSH developers (Arthur Taylor), ADCIRC developers (Rick Luettich and Jason Fleming). The National Hurricane Center storm surge unit director Jamie Rhome. Training for both models will be done that afternoon. Fitzpatrick is also providing a storm surge spreadsheet exercise, and a 1D storm surge modeling written in two software languages (Python and FORTRAN). The class was taught January 10, 2016.

Reviewer for Journal of Geophysical Research-Oceans. The topic was hurricane parametric forcing for storm surge modeling.

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

Related NOAA Enterprise Objectives: Science and Technology, Engagement

NGI File #15-NGI2-116: 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

Project objectives and goals

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 (typically 150-300 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.

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) from the Apalachicola River during the summer 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 has been approved by Jason Reuter, 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

Organization and quality control/quality assurance of the Genetic Database has almost been completed. At this point there are 1299 microsatellite genotypes in the database from individuals representing the following drainages as indicated in Table 6.

Table 6 Drainage basins from which Gulf Sturgeon have been collected.

Drainage	N
Pascagoula	197
Pearl	127
Escambia	74
Yellow	64
Blackwater	64
Escambia Bay	13
Choctawhatchee	278
Brothers	67
Apalachicola	53
Ochlockonee	52
Suwannee	310

From these I have almost completed the selection of a core set of samples to represent reference genotypes for each of the major river systems. This requires identifying migrant individuals (ones caught in one location but demonstrating genetic ancestry in a different drainage). These analyses have been completed, and I am currently in the process of interpreting the data.

2. Laboratory Work - new genotyping efforts
On the basis of discussions at the last 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 will be aimed at the new samples currently being collected on the Apalachicola River this summer. 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.

Description of significant results, protocols developed, and research transitions
The massive Gulf sturgeon genetic database that we have built provides opportunities above and beyond the original scope of the work. Using sonar tracking, researchers have recognized that adult Gulf sturgeon can travel far from their natal rivers as they utilize coastal habitats. In the cases where we have genetic data for these monitored individuals, we can develop further insight into the scope of these movements by identifying where the fish was located relative to where it was spawned. With the future inclusion of age-1 and 2 fish from the Apalachicola, we should also be able to take a new analytical approach to quantifying successful reproduction in Gulf sturgeon in a much quicker time frame rather than waiting for the recruits to enter the currently monitored adult population.

Information on collaborators / partners: None reported

Information on any outreach activities: None reported

Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology

NGI File #15-NGI2-117: 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

Project objectives and goals

The goal of this project was to pursue close collaboration between Mississippi State University (MSU) and Atlantic Oceanographic and Meteorological Laboratory (AOML), so that data collected and processed by MSU's 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, 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, TA, DIC, and pCO2 data in the region of Gulf of Mexico where less accurate estimations are made because of Mississippi River outflow. These field data will be used *in tandem* with satellite data to create products that could be integrated into OAPS.

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

Since this spring, an M.S. student and a Ph.D. student, whose theses are based on ocean acidification, have started to work with me. The students and I conducted a thorough literature review and presented several times in our weekly group meetings. The students wrote their thesis and dissertation proposals, and I prepared a proposal with the concepts for next year. In March, 2016, I visited AOML to meet Dr. James Hendee, Dr. Ruben van Hooidonk, Dr. Derek Manzello, and others; to give a seminar; and to get feedback on my concept for next year. At AOML, I presented many research questions to address. Later, after discussions with Dr. Ruben van Hooidonk, we identified specific objectives to work on first and others to tackle later.

The M.S. student specializes in remote sensing, and the Ph.D. student specializes in water biogeochemistry. The M.S. student took the course 'Advanced Remote Sensing' that I teach every spring. In the month of June, he went to the NASA-Cornell University workshop to be trained in time-series satellite data processing. After his return, he began preparing a manuscript on ocean acidification. During the summer, the Ph.D. student finished writing his proposal and processing water samples for parallel factor (PARAFAC) modeling so that he will be able to detect different water types from the water samples from northern Gulf of Mexico. Both the students will defend their proposals by the start of the fall semester. A total of six publications has been planned so far from this research work.

Originally, I had proposed to visit AOML sometime in the fall, send the student for the two-week internship in December, and then go to AOML in March to present the concept for next year. Since the students started in the spring, I decided they would work on their proposals during the spring and visit AOML during the summer. I had participated in the NASA-Cornell workshop back in 2006 and received a training on time-series satellite data processing and IDL. Now, NASA uses python programming and the software and the satellite sensors have changed. So, with Dr. Molly Baringer and Dr. Robert Moorhead's approval, I decided to send one of the students, who will later work on the remote sensing

aspects of this project, to the same workshop. To support him for this NASA-Cornell workshop, I curtailed my trip to AOML from two trips to one trip.

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

While oceans slow down global climate change by removing CO_2 from the atmosphere, ocean acidification, due to CO_2 uptake by the oceans, profoundly affects the marine carbonate system presenting a myriad of negative ecological consequences (Barker & Ridgwell, 2012). When CO_2 reacts with seawater, it forms carbonic acid, which is highly reactive and reduces the concentration of carbonate ion and affects the shell formation of marine animals such as corals and shellfish (Figure 54a). Hence, measurement and monitoring of ocean acidification rates and estimating their impacts is a priority both for coral reef and shellfish research and management and for understanding the implications of global climate change.

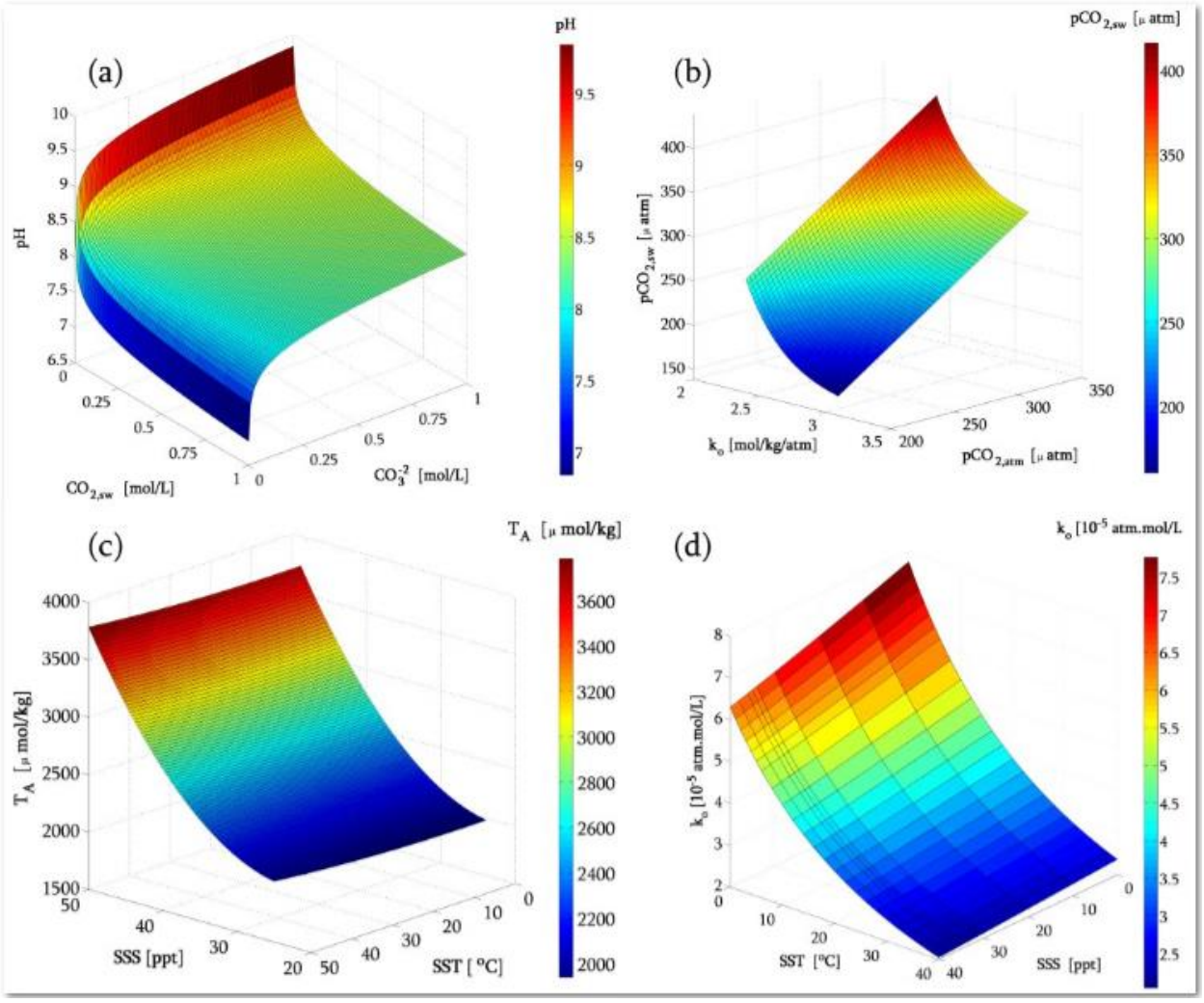

Figure 54 (a) Reduction in carbonate ion concentration as a response to decrease in pH due to increased CO_2 in seawater, (b) An exponential relationship between ko and pCO2, sw and a linear relationship between pCO2, atm and pCO2, sw, (c) Variability in TA as a function of SSS with a minor dependence on SST, and (d) Variability of ko as a function of SST with a minor influence from SSS.

Ocean Acidification Product Suite (OAPS), a tool developed 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 CO_2 (pCO2) as input (AOML NOAA, 2016; Gledhill et al., 2008).

During our preliminary analysis of the ocean acidification parameters, it was observed that (1) the variability in TA is mainly attributed to variation in sea surface salinity (SSS) with a minor dependence on sea surface temperature (SST); and that (2) variability in pCO2 is mainly attributed to variation in SST with a minor influence from SSS (Figures 54b, 58c, and 58d). 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, particulate carbon, and dissolved carbon to the ocean.

Additionally, the organic carbon pump plays a greater role in the river outfall regions by intensifying 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 is also known to be a large exporter of alkalinity, which acts as a buffer to changes in pH (Raymond and Cole, 2003; Cai et al., 2011). 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 outflow has been detected up the Southeast coast to the latitude of Georgia (C. Hu et al., 2005). Hence, Mississippi River water and outflow from other rivers could affect the estimations of pH, Ωarag, and Ωcalc in the Gulf of Mexico and beyond. This project is aimed at using the pertinent existing data, collecting additional *in situ* data from the northern 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. A three-month composite of SeaWiFS images showing the global phytoplankton distribution is presented in Figure 55. While the improved estimations will be helpful for obtaining 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.

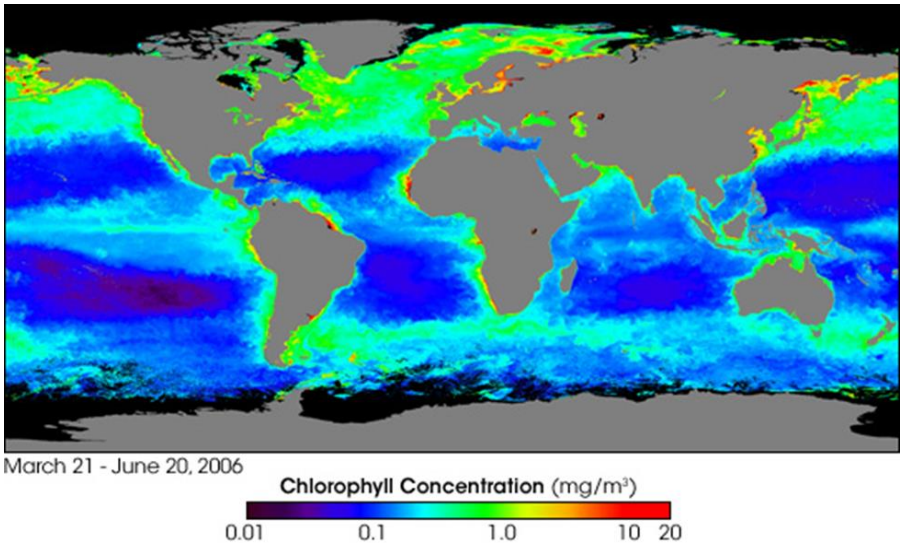

Figure 54 A three-month composite of SeaWiFS images showing the global phytoplankton distribution.

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

Information on any outreach activities: None reported

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

Related NOAA Enterprise Objectives: Science and Technology

NGI File #15-NGI2-118: 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

Project objectives and goals

Task 1

1. 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.
2. Obtain land-cover, land-use (LULC) information from the bimonthly overflights.
3. Obtain land-water masks from each mission data.
4. Organize and execute a workshop in the October-November timeframe to update the NWS/RFC personnel on UAS capabilities; 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

1. Develop an image cache data portal for the data we collect.
2. Develop a data management plan for LASE data.
3. 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

1. Two weeklong UAS-based data collection missions were conducted in the Pearl River coastal watershed August 9-14, 2015 and December 14-18, 2015.
2. Imagery collected from all 8 weeklong missions (July 2014-December 2015) were radiometrically calibrated and atmospherically corrected. Classified the imagery from all flights. Analyzed the data. Several papers and presentations have resulted.
3. Initiated a study to determine the ability and feasibility of using a small UAS to determine water quality by collecting water samples where the UAS was collecting data. Initial results are very promising. Two presentations have already been given and 2 journal papers are in preparation.
4. Collaboration with the National Estuarine Research Reserves (NERR) program continued. In July 2015, we collected imagery documenting the extent and impact of a 1700 acre marsh fire. In spring 2016, we provided input and review for a UAS users-guide for the NERR Stewardship Program.
5. We made two presentations on our research at the Midsouth Aquatic Plant Society Meeting (September 2015), presented a poster and a paper on the water quality detection work at CERF (November 2015), we contributed to two AGU talks (given December 2015), made two presentations and contributed to two others at AMS (January 2016), presented a poster on

some of the research results at the Gulf of Mexico Oil Spill and Ecosystems Sciences Conference (June 2016), presented a paper on the research results at the State of the Coast conference (June 2016), published and presented a paper at AIAA Aviation (June 2016), and prepared two talks on the research results for NOAA Science Days and a related Media event to be held in July 2016. A journal paper on the ability to detect invasive plant species from the UAS-collected imagery has been accepted.

Task 2

1. Added additional data to the web-accessible image cache data portal we created. One can see online and download the original images, all the tiles of a mosaic created from the images collected during each flight, or a reduced-resolution rendition of the mosaic.
2. Presented a poster on the data portal at the Gulf of Mexico Oil Spill and Ecosystems Sciences Conference (June 2016)
3. Developed a data management plan for NOAA's LASE UAS data
4. Created a data dissemination portal for LASE data collected under NOAA UAS Program funding

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

Task 1

The NERR Sentinel Site work was the case study work for the NERR's UAS guideline document. We have shown that it is possible to collect significant information about harmful algal blooms (HABs), suspended sediments, and colored dissolved organic matter (CDOM) by flying small UAS at 800 feet AGL, using RGB, CIR, and hyperspectral cameras. Harmful Algal Blooms (HABs) may cause harm through the production of potent chemical toxins or by their accumulated biomass. Impacts include massive fish kills, loss of sales revenue primarily from fisheries and tourism, loss of commercially valuable and culturally vital shellfish resources, illness and death in populations of protected marine species, and threats to human health. Among the many HAB impacts in the northern Gulf of Mexico, those due to blooms of the cyanobacteria with its associated toxin microcystin, diatoms genus Pseudo-nitzschia with its associated toxin domoic acid, and the dinoflagellates of the genus Karenia with its associated toxin brevetoxin are of particular concern. The Mississippi Gulf Coast experienced a rare Karenia (red tide) issue in December 2015 during one of our missions. Due an unfortunate traffic accident and some technical issues, the graduate student has yet to finish the data analysis to see how well we were able to detect and measure the infestation.

Suspended sediments concentration is the most widely measured water quality parameter since it relates directly to water quality as well as clarity. Suspended sediment concentrations can indicate the trophic conditions and also considered as carriers of pathogens, nutrients, toxic elements and heavy metals. CDOM represent the colored fraction of dissolved organic matter (DOM) is an important water quality parameter as excess DOM in a water body is related to algal growth, decreases dissolved oxygen levels and turns the water acidic. Water quality of lower Pearl River estuary is especially important because of numerous coastal shellfish beds that could be impacted negatively because of freshwater input through the estuary. Therefore, the high spatial and spectral resolutions of UAS will provide information about the concentration of HABs, suspended sediments, and CDOM that could affect the quality and safety of resources like native shellfish beds. We are in the process of disseminating our research results via local science meetings, national conferences, and the archival literature.

Task 2
Provided over a TB of image data via the image cache
Developed a data management plan for NOAA's LASE UAS data
Created a data dissemination portal for LASE data collected under NOAA UAS Program funding

Information on collaborators / partners

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

Name of collaborating organization: NRL/SSC
Date collaborating established: 1994
Does partner provide monetary support to project? No Amount of support? N/A
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
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.

Name of collaborating organization: St. Tammany Parish Engineering Department
Date collaborating established: November 2013
Does partner provide monetary support to project? No Amount of support? N/A
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
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.

Name of collaborating organization: Grand Bay NERR
Date collaborating established: February 2015
Does partner provide monetary support to project? Yes Amount of support? $10,000
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.
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, Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology

NGI File #15-NGI2-119: Predicting the Impact of Anthropogenic Climate Change on Physical and Biogeochemical Processes in the Northern Gulf of Mexico

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

Co-PI(s) name, affiliation, email address: Sang-Ki Lee, Atlantic Oceanographic and Meteorological Laboratory, NOAA, sang-ki.lee@noaa.gov; John Lamkin, Southeast Fisheries Science Center, NOAA, john.lamkin@noaa.gov; and Yanyun Liu, Atlantic Oceanographic and Meteorological Laboratory, NOAA/ Cooperative Institute for Marine and Atmospheric Studies, University of Miami, yanyun.liu@noaa.gov

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

Project objectives and goals

The main objective of this project is to provide a range of realistic scenarios of future environmental changes in the northern GoM (including the shelf region) for the research community and fisheries resource managers. The first project task (Year 1) is to configure and validate a high-resolution ocean-biogeochemical model forced with historical environment conditions from 1979-2014. The second task (Year 2) 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 scenarios, using the model configured from task 1 and projected atmospheric fields from the Coupled Model Intercomparison Project phase-5 (CMIP5).

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

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 the Fennel biogeochemical model to simulate the nitrogen cycle and dissolved oxygen (Fennel et al., 2006; 2011). 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).

Description of significant 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 (Figures 56 and 57). Currently, we are performing a validation of the GOM25 model outputs against available observations. The next step for the first project year is to configure a higher resolution (~4 km) model for the Gulf of Mexico, which can better resolve ocean processes over the shelf region, deep ocean dynamics, and their interactions.

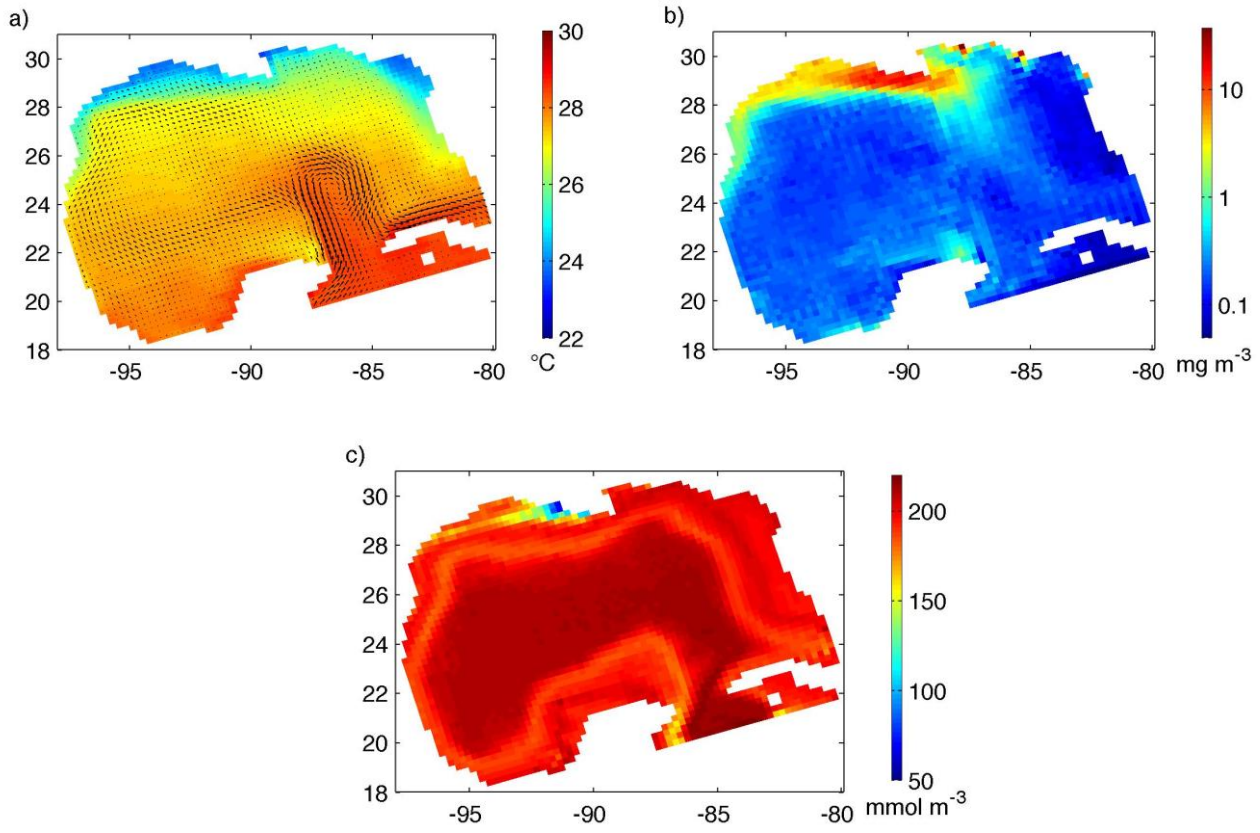

Figure 55 (a) Annual mean sea surface temperature and surface currents (vectors); (b) annual mean surface chlorophyll; c) July mean bottom oxygen concentration.

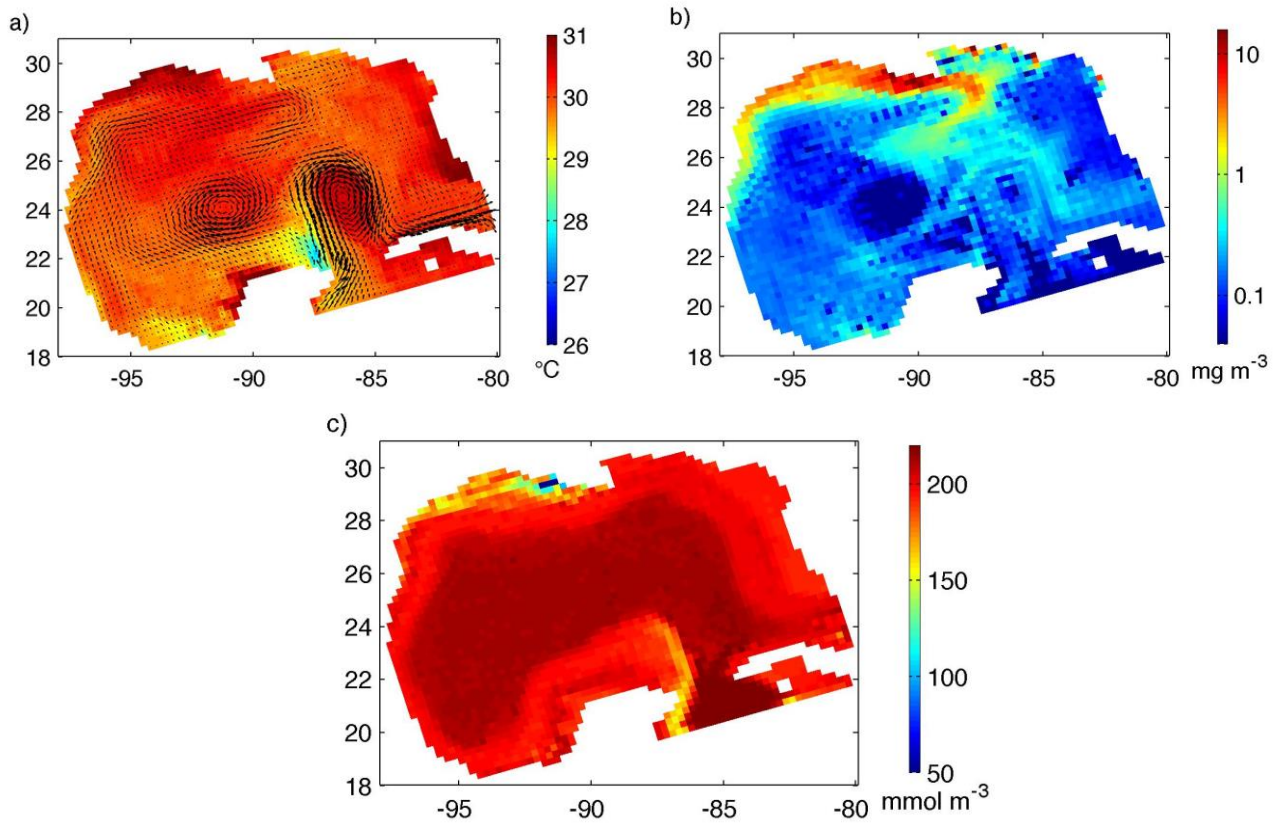

Figure 56 July snapshots of modeled sea surface temperature and surface currents (a), surface chlorophyll concentration (b), and bottom oxygen concentration (c).

Information on collaborators / partners: None reported

Information on any outreach activities: None reported

Related NOAA Strategic Goals: Climate Adaptation and Mitigation

Related NOAA Enterprise Objectives: Science and Technology

References:

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Smith, W., D. Sandwell (1997), Global seafloor topography from satellite altimetry and ship depth soundings, Science, 277: 1956**–**1962, doi:10.1126/science.277.5334.1956.

NGI File #15-NGI2-120: Further Refinements to Stepped-Frequency Microwave Radiometer Surface Wind Measurements in Hurricanes

Project Lead (PI) name, affiliation, email address: Mark A. Bourassa, Center for Ocean-Atmospheric Prediction Studies, Bourassa@coaps.fsu.edu

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

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

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:

1. Obtain additional measurements from NOAA hurricane reconnaissance flights as necessary;

2. Extend SFMR software algorithms for general use at all wind speeds and practical incidence angles;

3. Develop a new SFMR data product revision to be made available to the research community; and

4. 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), so it was not possible to collect additional SFMR high incidence angle data needed to fully develop the algorithm corrections.

Description of significant 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 to wave direction. Figure 58 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 58 have similar wind and wave directions (August 26, 2014 and February 8, 2015) while the third case (February 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.

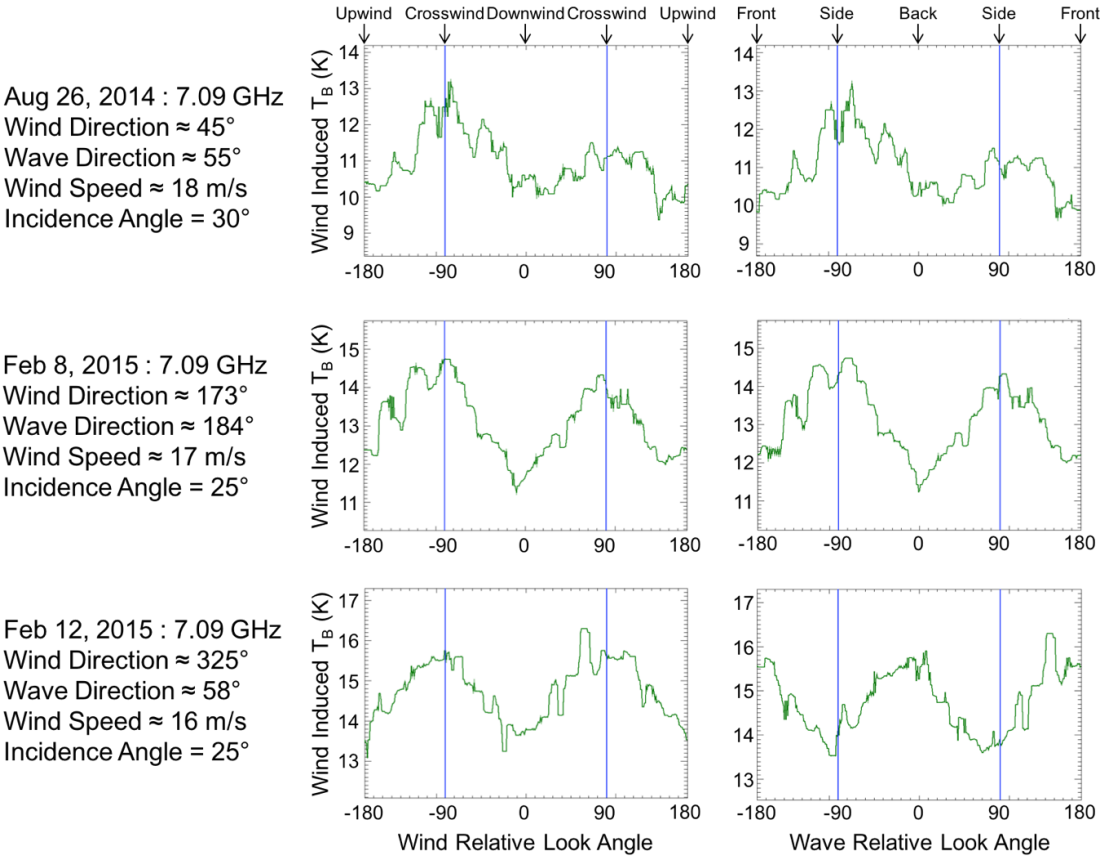

Figure 57 7.09 GHz channel wind-induced brightness temperatures (TB) as a function of wind relative SFMR look angle (left column) and wave relative SFMR look angle (right column) for flights on August 26, 2014 (top row), February 8, 2015 (middle row), and February 12, 2015 (bottom row). Green lines denote the 10° relative look angle bin running median values of wind-induced TB. 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.

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 59). So far, SFMR high-incidence angle data has been collected in the storm relative locations shown in Figure 60. In order to complete the algorithm improvements, more SFMR high-incidence angle data will be collected in storm relative locations that have not been sufficiently sampled and also in regions of rain during the 2016 HRD HFP.

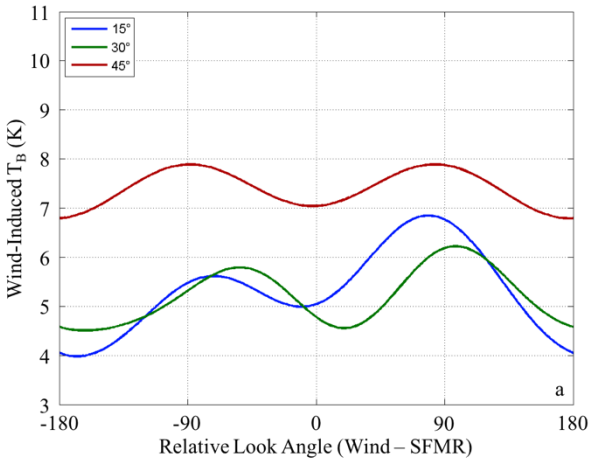

Figure 58 Harmonic fits to the wind-induced brightness temperatures vs SFMR relative look angle with respect to the wind direction for the 4.74 GHz channel for the flight in Hurricane Cristobal on August 24, 2014. The wind speed for the August 24, 2014 flight in the location of the circles was about 15.1 m/s. The line colors correspond to the incidence angles given in the legend.

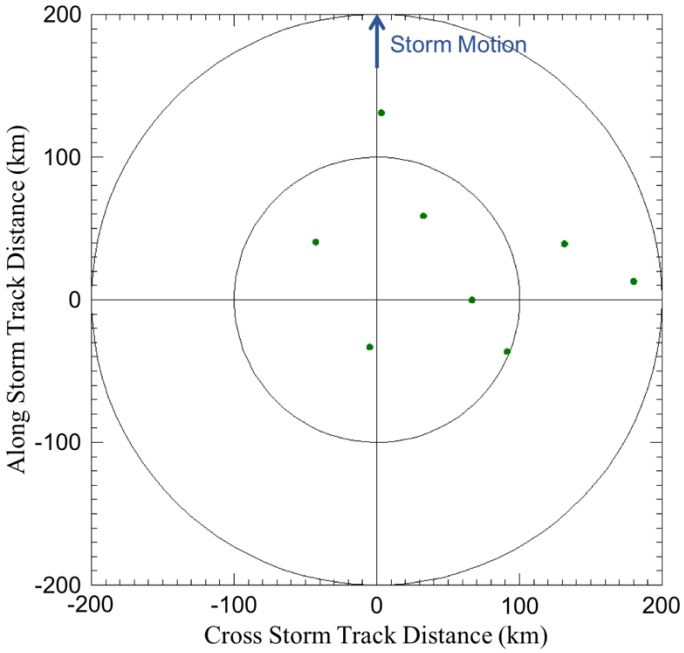

Figure 59 Storm relative locations of high-incidence angle SFMR data (green dots). Storm motion is towards the top of the plot and rings denote 100, and 200 km radii.

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 61).

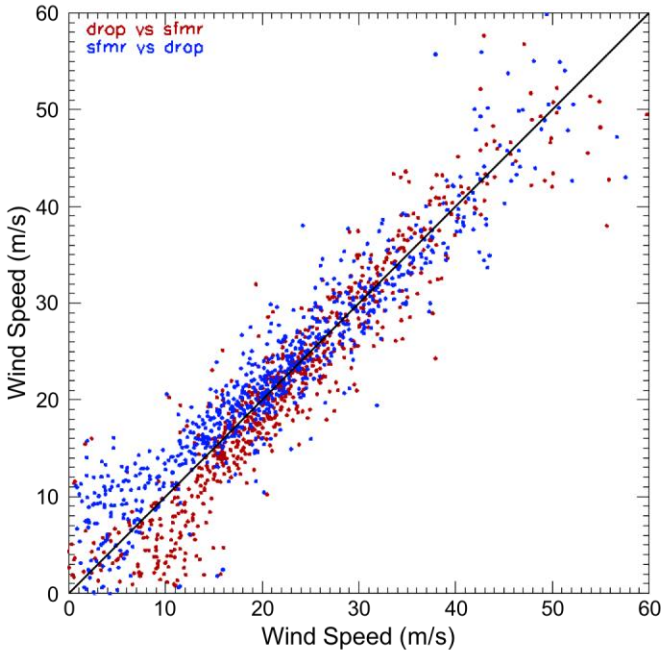

Figure 60 SFMR retrieved wind speed versus dropsonde WL150 surface adjusted wind speed (blue) and dropsonde WL150 surface adjusted wind speed versus SFMR retrieved wind speed (red). 1:1 line is shown in black.

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.

Information on collaborators / partners:
Name of collaborating organization: NOAA/AOML/HRD
Date collaborating established: February 2013
Does partner provide monetary support to project? Amount of support? No
Does partner provide non-monetary (in-kind) support? Yes
Short description of collaboration/partnership relationship: Help mentoring graduate student and postdoctoral fellow; collect data

Information on any outreach activities: Not applicable

Related NOAA Strategic Goals: Weather-Ready Nation

Related NOAA Enterprise Objectives: Science and Technology

NGI File #15-NGI2-121: U.S. Research Vessel Surface Meteorology Data Assembly Center

Project Lead (PI) name, affiliation, email address: Shawn R. Smith, Center for Ocean Atmospheric Prediction Studies, Florida State University, smith@coaps.fsu.edu

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

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

Project objectives and goals

The central activity of the U.S. Research Vessel Surface Meteorology Data Assembly Center (DAC) at the Florida State University (FSU) is the implementation of the Shipboard Automated Meteorological and Oceanographic System (SAMOS) initiative (http://samos.coaps.fsu.edu/). The SAMOS initiative focuses on improving the quality of and access to surface marine meteorological and oceanographic data collected *in situ* by automated instrumentation on research vessels. In FY15, 1 New Zealand- and 30 United States-operated research vessels routinely transmitted daily emails containing one-minute averaged meteorology and surface oceanographic data to the DAC. Broadband satellite communication facilitates this daily transfer at ~0000 UTC. A preliminary version of the data is available 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.

Through the reporting period, the DAC was 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 each 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 research conducted during the reporting period and milestones accomplished and/or completed

Accomplishments in FY15 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 flow of SCS data from the NOAA vessels to NCEI (funded by OMAO).

Deliverables 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 NODC.
C4 - Develop, test, and implement new automated quality control methods.
C5 - Continue to update SAMOS instrumental metadata for all recruited vessels supported by NOAA.
C6 - Engage new user communities via meetings, publications, and electronic communications.
C7 - Continue collaborations with U.S. and international (limited) partners and throughout the marine climate community

Deliverables for OMAO include the following:
O1 - Expand a data assembly center at FSU to evaluate SCS data flow into NCEI following each cruise from NOAA vessels.
O2 - Coordinate feedback to operators regarding device problems in collaboration with key U.S. partners.
O3 - 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.
O4 - Disseminate recommendations from the U.S. and international marine climate community regarding routine underway data collection on NOAA vessels to meet the needs of secondary data users (scientists not on cruise).

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 Shipboard Automated Meteorological and Oceanographic System (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 have been used to improve algorithms that retrieve air temperature and humidity near the ocean surface using space-based satellite observing platforms (Jackson and Wick 2014). 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 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.

Description of significant results, protocols developed, and research transitions

2.1.1 COD

The primary achievement in FY 2015 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 and yielded a slight increase in the number of days of data received (though much of this increase is from dockside observations from the retired Melville). Three new vessels were recruited (Reuben Lasker, Pelican, and Sikuliaq), four were retired (Knorr, Melville, New Horizon, and Southern Surveyor), and the Healy did not transmit data in FY15. We were able to restart processing for the Tangaroa via IMOS, but still have not been able to restart data flow from the Aurora Australis. These data span the global ocean, extending into poorly sampled regions of the southwest Atlantic, South Pacific, and Southern oceans. In FY15, we received more than typical numbers of data reports from the western tropical Pacific and eastern Indian oceans. 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 C5] 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 under COD funding] and the RV Falkor (SOI funding). 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 was lead author of the 2015 SAMOS annual report that summarizes the data quality for all vessels contributing data for the calendar year 2014. The report has been distributed to all operators of SAMOS vessels and posted to the SAMOS web site. In addition, Ms. Briggs tracks the completeness of daily SAMOS data submissions from the NOAA fleet to the DAC and for FY15 we received 2073 ship days of data from the scheduled 2702 NOAA science days (77%). The completeness varied by vessel from over 90% for 4 vessels to a low of 10% for the Ferdinand Hassler.

DAC personnel continue technical enhancements to the SAMOS data processing, distribution, and archival systems. Our software team developed an enhanced “vessel over land” quality test that uses the latest NCEI 1-minute resolution topography dataset [deliverable C4]. Additional documentation and error logging has been developed along with upgrades to our web services to improve the download speeds of our dynamic SAMOS web pages. We also continue to explore using Google analytics to determine who is using the SAMOS observations. In FY15, visitors from 56 countries have accessed the SAMOS web pages, with the largest percentages from the U.S. (53%), India (4.6%), United Kingdom (3.5%), France (2.6%), South Korea (2.3%), and Canada (2%).

Engaging the international marine climate community [Deliverable C7] included Mr. Smith’s involvement with the Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) Ship Observation Team (SOT) and the International Comprehensive Ocean-Atmosphere Data Set (ICOADS). Mr. Smith continues to serve on the SOT task teams focused on the Marine Climate Data System (TT-MCDS) and Instrument Standards (TT-IS). For the former, he contributed to the drafting of two WMO publications (#471 and #558) for the Expert Team for Marine Climatology and for the latter the completion of an initial release of JCOMM Technical Report 63 outlining best practices for humidity observations at sea.

2.1.2 OMAO

The primary task of the DAC for OMAO in FY15 was to develop a system to monitor the flow of post-cruise SCS data packages from the NOAA vessels to NCEI [Deliverable O2]. Mr. Suchdeve has led the development of the software to monitor both the timeliness of SCS data delivery to NCEI and the completeness of the submitted data packages. He established a virtual machine (VM) at COAPS to host the database, website, and web tools that automatically monitor the SCS data flow. Through FY15, Mr. Suchdeve designed timeliness software to monitor NOAA data deliveries to NCEI to determine when data are submitted, received, and published for each period and project. When the criteria (set by OMAO) that data are to be received by NCEI within 60 days and to be published by NCEI within 90 days of the end of the period is not met, notification emails are sent to OMAO and NCEI to determine the source of the data delay and aid them in rectifying the data submission problems. Mr. Suchdeve also developed code to assess the completeness of each SCS data package submitted to NCEI. At the end of each project, an automated process downloads the published data package from NCEI to local servers at the DAC. The software then extracts information from the NCEI file manifest and SCS device configuration files and stores the information in the DAC database. The code then searches for data files that match each device in the configuration file and the date range when that configuration file is active. Statistics are developed that account for files in the package that are “expected and found”, “expected and not found”, and not expected (no device in the configuration file).

The second primary task for FY15 was developing an issue tracking system (ITS) to support

communication between the DAC, NOAA vessel technicians, OMAO, and NCEI [Deliverable O2]. Mr. Suchdeve established a prototype ITS hosted on Google groups under the COAPS local VM. The ITS supports access via a web interface and email and has been designed to allow issues to be assigned to different topic areas that include Equipment, NOAA notifications, SCS, and individual NOAA vessels. Several test messages (tickets) have been submitted to the system for the Ronald Brown, the first vessel for which we are trialing the ITS. Ms. Briggs, the ITS ticket administrator, has been in communication with several technicians to familiarize them with the ITS. In addition to vessel notifications, the ITS is used to notify OMAO and NCEI regarding the timeliness of SCS post-cruise data package delivery and processing by NCEI.

A user survey seeking input on the requirements for underway observations from NOAA vessels was developed by the PI using Survey Monkey and was distributed to a number of mailing lists throughout the international marine climate community. Preliminary results were provided to OMAO during a WebEx on September 15, 2015 and a PDF of the survey data was sent to OMAO for their use following this meeting [Deliverable O4]. Survey respondents ranked the importance of a number of underway data parameters, which can be used by OMAO and other RV operators to justify support for ensuring operation of these sensors whenever their vessels are at sea. We gained further input from U.S. scientists and presenting the final survey results at Ocean Sciences 2016.

Finally, SCS DAC personnel collaborated with Bob Arko at the UNOLS R2R project to ensure that reciprocal links to the SAMOS data appeared on a prototype NOAA cruise catalog that Mr. Arko developed for OMAO. This will ensure consistency between activities of the SCS DAC, SAMOS, and the UNOLS and NOAA R2R projects for QA reporting [Deliverable O3].

2.2. Facilitating Science

The DAC developed two new data products in FY15 to facilitate the application of SAMOS observations for scientific research. First, we completed and released a second version of the SAMOS air-sea flux product (SAMOS Flux 2.0) derived using the quality-controlled SAMOS observations. This flux product provides estimates of latent and sensible heat exchange between the ocean and atmosphere, wind stress at the ocean surface, and 10-m height adjusted winds, air temperature, and specific humidity using three different surface flux algorithms. Unlike most flux products, the derived fluxes are provided along ship tracks and are not interpolated to a grid. This allows users to compare the derived fluxes at a point location to other methods for deriving air-sea exchange estimates (e.g., using satellites or numerical models). A manuscript has been published in the Geoscience Data Journal and the dataset is available at the National Center for Atmospheric Research (NCAR) – Research Data Archive. For the second product, Ms. Jocelyn Elya (SAMOS lead programmer) created an hourly subset of the SAMOS data for inclusion in the upcoming release 3.0 of the International Comprehensive Ocean-Atmosphere Data Set (ICOADS). ICOADS is a foundational marine climate dataset which includes surface marine observations dating back to sailing vessels of the late 1600s. Development of this dataset required creating 10-minute averages of the SAMOS observations at the top of each synoptic hour for the entire SAMOS record covering 2005-2014. The hourly data were provided to the ICOADS project in the International Marine Meteorological Archive format and are archived at NCAR. Both of these products will engage existing and new users in the SAMOS initiative [Deliverable C6].

2.3 Data Dissemination and Archival

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. 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 (formerly National Oceanographic Data Center) 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. In FY 2015, NCEI upgraded their access to the SAMOS data and assigned a DOI reference to the dataset to facilitate citation. The landing page for SAMOS at NCEI is http://data.nodc.noaa.gov/cgi-bin/iso?id=gov.noaa.nodc:COAPS-SAMOS. As of 30 September 2015, a granule search from the landing page located 1710 monthly SAMOS ship archive sets at NODC. Periodically, the PI downloads SAMOS data from NODC to ensure system integrity.

Information on collaborators / partners:
As noted in section 2, 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 Mark VanWaes at OMAO. In addition, we collaborate with Chris Paver at NCEI to ensure timely archival of all SAMOS datasets. In FY15, 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 any outreach activities:
We continue to train the next generation of marine and data scientists. Harrison Harward, an undergraduate studying computer science, has been working on the SAMOS automated data processing codes and learning the complexities of building robust data quality analysis software. Nicolas Lopez, a graduate student studying scientific computing, has been instrumental in developing the SAMOS 2.0 flux product. Through this project he has learned techniques to implement multiple flux algorithms and to create both user-friendly data files (CF-compliant netCDF) and documentation.

In February 2016, we conducted outreach to the general public as part of the second COAPS Open House. During the event, attended by over 800 people, Jeremy Rolph and the PI demonstrated the operation of marine meteorological instrumentation. Informing the wider marine climate community of DAC activities was done through presentations at national/international meetings.

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: 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

Project objectives and goals
The main goal of the project is to better understand the health, function, and resiliency of marine ecosystems by 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; and

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
Water samples collected during summer solstice 2014 processed and the extracted DNA have been sequenced through the Ocean Sampling Day (OSD) Project. Detailed DNA sequence analysis is currently ongoing. Samples collected during summer solstice 2015 have been shipped to the Max Planck Institute for Marine Microbiology in Bremen, Germany and are in the pipeline for high-throughput sequencing. Water samples for summer solstice 2016 have been collected, filtered and are now stored at -80°C. Samples from multiple sites around the U.S. will be shipped to AMOL NOAA in Miami, FL for consolidation on July 6th and all samples collected in the U.S. will be shipped at one time to Germany for processing and sequencing.

A search is currently ongoing to hire a postdoctoral researcher with high level computational expertise and bioinformatics experience to help with metagenomics analysis of NGS data. Advertisements are currently running in Science, the American Society of Microbiology Career Connections, LinkedIn and Research Gate.

Description of significant results, protocols developed, and research transitions
16S rDNA amplicon and metagenome data for all sampling sites from summer solstice 2014 have been collected and are now ready for detailed analysis. A postdoctoral researcher with bioinformatics expertise will be hired soon to help analyze the data.

Information on collaborators / partners:
Name of collaborating organization: NOAA AMOL
Date collaborating established: 09/01/2013
Does partner provide monetary support to project? Amount of support? Not directly. Support is provided through a NOAA cooperative agreement to NGI. The amount of support through the cooperative agreement is $126,275.
Does partner provide non-monetary (in-kind) support? Yes, NOAA partners help with coordination of field sampling efforts and shipment of samples to Germany for processing and high-throughput DNA sequencing. NOAA partners also help with evaluation of applicants for the postdoctoral research associate position.
Short description of collaboration/partnership relationship: While I collect and process marine water samples from the Northern Gulf sampling site, the NOAA partner collects and processes marine water samples from Florida sampling sites. I am in regular contact by telephone and email in our search to fill the postdoc position.

Information on any outreach activities: None reported

Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology

NGI File #15-NGI2-123: Integrated Ecosystem Assessment for the Northern Gulf of Mexico Estuaries

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

Co-PI(s) name, affiliation, email address: Just Cebrian, Dauphin Island Sea Lab, jcebrian@disl.edu; Scott Milroy, University of Southern Mississippi, scott.milroy@usm.edu; Anna Linhoss, Mississippi State University, alinhoss@abe.msstate.edu; Cristina Carollo, Harte Research Institute at TAMUCC, cristina.carolla@tamucc.edu; and Richard Fulford, Enviornmental Protection Agency, Richard.fulford@ep.gov

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

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 workshops will be held 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, Apalachicola Bay). 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 (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). These lists of ecosystem services will be compared to the literature observations of ecosystem services provided by oyster reefs and the other components of selected estuaries to develop a preliminary list of specific ecosystem services. This list will be refined during the workshops with resource management agencies and industry stakeholders. The revised 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 and incorporated into the IEA (Dillard et al. 2013).

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

The Trophic Simulation model (TroSim) was set up for scenario analysis using oyster reef data for the MS Sound. TroSim was enhanced to include multiple parameters relevant to oyster production. Preliminary results of the TroSim modeling were presented to the Mississippi Department of Marine Resources. The response was positive. To better understand the synergy between resource managers and the oyster fishing community, a workshop will be held to get public and management input on how to better integrate domains of human well-being into the decision-making process and how tools like the TroSim model can help inform the process.

In order to understand oysters in the Gulf of Mexico and the ecosystem services that they provide the drivers of oyster population dynamics must first be understood and quantified. Important drivers of oyster population include salinity, temperature, total suspended solids, dissolved oxygen, nitrogen, phosphorous, dissolved silica, water depth, and current speed. During the project period, the team became aware of a water quality model for St. Louis Bay, MS which is in the vicinity of several oyster reefs. We are using a 3-dimentional hydrodynamic model (Environmental Fluid Dynamics Code, EFDC) and a water quality model (Water Quality Analysis Simulation Program, WASP) to simulate these parameters in space and time.

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 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

Modifications were made to the TroSim model, specific to oyster reef production, in order to provide a means of scenario-testing for natural resource managers (e.g. Mississippi Department of Marine Resources) to use as a potential tool for decision-support. These model modifications included (1) habitat suitability indices (HSI's) for three different age-classes of oysters (Spat, Seed, Sack) to simulate disparate oyster age-class response to a number of environmental forcings, such as temperature, salinity, dissolved oxygen, and water depth; 2) introduction of "combined effect" HSI's to illustrate how HSI output from singular environmental forcings can realistically be combined to produce oyster age-class response to multiple simultaneous environmental forcings; 3) introduction of HSI effects specific to oyster spawning and recruitment (beyond simple somatic growth); 4) a

parameterization of promotion/recruitment dynamics between modeled oyster age classes (Spat → Seed, Seed → Sack, Sack → Gamete, Gamete → Spat); and 5) introduction of Reproduction Efficiency Factors (REF's) to more accurately calculate the proportion of oyster biomass which can be dedicated to gamete production based on the nutritional status of the oyster which is relative to seasonal and environmental forcing.

To illustrate the simplicity and utility of using "combined-effect" HSI output, a hindcast simulation was performed for the Henderson/Pass Marianne oyster reefs in the Mississippi Sound, using 2009 historical data. Baseline simulations were conducted with actual temperature (T) and salinity (S) measures measured daily at USGS Merrill Shell station (301429089145600), and again using salinity measures reduced by 50% to represent chronic freshwater intrusions to illustrate the modeled impacts on oyster production, and the ease to which such scenarios could be tested in model-space (Figure 62).

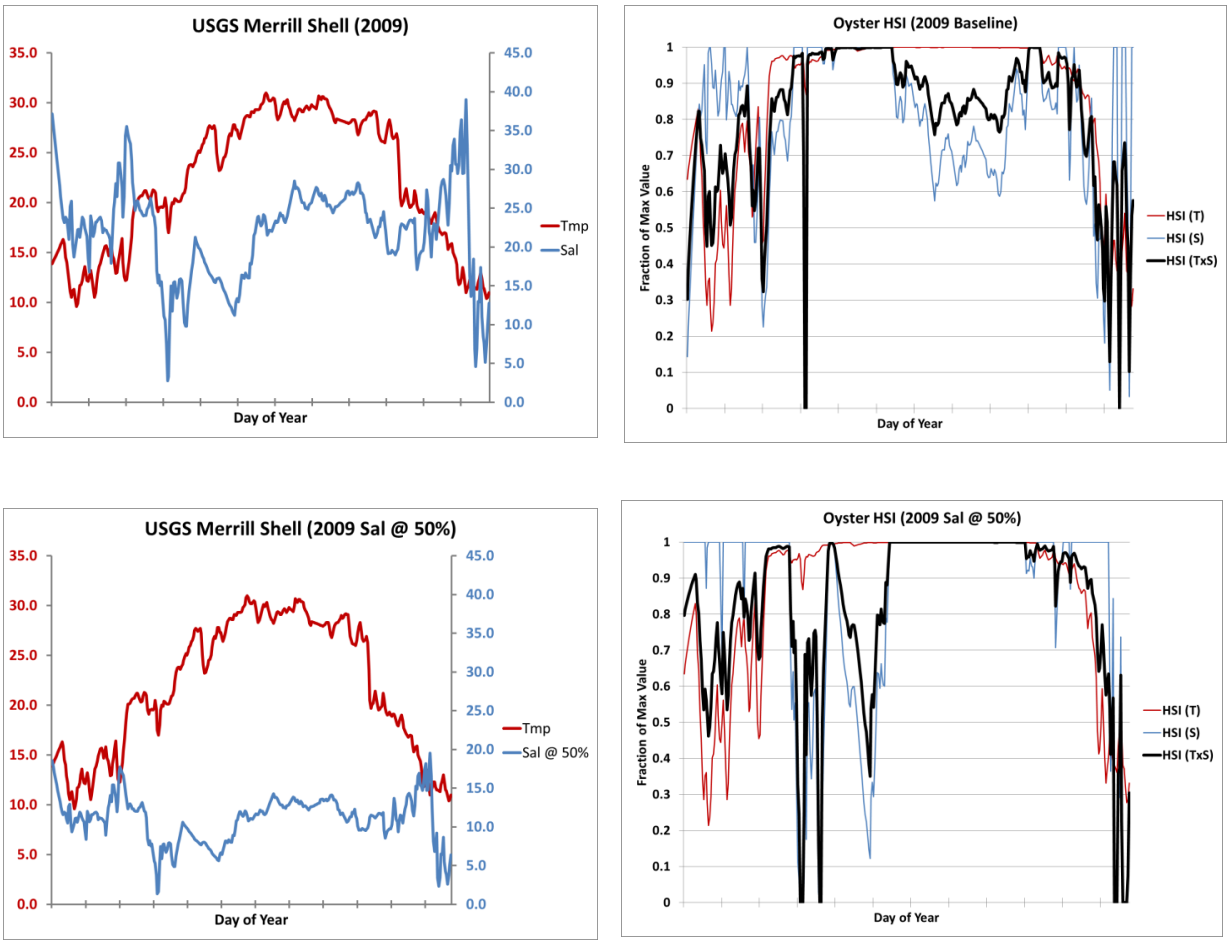

Figure 61 Daily measures of water temperature (Tmp) and salinity (Sal) in 2009, USGS Station 301429089145600 at Merrill Shell (top left). Baseline TroSim results indicate calculated HSI values for Sack Oyster response to temperature (HSI-T, in red), salinity (HSI-S, in blue), and the combined effect of temperature & salinity (HSI-TxS, in black), where a value of 1.0 indicates ideal conditions and a value of 0.0 indicates the lower limit of survivability (top right). When the model was run with daily salinity values reduced by 50% (lower left), the modeled response of Sack Oyster is easily apparent in the resultant HSI calculations (lower right).

MDEQ has supplied an existing EFDC/WASP model that was developed for the Bay St Louis and surrounding oyster reefs. This model has been calibrated, validated, and refined over the past 10 years (Camacho and Martin, 2012; Camacho *et al.*, 2014; Liu *et al.*, 2008).
The most recent version of the Bay St Louis EFDC/WASP model is calibrated to 2011 data (Camacho et al. 2014). The calibration of this model used field collected measurements from 52 sites of N, P, chl *a*, CBOD, DO, and TSS collected over a year. Overall, the model performs very satisfactorily with most water quality parameters having small root mean square errors, absolute percentage biases below 10, and index of agreements above 0.6. Specifically, for salinity the average root mean square error was 2.3 ppt and the index of agreement was 0.93. We have access to this model and grid (Figure 63) and are currently running the model for the Bay St. Louis area.

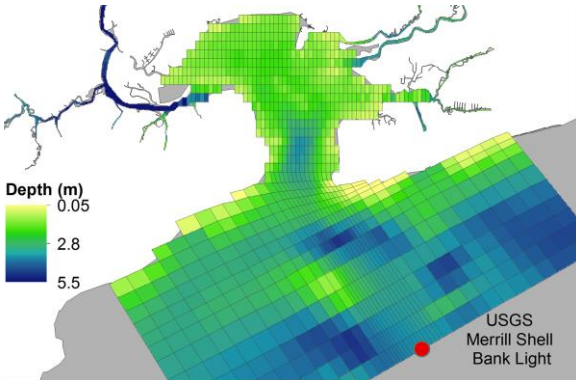

Figure 62 Bay St. Louis EFDC grid. Taken directly from Camacho et al. (2014).

The most appropriate valuation method depends upon the service to be valued and identified needs. If, for examples, two services need to be compared to determine the importance of one versus the other, there may be no need to express the value in monetary terms, as long as an alternative common unit is defined (e.g. biomass). However, expressing the value using monetary terms makes it easy for people to compare services not only amongst each other, but to other commodities. Due to the limited time and resources available for this project no original valuation study can be carried out to determine the willingness to pay for passive use services (e.g., water quality and aesthetics and existence). Instead, value transfer methods can be used as substitutes. Value transfer (VT), sometimes referred to as benefit transfer, is a common practice in economics that involves the use of existing data in a different setting other than that for which it was collected. The goal of VT is to estimate the benefits of one study area by adapting an estimate or benefit from another study. The original site is usually called the study site and the location for which information is needed is called the policy site. There are two ways of conducting VT: one involves transferring final economic values (unit transfer) and the other involves transferring functions (function transfer). Transferring functions performs better than transferring final values alone as these functions provide (1) a chance to control for differences brought by various valuations methods used in the primary studies; and (2) the ability to set the variables specific to the policy site allowing for better accountability of the differences between the study and the policy site. Function transfers can utilize demand functions from a specific study or meta-analysis, in which the outcomes of multiple studies are summarized and applied to a policy site. The meta-analytic approach is preferred because by using the estimates from multiple studies the derived function is more comprehensive (it provides a more rigorous measure of central tendency of values) and potentially more representative of the policy site's true value. However, its performance depends upon the number of existing available studies at the time of analysis. If limited studies are accessible, final value transfer may be the only option.

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? N/A
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
Preliminary 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 plan the workshop.

Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology

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NGI File #15-NGI2-124: 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

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

During the time period from July 1, 2015 to June 30, 2016, biases of AHI infrared channels from Himawari-8 are estimated using two radiative transfer models that are most popularly used for GOES-R data assimilation. Japanese geostational meteorological satellite Himawari-8 carries a state-of-the-art optical sensor called the Advanced Himawari Imager (AHI), providing sixteen spectral channels in geostationary orbit for the first time. This new feature of AHI is combined with its high spatial resolutions of 0.5, 1 and 2 km for three visible, four near-infrared and nine infrared channels, respectively, as well as short revisit times of around 10 minutes for full disk and 2.5 minutes for sectored regions. Applications of AHI data for improved numerical weather prediction through clear-sky radiance assimilation and for deriving quantitative products (e.g. atmospheric motion vector, cloud mask, cloud top pressure etc.) of rapidly changing weather phenomena require that the AHI data biases be properly estimated. In this study, bias characteristics of AHI brightness temperatures between observations (O) and model simulations (B) for the nine infrared AHI channels are compared between two most commonly used radiative transfer models: CRTM and RTTOV. The same European Center for Medium range Weather Forecasting (ECMWF) analysis is used as the input to both CRTM and RTTOV for representing the model atmospheric state. It is shown that AHI O-B biases calculated by CRTM and RTTOV are consistent and small (<? K) over ocean but not over land. By changing CRTM to use the same land IR surface emissivity database as RTTOV, CRTM simulated biases and standard deviations are the same as those of RTTOV over land. A journal article on this research was completed and submitted in spring 2016 (see publication list).

Another study conducted during the reporting period was testing a modified infrared-only cloud detection algorithm applicable for AHI radiance assimilation. Cloud detection is an important procedure for the geostationary imager radiance assimilation. The cloud mask (CM) algorithm for identifying cloud-contaminated pixels in imager infrared radiance assimilation should not involve any visible or near-infrared channels. In this study, an infrared-only CM algorithm is developed and tested for the Advanced Himawari Imager (AHI) radiance observations. It consists of a new CM test for optically thin clouds, two modified Advanced Baseline Imager (ABI) CM tests and seven other ABI CM tests. The ten CM tests are used to generate a composite CM for AHI data. A validation with the Moderate Resolution Imaging Spectroradiometer (MODIS) CMs with 12-day data on September 22-24 and December 15-17

2015 as well as March 20-22 and June 5-7, 2016 shows that the new infrared only CM algorithm achieves a lower false alarm rate and a higher Probability of Correct Typing (PCT) than the Clouds from the AVHRR Extended System (CLAVR-x) technique over ocean. However, the new algorithm has a relatively high leakage rate (LR) of 7.54% over land during daytime in the presence of low stratus clouds. During nighttime, the LR of the new CM algorithm over land is as low as 3.45%. The PCT of the new CM algorithm over land is as high as 92.84%. A journal article on this research was completed and submitted in spring 2016 (see publication list).

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

Information on collaborators / partners: None reported

Information on any outreach activities:
Hosted speakers, workshops and/or any training: Yes
Type: Speaker
Name of event: (1) The 96th Annual Meeting of American Meteorology Society (AMS); (2) The Sixth Asia/Oceania Meteorological Satellite Users' Conference (AOMSUC-6)
Date: (1) January 11-14, 2016; and (2) November 9-13, 2016
Location: New Orleans, LA
Description: (1) An oral presentation entitled "Assimilation of AHI Infrared Radiance Measurements for Improved Tropical Cyclone Forecasts Using HWRF" was given at the AMS 12th Annual Symposium on New Generation Operational Environmental Satellite Systems. The paper number was: J9.1. (2) An oral presentation entitled "Assimilation of AHI GOES Infrared Radiance Measurements for Improved Tropical Cyclone Forecasts Using HWRF" was given at AOMSUC-6.Approximate Number of Participants: None reported

Related NOAA Strategic Goals: Weather-Ready Nation

Related NOAA Enterprise Objectives: Science and Technology

NGI File #15-NGI2-125: 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

Co-PI(s) name, affiliation, email address: Russ Beard, NCEI, russ.beard@noaa.gov

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

Project objectives and goals
The goal of this project is to provide secure storage for NOAA/NMFS preserved specimens.

Description of research conducted during the reporting period and milestones accomplished and/or completed
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 (1) enhance and support integration of regional ecosystem data management into the EDAC via NOAA's National Centers for Environmental Information (NCEI); (2) continue NOAA's affiliation with DISL to meet NOAA data management goals; (3) continue creation and publication of place-based metadata and associated summary data sets as DISL's contribution to this assimilative effort with NOAA; (4) continue testing and integrating automated end-to-end data management (sensor to archive) techniques (this year we will update our approach to meet NOAA's new standards); and (5) 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

1. Six new metadata records published;
2. Twenty metadata records in progress;
3. Nine new datasets submitted to NOAA NCEI Ocean Archive System; and
4. Four dataset major revisions submitted to NOAA NCEI Ocean Archive System.

Description of significant results, protocols developed, and research transitions

The data management program at DISL, consisting of a formal Data Management Center, Senior Data Manager, Data Management Specialist, and Data Management Committee, has been extremely successful at incorporating metadata creation, data archiving, and overall data management into the regular process of research at DISL. We had two major categories of accomplishments during the time

period covered by this report: (1) transition continued from use of the FGDC CSDGM metadata standard to ISO 19115-2, to follow the transition in metadata standard of all U.S. federal agencies; and (2) the Data Management Center is in the process of migrating metadata records from MERMAid in advance of its scheduled discontinuation in September 2016.

Participation by the data management specialist in NSF's EarthCube OntoSoft Geoscience Papers of the Future (GPF) Initiative.

Information on collaborators / partners:
Name of collaborating organization: EarthCube OntoSoft Geoscience Papers of the Future Initiative http://www.ontosoft.org/gpf
Date collaboration established: 16 May 2013
Does partner provide monetary support to project? Amount of support? Partner provides funding for travel to meetings related to GPF planning and outreach.
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. The data management specialist (Mimi Tzeng) is a regular co-instructor for the GPF Training Workshops (slides are available at https://figshare.com/articles/The_Geoscience_Paper_of_the_Future_OntoSoft_Training/1586773).

Information on any outreach activities:

1. Annual Metadata Training Workshop at DISL on March 30, 2016 with Kathy Martinolich of NCEI. We focused on the ISO 19115-2 metadata standard in detail. We also presented introductory concepts on software documentation and the OntoSoft portal and offered information about GPFs. There were 12 students, interns and research staff in attendance.
2. Introduction to Metadata Session for DISL REU Summer Interns on June 30, 2016 with Kathy Martinolich of NCEI. There were 9 attendees (8 REU interns and one staff from MBNEP).
3. DISL Data Management Newsletter distributed quarterly by email.
4. Mimi Tzeng was a co-instructor for the GPF Training Workshop webinar on September 16, 2015.
5. Mimi Tzeng attended the Geological Society of America (GSA) Annual Meeting and Exposition on November 1-4, 2015 in Baltimore, Maryland as a co-instructor for the GPF Training Workshop that took place on November 2 with approximately 6 attendees.
6. Mimi Tzeng attended the American Geophysical Union (AGU) Fall Meeting on December 14-18, 2015, in San Francisco, California:
    a. co-convener for the session "Informatics and Intelligent Systems in Reproducible Geoscience Research" (IN43D, IN44A, IN53B)
    b. co-instructor for the workshop "Geoscience Paper of the Future Training Session: Learning Best Practices for Scholarly Publication" that took place December 17 with approximately 8 attendees
    c. presenter of the poster "Data Processing for a Small-Scale Long-Term Coastal Ocean Observing System near Mobile Bay, Alabama" (IN53B-1835). Co-authors were Brian Dzwonkowski and Kyeong Park.

Related NOAA Strategic Goals: Resilient Coastal Communities and Economies

Related NOAA Enterprise Objectives: Science and Technology

NGI File #15-NGI2-126: Northern Gulf Institute Diversity Internship Program

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

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

Project objectives and goals
The primary objective of the NOAA-NGI Diversity Internship Program is to support work experiences for 6 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://www.disl.org/ngi_internship). Mentors are selected based in part on matching mentor projects to student interests as well as 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 2015 NOAA-NGI Diversity Internship Program supported 6 interns at 6 academic and federal agency laboratories across the Gulf of Mexico coast in summer 2015 (Table 7). Interns were from 4 demographic groups underrepresented in NOAA's workforce (African-American, Asian, Hispanic/Latino, American Indian) and included 5 undergraduate students and one M.S. candidate. Students were mentored by 6 different individuals, half of whom had not mentored students in this program before. There were 89 applicants for the internship positions, however, approximately half of these did not meet the criterion of being from an underrepresented population.

Figure 63 2015 NOAA-NGI Diversity Internship Program Interns

NOAA-NGI Diversity Internship Program
Interns - 2015

	First Name	Last Name	Current Institution	Intern email address	Home	Education level	Internship Location	Mentor
1	Andres	Gonzalez	St Mary's University (TX)	agonzalez104@mail.stmarytx.edu	Arizona	Undergraduate	HARTE Research Institute, Corpus Christi, TX	Paul Montagna
2	Katie	Homa	Columbia University (NY)	keh2172@columbia.edu	New Mexico	Undergraduate	Gulf Coast Research Lab, Ocean Springs, MS	Frank Hernandez
3	Courtlyn	Robinson	University of Alabama - Birmingham	cgerobinson@icloud.com	Alabama	Undergraduate	Dauphin Island Sea Lab, Dauphin Island, AL	Alison Robertson
4	Sarah	Stockton-TeKeste	Duke University (NC)	sarah.stockton.tekeste@duke.edu	North Carolina	Graduate (MS)	NOAA Fisheries Lab - Pascagoula, MS	Andre Debose
5	Gabrielle	Tran	Mississippi State University	gt223@msstate.edu	Mississippi	Undergraduate	Mississippi State University, Starkville, MS	John Ramirez-Avila
6	José	Velasquez	University of South Florida	jmvelasquez@mail.usf.edu	Florida	Undergraduate	Water Institute of the Gulf, Baton Rouge, LA	Tim Carruthers

Table 7 2015 NOAA-NGI Diversity Interniship participants, mentors, and intership location

The program began with an orientation session at the Dauphin Island Sea Lab on June 1-2, 2015. The session provided interns with an introduction to NOAA, NGI and a discussion of program obligations and opportunities as well as a hands-on introduction to the northern Gulf of Mexico. We were fortunate to have Russ Beard, NOAA NCEI; Julie Bosch, NOAA-NCEI; Steve Ashby, NGI Co-Director; and Mr. Eli Salahuddin, NOAA-NESDIS EEO join us for the orientation session at DISL. During this time, the interns received training in data management and metadata given by Kathy Martinolich and Jaci Mize, NOAA-NCEI. Interns were introduced to some aspects of the northern Gulf of Mexico through a boat trip to Mobile Bay aboard DISL's research vessel Interns completed a pre-program assessment (results given below).

Figure 64 Intern orientation session at Dauphin Island Sea Lab June 1-2, 2015

In contrast to previous years, most of the intern projects were rooted in ecology. Projects included impacts of freshwater inflow on mobile benthic fauna, PCBs in American Alligators, submerged aquatic vegetation associated infauna, larval fish morphology, and a comparative analysis of visual imagery vs catch rates for fish trawls. One intern conducted a methodological comparison of water quality techniques, and analysis of historical water flows.

Contact was maintained with the interns during the 10 weeks of the program using emails, an occasional phone call and a Facebook page. Interns were also provided a document with guidelines for a successful presentation approximately half-way through the program. The day before the Summit, interns gave their presentations to each other and received input from the other interns, the program coordinator and the PI.

An Internship Summit was held on August 4, 2015 in the NOAA-NGI building at Stennis. During the morning, interns participated in a NOAA Career Roundtable. Several NOAA employees gave of their time and discussed career paths and choices, pros and cons of the various positions in STEM fields, and strategies for seeking employment in NOAA and other federal agencies. This Roundtable was facilitated by Steve Ashby, Co-Director, NGI. NOAA participants included Russ Beard, Amy Clark, Sharon Mesick, Andre Debose, and Kristin Ransom. In the afternoon, interns gave a short (15-20 min) presentation on their work to an audience of mentors, mentor team members, NGI staff and NOAA employees. Interns were asked to include reflections on the value of the program. Electronic copies of the presentations at the NOAA-NGI Internship Summit (which include pictures and other graphics) have also been submitted to the NGI Program Office and are available for viewing on the NGI website. After the Summit, NOAA-NGI Interns returned to the Dauphin Island Sea Lab to complete program evaluations (results given below).

Figure 65 Internship Summit at the Stennis NOAA-NGI building, August 4, 2015.

Description of significant results, protocols developed, and research transitions
Given the educational nature of this grant, there are no research results, protocols developed or research transitions. Interns completed a pre and post-program and evaluation. These documents consisted of a series of questions that assessed the interns in 5 major categories – organizational awareness (NOAA, NGI), presentation skills, research skills, data skills, and Gulf of Mexico literacy. Using a Likert scale, students were asked their relative degree of agreement with statements in each category. At the completion of their internship, students were asked to answer the same questions as well as a series of free response questions that investigated the degree of mentoring they received (and asked for), the value of specific activities (Summit), and the impacts the program may have had on their career plans. Additionally, they were asked to rate their overall experience and to make recommendations for future years.

To reiterate, the goals of the program included (1) organizational awareness of NOAA, NOAA entities, and their missions; (2) awareness of NGI and DISL; (3) awareness of career opportunities within NOAA; (4) recognition of role and importance of data and data management in NOAA fields; (5) metadata familiarity – what is it, why do we need it, how to access it, how to interpret it, how to write it; (6) development of research skills – accessing info, field/lab skills, info organizational skills, data analysis skills, technical writing skills; (7) oral presentation skills; (8) Gulf of Mexico literacy; and (9) networking.

Summarizing the 6 responses, the major changes seen comparing pre and post-assessments were an increase in understanding of NOAA's mission, its goals, structure, and career opportunities; knowledge of and keeping up to date with news about the Gulf of Mexico; and time spent investigating careers. Interestingly, and in contrast to previous years, this group reported less comfort with data skills (data analysis, visual presentation of data, database use) after the internship than seen in prior years. Perhaps this year's projects demonstrated some of the complexities of working with data gathered from fieldwork and the myriad ways to approach data analysis.

In evaluating their experience with the program, using a scale of 1 to 5 (with 5 being the highest), two interns rated the experience a 5, two a 4 and two a 2. These rankings are lower than the program has had in years past. One low ranking can be attributed to the prolonged absences of the mentor. The other low ranking is most likely caused by a difference in work ethic expectations. Interns were asked how the program impacted their career goals: answers included solidifying their goals, redefining their directions (to another STEM field), recognizing their personal limitations ("I do not have a very strong background in working in a laboratory, so if I pursue this career, I would have to step up with my lab skills"), and helping with networking. When asked how the internship impacted what they would do back on campus, answers included looking for additional internships, an increased focus on policy, taking additional statistics classes, and asking professors for additional research opportunities.

Information on collaborators / partners:
Name of collaborating organization: (1) NOAA-NCEI, (2) NGI
Date collaboration established: (1) January 2013; and (2) January 2013
Does partner provide monetary support to project? Amount of support? (1) Yes, $60,467, (2) No
Short description of collaboration/partnership relationship:

1. The NOAA NCEI office supported these internships through the grant award. They also provided personnel for metadata training, assistance in advertising, and facilitation of the Internship Summit.
2. NGI supported these internships with administrative resources (e.g. hosting the Summit, advertising the program, presentations on the webpage).

Information on any outreach activities:
Type: training
Name of event: An introduction to metadata (Kathy Martinolich, Jaci Mize NCEI)
Date: June 1, 2015
Location: Dauphin Island Sea Lab
Description: An introduction to metadata –what is it, why do we have it, where is it, and how do you access it.
Approximate Number of Participants: 10

Type: educational field trip and short workshop
Name of event: Research vessel trip – Mobile Bay, coastal Gulf of Mexico
Date: June 1, 2015
Location: Dauphin Island Sea Lab
Description: A field trip to Mobile Bay and the coastal ocean to measure water quality, to sample nekton, plankton, benthos, to learn how common sampling gear are deployed and to discuss estuarine ecosystems and the Gulf of Mexico.
Approximate Number of Participants: 8

Type: speakers
Name of event: NOAA Career Roundtable 5
Date: August 4, 2015
Location: Stennis Space Center
Description: A discussion of experiences, opportunities and career advice among NOAA personnel and interns.
Approximate Number of Participants: 14

Type: speakers
Name of event: Internship Summit
Date: August 4, 2015

Location: Stennis Space Center
Description: Presentations by interns to mentors, NOAA personnel and other NGI staff
Approximate Number of Participants: approx. 25

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-NGI2-127: 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 Howden, University of Southern Mississippi, Stephan.howden@usm.edu

Co-PI(s) name, affiliation, email address: Steven Lohrenz, University of Massachusetts at Dartmouth, Steven.Lohrenz@usm.edu; Jeff Book, Naval Research Laboratory at Stennis Space Center, jeff.book@nrlssc.navy.mil; and Richard Jenkins, Saildrone, richard.jenkins@mac.com

NOAA sponsor and NOAA office of primary technical contact: Chris Sabine, AOML

Project objectives and goals

There are six operational objectives for this project and two related main hypotheses to be addressed. The operational objectives are focused on demonstrating new technologies that can be used to monitor carbon and nutrient fluxes and transformations in the Gulf of Mexico.

The objectives are:

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

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

3. Demonstrating the effectiveness of the NOAA/PMEL MAPCO2/DIC system on a mooring (hereinafter referred to as the DIC mooring) at the continental slope of the northern Gulf;

4. Demonstrating the feasibility of operating the Saildrone in the northern Gulf of Mexico within a high amount of maritime activity, including commercial and recreational fishing, shipping, and oil and gas platforms and associated servicing vessels;

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

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.

The two hypotheses are:

1. Cross-shelf flows driven by mesoscale eddies at the continental slope are significant sources of DIN, DIC and DOC to the open Gulf of Mexico; and
2. Dissolved oxygen on the shelf in the northern Gulf is impacted by upwelling of low dissolved oxygen waters from the deep Gulf associated with eddy driven flows.

Description of research conducted during the reporting period and milestones accomplished and/or completed
Reporting Period: July 1, 2015—June 30, 2016

Cruises
R/V Pt Sur for cruise (cruise ID: PS16_18) to deploy two PMEL moorings at the shelf break south of Mississippi for the Shelf-Slope project, 4-5 August, 2015.

R/V Pt Sur cruise (piggyback) to repair DIC system. (September 14-19, 2015). Vernon Asper Chief Scientist. John Shanley (engineer PMEL) and Andrea Fassbender (postdoc PMEL)

R/V Pelican for CONCORDE cruise (November 1-7, 2015). A PMEL engineer and scientist joined to science team in order to replace the PRAWLER system on PMEL mooring M1. The buoy was successfully brought on board and the system repaired. The project paid for one of the ship days.
R/V Pt Sur (cruise ID: PS_16_05) for cruise to recover the two PMEL moorings at the shelf break south of Mississippi for the Shelf-Slope project.

Mooring Deployments
Mooring M2 was deployed on August 4, 2015 from the R/V Pt Sur at 29o 06.422'N, 088o 17.032'W in 475 m of water (Figure 67). After leaving the mooring location and arriving at the location for mooring M1, Howden was informed that the DIC mooring was not getting water to the DIC system. The possibilities were that (1) the pump was not primed; (2) the pump was clogged by a filter that turned to goo from the heat; or (3) a bad pump. Possibility 1 could right itself over time. Possibility 2 was suggested because the DIC system had never been in the intense heat that was experienced while the buoy was on the dock in Gulfport, and on the deck of the ship prior to deployment. A discussion was had about going back to the buoy to try and fix the problem, but after a sat-phone discussion with engineers at PMEL it was decided that due to logistical constraints we would not recover the buoy. Instead, it was decided reluctantly that the best course of action was to go to CenGOOS buoy and hope that the pump primes itself.

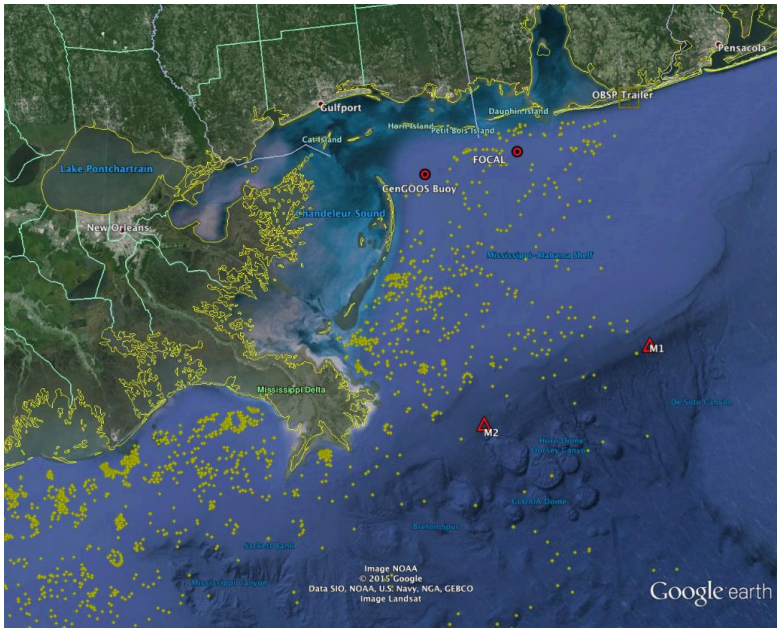

Figure 66 Study region. M1 and M2 are the PMEL mooring locations on the 500 m isobath. The USM CenGOOS buoy is on the 20 m isobath. The yellow marks are oil and gas platforms from a shapefile downloaded from the Bureau of Ocean Energy Management.

Mooring M1 was deployed on August 4, 2015 from the R/V Pt Sur at 29o 15.193'N, 087o 43.119'W in 490 m of water (Figure 67).

Mooring Operations

The DIC system on mooring M2 did not reprime itself, so in September the project piggybacked on a cruise on the R/V Pt Sur to fix the system. An engineer and postdoc from PMEL came on the cruise to repair the system. Because the buoy needed to be brought onboard to repair the DIC system, and the mooring does not have a large watch circle, a flotation sphere was brought to attach to the mooring and keep it in place after removing the surface buoy. The DIC buoy was recovered on September 16, 2015.

Two days later, and after repairs had been made, the DIC buoy was reattached to the mooring (September 18, 2105). Figure 68 shows a time series of DIC from the buoy that starts on September 18, 2015. The acid supply for the DIC system ran out prematurely in late January 2016. The SAMI pH sensor also developed problems during the mission as evident from the time series.

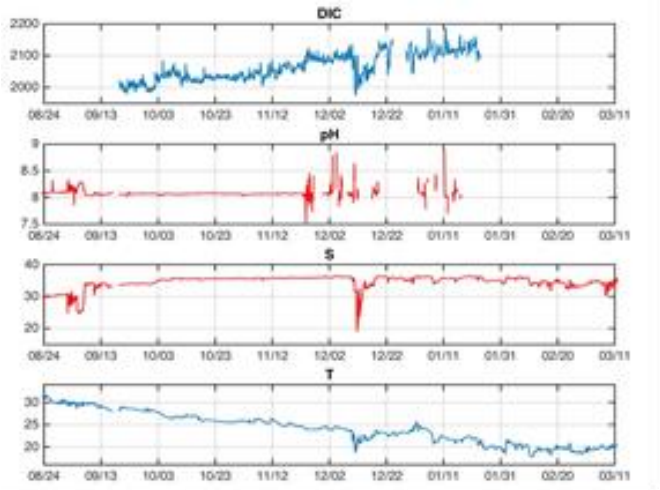

Figure 67 Time series from mooring M2. Top panel is dissolved inorganic carbon ((Mol /kg), second panel from the top is pH, third panel from the top is salinity (pss) and bottom panel is (°C).

The PRAWLER on mooring M1 stopped ascending and descending in October 2015. Fortunately, a spare PRAWLER was built for the project and a cruise on the R/V Pt Pelican was piggybacked on to swap out the new package for the defective one. On November 6, 2015 the PMEL mooring was pulled on deck of the R/V Pelican and the systems swapped out. Figures 69 and 70 show a portion of the temperature and salinity data from the PRAWLER, with a gap from mid-October to mid-November.

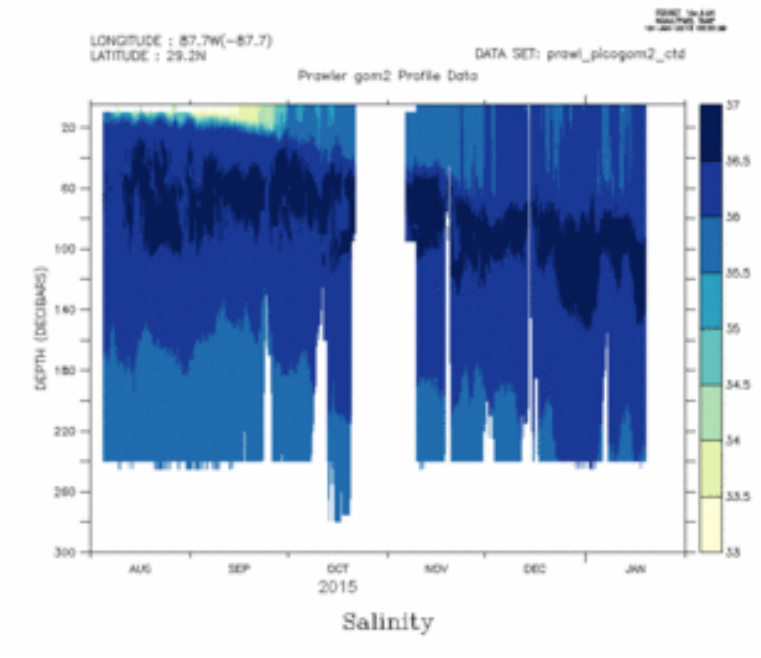

Figure 68 Portion of the salinity record from the PRAWLER.

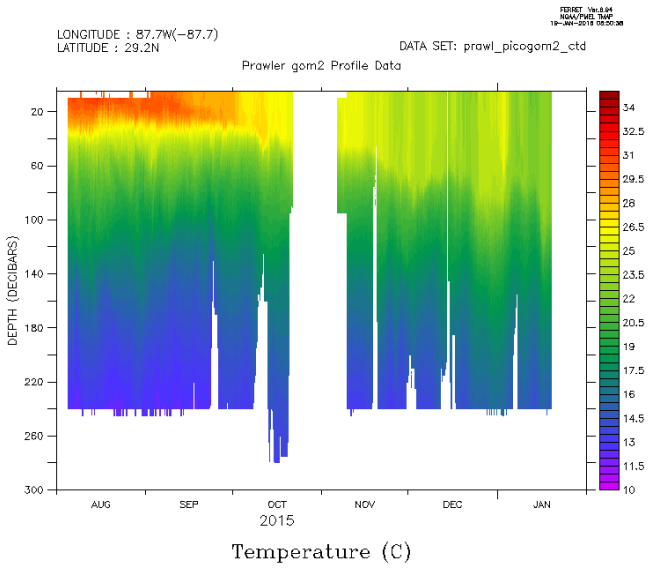

Figure 69 Portion of the temperature record from the PRAWLE

Remote Sensing Planning/Preparation

Figure 71 shows an example of pCO2 derived from VIIRs imagery by Dr. Lohrenz of UMASS-D. In this December image the pCO2 is low in coastal waters compared with offshore waters. These data will be analyzed along with the *in situ* data to give a broader context to those observations.

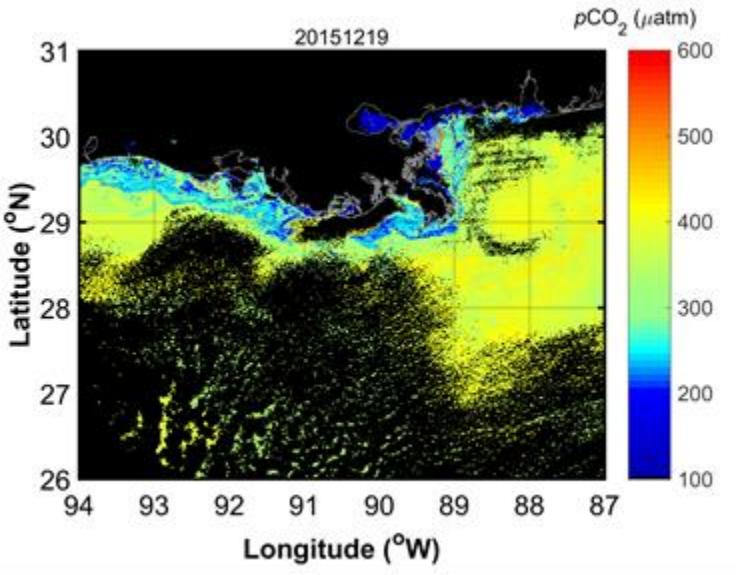

Figure 70 VIIRS derived pCO2 data from December 2015 showing low pCO2 around the Mississippi River Delta.

Saildrone and Gliders

Two Saildrones were launched on 9/24/15. One did not charge and was recovered for repair. After repair it was relaunched, but crashed into an oil rig. The second Saildrone operated for a total of 118 days and its track is shown in Figure 72. It was recovered in February, 2016.

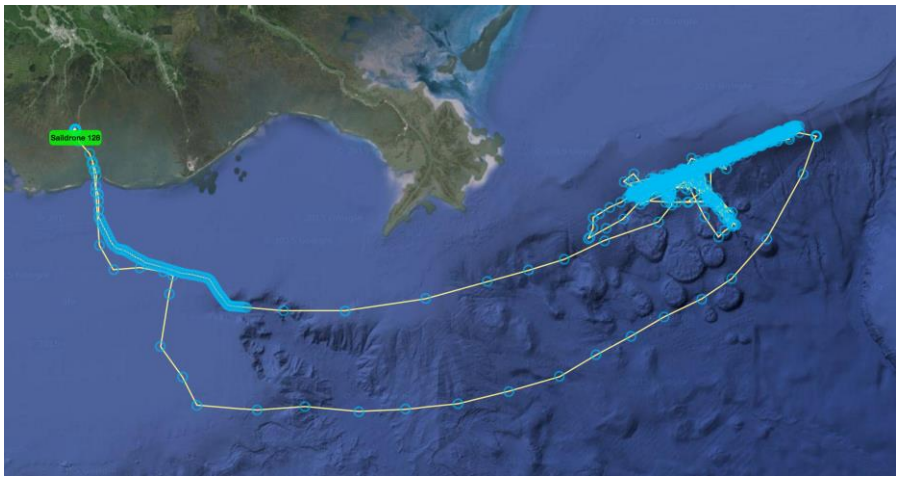

Figure 71. Saildrone SD128 , mission track over 118 days in the Gulf of Mexico.

An NRL Slocum was launched several times, but each time there was a failure and it had to be recovered. The longest deployment was for about a week. Figure 73 shows data from the USM Slocum glider.

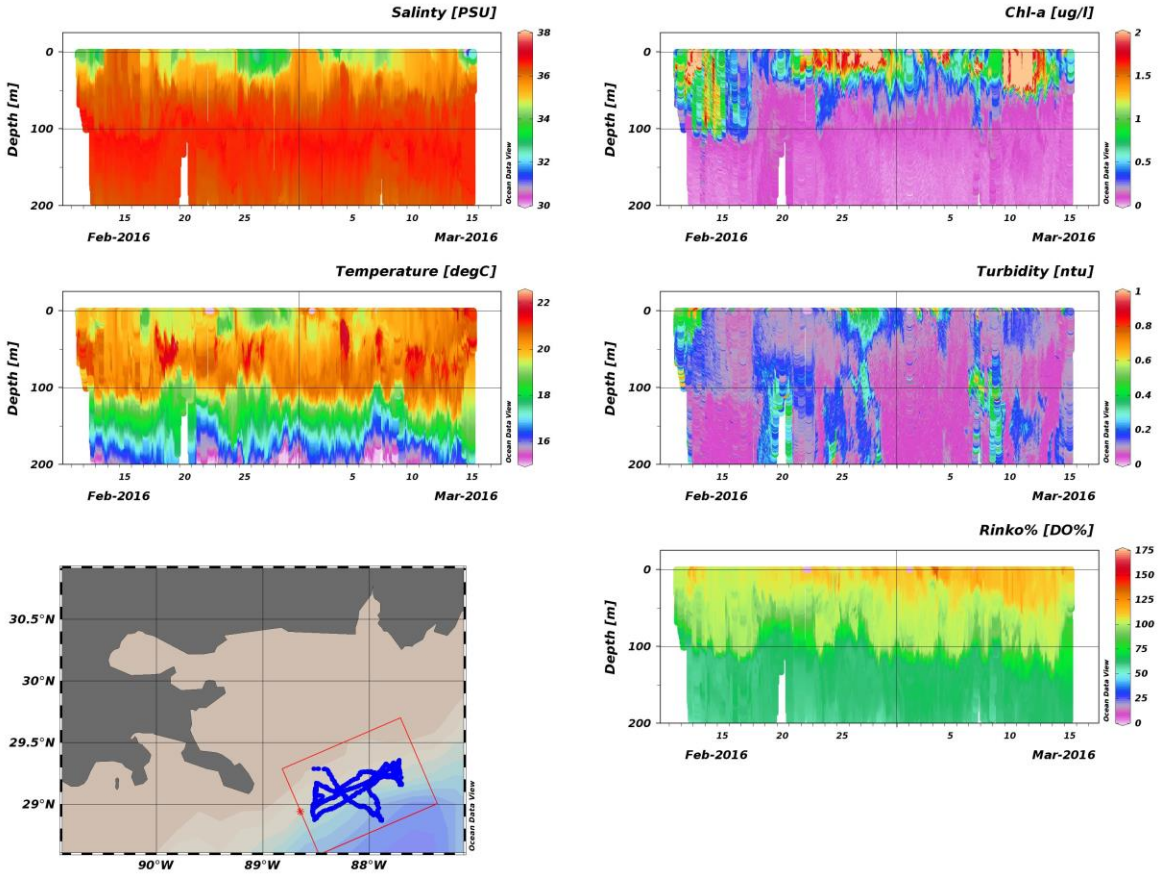

Figure 72 USM glider mission.

Description of significant research results, protocols developed, and research transitions
Despite the many problems with instruments and platforms, a large amount of data was collected. Much was also learned about operations of the new technologies in the northern Gulf of Mexico, which has some unique challenges.

Information on collaborators / partners (if applicable):
Name of Collaborating Organization: Chris Meignin, NOAA Pacific Environmental Laboratory, Christian.Meinig@noaa.gov
Date collaborating established: 2014
Does partner provide monetary support to project? No Amount of support? N/A
Does partner provide non-monetary (in-kind) support? Yes
Short description of collaboration/partnership relationship:
A significant portion of this project consists of a technology demonstration for the northern Gulf. USM and NRL are working with PMEL to demonstrate that the mooring systems and Saildrones are viable in the unique conditions found in the northern Gulf. PMEL, in turn, through the technology provided are helping USM. UMASS-D and NRL answer the science questions.

Information on any outreach activities: None reported

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

Related NOAA Enterprise Objectives: Science and Technology

NGI File #15-NGI2-128: 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:

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

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.

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

Public Perception Data Collection

The Center for Advanced Public Safety social science research team under the direction of Myers will develop and administer an online survey, in-person survey, focus groups, and interview protocol to obtain decision-making information from the public impacted in real-time severe weather events. The social science research team will work with the Teams 1 and 2 to develop questions consistent with prior severe weather public perception studies as well as the goals of the study.

The survey was developed in conjunction with the other teams (LaDue and Friedman) in the project and was implemented late spring, as the spring 2016 severe weather season was ending. The online survey protocol is still being implemented and as up today, there are over

220 completed surveys. Focus groups and interview protocols are currently underway in the region and will be completed by August 31.

Weather Enterprise Network Contacts
All three PIs have positive relationships with National Weather Service and emergency managers and will use these to gain access to those in the southeast. More specifically, Myers and her research team have strong, existing weather enterprise network contacts from the CWA for all three parts of the project.

Myers provided the contacts for the relationships needed between all of these groups and the project PIs. All of the regional emergency manager contact information was mapped and provided to Dr. LaDue for the emergency manager portion of the study. Myers has provided data from her previous research in the region to serve as a baseline of information and to provide the context of this region to use in the collection and analysis of data for this project.

Description of significant results, protocols developed, and research transitions

- Developed qualitative analysis of spring severe weather season to determine events and non-events to provide context for public perception research protocols.
- This analysis revealed the public perception study would need to focus more on non-events and on the warning process than on actual events. There were no significant actual events during the season that impacted more than a few people.
- The online survey preliminary analysis has generated several critical findings in regard to Dixie Alley tornado warning processes, including
    - Very consistent knowledge of the warning process with actual events.
    - An increase in use of cell phone alert messaging with a decline in the use of other modalities such as NOAA Weather Radio, sirens, and television.
    - The need for proximity indicators in the warning process.
    - A need for more information in severe thunderstorm warnings.
    - The need for all clear indicators from warnings.
    - Actions taken are consistent with calls to action.
    - Very few people feel they have not been warned properly.

Information on collaborators / partners:
Daphne LaDue and Jack Freeman, University of Oklahoma

Information on any outreach activities:
Interviews for local media on the VORTEX-SE research project in general and the public opinion/social science part in particular.

Related NOAA Strategic Goals: Weather-Ready Nation

Related NOAA Enterprise Objectives: Science and Technology

NGI File #15-NGI2-129: 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, NOAA/NOS/NCCOS

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
Bathymetric and topographic data sets for the Hampton Roads region and along the coast from Chesapeake Bay to the Delaware Bay inlet have been acquired. In addition we have acquired both the ADCIRC meshes that were used for Flood Insurance Studies in the region and the USACE model that was used in a preliminary sea level rise analysis.

Coasts and tidal creek shorelines have been digitized and an examination of the resolution of the USACE mesh has been completed in order to define additional refinements. Refinement of the USACE mesh in the region will include tidal creeks and a higher resolution of the intertidal zones, as well as the urban areas, is well underway.

Initial model testing has begun and an assessment of the effectiveness by the intertidal zone and marshes to attenuate storm surge is presently being conducted.

Description of significant results, protocols developed, and research transitions
A unique means of specifying mesh density based on the medial axis has been developed. This important breakthrough enables semi-automation of the unstructured mesh generation and increased flexibility in our range of feature descriptions. A publication will be forthcoming.

Information on collaborators / partners:
Hagen and Kidwell held monthly phone calls.

Kidwell visited LSU on April 28-29, 2016.

Information on any outreach activities:

On March 24, 2016 Hagen met with and discussed the research project with the US Army Corps of Engineers at the Coastal Hydraulics Laboratory in Vicksburg, MS.

The LSU team was invited and participated in the Great Marsh Resiliency Model Workshop, held at the Parker River National Wildlife Refuge on April 11, 2016. 56 participants from universities, federal and state agencies, NPOs, and local municipalities attended.

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-NGI2-130: 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

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

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

Project objectives and goals

The Hydrographic Science Research Center (HSRC) at The University of Southern Mississippi has a well-established expertise in collection and processing of hydrographic data for the compilation of nautical charts. Additionally, through its partnership with Teledyne Optech in the development of the Coastal Zone Mapping and Imaging LIDAR (CZMIL), the HSRC has a long term association with Airborne LIDAR Bathymetry (ALB) systems for the collection of bathymetric and imagery data. ALB has gained wide acceptance as a source of coastal intelligence on which to base decisions regarding coastal resiliency, coastal zone management, and shoreline delimitation. Substantial amounts of ALB have been collected through the U.S. Army Corps of Engineers' National Coastal Mapping Program (NCMP) in support of its sediment management responsibilities. The Coastal and Marine Geology Program of the U.S. Geological Survey has produced extensive data sets to support coastal zone management while NOAA's National Geodetic Survey routinely uses Airborne LIDAR for shoreline delimitation. Additionally, coastal states (e.g. California) are commissioning ALB surveys of their coasts to affect their own coastal zone management decisions. With a view towards ensuring these data can be used for multiple applications, the Interagency Working Group on Integrated Ocean and Coastal Mapping has established minimum standards to which government funded data collection should adhere.

However, NOAA's Office of Coast Survey uses ALB data infrequently as the sole source of bathymetry for navigational charting. Several factors have contributed to this infrequency. The strict management of the uncertainty associated with the measurement of the water depth, horizontal position and vertical position derived from an ALB survey continue to improve and, in general, support International Hydrographic Organization (IHO) order 1b standards. Full bottom coverage and object detection requirements remain a theoretical obstacle.

Given that the large expanse of the U.S. coastal waters for which the source data for navigational charts is based is inadequate, outdated, or nonexistent; these extensive ALB data could provide a modern verification, update, or initial sounding data to enhance the safety of navigation within these areas where traditional acoustic hydrographic data collection is infrequent. The use of ALB data for navigational charting requires a systematic review of the standards to which these data are collected, a detailed knowledge of the bottom coverage and object detection capability of the system, and the assimilation of these data into a format consistent with the format that acoustic data is handled within the Office of Coast Survey workflow. This project will evaluate ALB data for their fit-for-purpose to navigational charting and

develop a methodology whereby they may be assimilated into the hydrographic charting workflow.

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 according to their adherence to standards required for navigational charting, developing the documentation to support the submission of the data into the navigation charting workflow, and developing the data format for this submission.

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

To date, thirty-eight contemporary CZMIL surveys have been 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.

As noted in the report by Graduate Assistant Joshua Bergeron: “Area 3 (Padilla Fidalgo, Washington) had five surveys with overlap. The most recent was a 2010 survey with an available BAG file. There were also two surveys in 2003, one in 1994, and one in 1956 that showed overlapping areas. Area 5 (Coos Bay, Oregon) had three surveys with overlap. The most recent was a 2007 survey with an available BAG file. There were also two surveys in 1994 that showed overlapping areas. Area 7 (Nisqually, Washington) had four surveys with overlap. The most recent was a 2009 survey with an available BAG file. There were also surveys in 2001, 1996, and 1977 that showed overlapping areas. Area 10 (Whidbey, Washington) had three surveys with overlap. The most recent was a 2012 survey with an available BAG file. There were also surveys in 2002 and 1966 that showed overlapping areas. Area 11 (Egmont, Florida) had four surveys with overlap. The most recent was a 2000 survey with multibeam data. There were also surveys in 1999, 1995 and 1994 that showed overlapping areas. There have also been additional LIDAR surveys in 2012, 2010, and 2006.”

These findings were submitted to the Office of Coast Survey, and Coos Bay, Oregon was selected as the initial pilot project area. Coos Bay is a city located in Coos County, Oregon, where the Coos River enters Coos Bay on the Pacific Ocean. The city borders the city of North Bend, and together they are often referred to as one entity called either Coos Bay-North Bend or the Bay Area. The 2014 CZMIL survey of this area was about 15 nm2 over water and follows the river from Coos Bay to the Pacific Ocean.

There were three surveys available with bathymetric data that overlapped the LIDAR coverage in Area 5 (Figure 74). The most recent was a 2007 survey with an available BAG file. There were also two surveys in 1994 that showed overlapping areas.

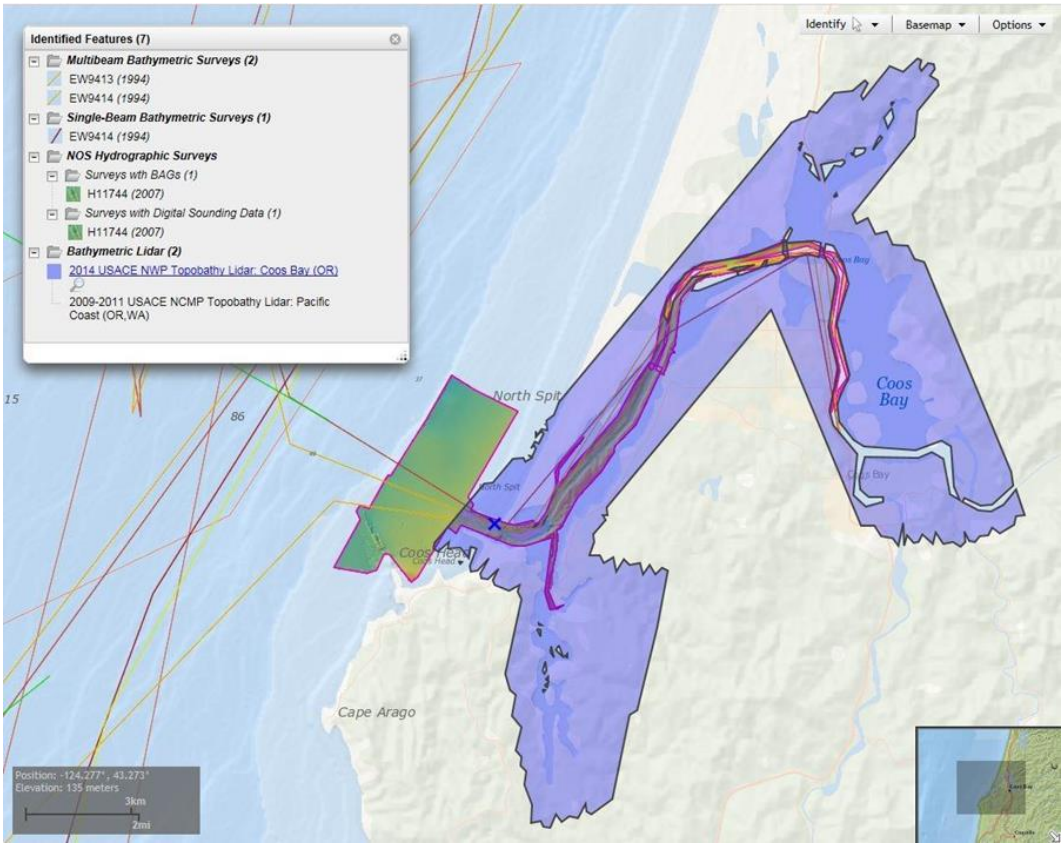

Figure 73 NOAA Bathymetric Data View of Area 5. The blue x is the point in the area in which features are identified.

Current efforts include the generation of surfaces derived from the LIDAR data and the acoustic data. These surfaces are being analyzed to detect biases or inconsistencies that will be catalogued and investigated in an attempt to determine their sources. Dangers to navigation noted in the acoustic records will be compared to the waveform returns of the LIDAR survey to determine the object detection capabilities of the LIDAR.

Once the LIDAR survey has been compared to the acoustic survey, supporting documentation using NOAA Office of Coast Survey formats will be generated for the submission of the LIDAR data set to the Office of Coast Survey for integration into the hydrographic charting workflow.

Description of significant results, protocols developed, and research transitions
To date, the efforts have been largely mechanical with the generation of routines to ingest data into map viewers and the generation of area derived statistics.

Information on collaborators / partners: None reported

Information on any outreach activities: None reported

Related NOAA Strategic Goals: Resilient Coastal Communities and Economies

Related NOAA Enterprise Objectives: Science and Technology

NGI File #15-NGI2-131: 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

Project objectives and goals

1. Build a truck-based mobile atmospheric profiling system;

2. Conduct analysis of existing data relevant to VORTEX-SE science goals;

3. Acquire field measurements from the Mobile Alabama X-band (MAX) radar, Mobile Integrated Profiling System (MIPS), Mobile Doppler LIDAR and Sounding System (MoDLS), and balloon soundings on events of interest prior to the VORTEX-SE field campaign;

4. Participate in the design and execution of the VORTEX-SE field campaign for the period March 1 to April 30, 2016; and

5. Begin data quality control and analysis of data collected under items (3) and (4).

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

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

The RaDAPS platform is smaller and more agile than the existing 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 are summarized in the following.
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, including a 7 kW generator, auxiliary fuel tank for the generator, an air conditioning system, and hydraulic leveling jacks. 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 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. 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 windows-based computers. Installation of instruments shown in Figure 75 include: a DeTect 915 MHz wind profiler ($271k); a Radiometrics MP-3000A 35-channel microwave radiometer ($161k); a Vaisala CL-51 ceilometer (new, purchased with UAH funds, $31k); and a Lufft surface instrument package with T, RH, wind (ultrasonic), pressure, solar radiation, and precipitation measurement capabilities ($3700). This instrument package is mounted on a 12 ft. telescoping tower to allow *in situ* wind measurements at the 4 m AGL level.

Figure 74 RaDAPS instruments, from left to right: DeTect 915 MHz wind profiler antenna, Radiometrics microwave profiling radiometer, surface instrument cluster on a telescoping tower (in folded position behind the radiometer)), and a Vaisala CL-51 LIDAR ceilometer. A Mesodome™ 360° camera (http://www.mesodome.com/, not shown) will be mounted on top of the tan-colored 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): (1) TG/TI occurring on the downslope; (2) TG/TI occurring on top of plateaus (Sand Mountain); and (3) 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 population 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 database 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

UAH facilities were deployed on potentially severe weather days, as summarized in Table 8.

Table 8 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 kts 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. VORTEX-SE field campaign activities

UAH facilities were deployed on potentially severe weather days, as summarized in Table 9. 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 9 Summary of VORTEX-SE 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.
3/13/16 IOP 1	QLCS, no severe weather	MAX @ Tanner MIPS @ SWIRLL	Nocturnal system weakened under appreciable cooling under clear skies.
3/24/16 IOP 2	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).
3/31/16 IOP 3	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 timeframe, 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.
4/27/13 IOP 4A	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.
4/29/13 IOP 4B	Weakening QLCS	MIPS @ SWIRLL MAX and MoDLS @ Courtland, RaDAPS @ Russellville	Weakening QLCS moved over domain, wave-like features apparent in reflectivity. More intense QLCS segment in southern portion of domain after 2200 UTC moved over RaDAPS. WRS features were apparent.
4/30/16 IOP 4C	Mesoscale evolution, Supercells	MoDLS at Hartselle, MAX @ Courtland, MIPS at 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 confined to a small domain. Observations from MoDLS suggest an evolving (heterogeneous) boundary layer.
5/1/16 IOP 4D	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 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 results, protocols developed, and research transitions: None reported

Information on collaborators / partners:
NOAA/NSSL was a primary collaborator during this project. This collaboration was established in during early 2015 and continues to the present. NSSL provided funds for both the RaDAPS development and field campaign activities and data analysis.

Information on any 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. The most recent event was a Weatherfest at McWane Science Center (http://www.mcwane.org/) in Birmingham, AL, in late April. 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: Enhancing the Mississippi Digital Earth Model

Project Lead: Scott A. Samson, Geosystems Research Institute, Mississippi State University, ssamson@gri.msstate.edu

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

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

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

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

The majority (71%) of the funding for this project is used in support of the development of (1) new LIDAR data for two counties (Lamar, Forrest), the southern two-thirds of Perry County, and a small area in southwest Greene County; and (2) enhanced (1:4800) hydrography database for 10 HUC-8 basins. The hydrography data is compatible with the standards set forth by the USGS for the National Hydrography Dataset. The new LIDAR database will update the previously compiled LIDAR database from 2005 and 2006 and has a relatively higher density of mass points and greater vertical accuracy than that of the 2005 and 2006 database.

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

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

information system data." The law requires the Mississippi Department of Environmental Quality (MDEQ) to develop seven base data layers of geographic information for the state, referred to as the Mississippi Digital Earth Model (MDEM).

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

Milestones Accomplished:
Since June 30, 2015, 10 workshops were delivered to 104 participants representing municipalities, counties and state agencies across Mississippi (the number of workshops was below the annual average due to long term illness with a member of the GEO Project). Technical assistance in the implementation and use of geospatial technologies was provided to many of the workshop participants who established GIS and associated technologies in their respective workplaces.

Two new GIS courses were developed and made available to the public in the fall and spring of 2015 and 2016. The courses are designed around the needs identified by workshop participants over the past several years. The 2-day workshops focus on open source GIS applications.

Mobile GIS applications are currently in development for Mississippi state and local governments. After software is tested and evaluated by end users the source code will be made available to the public. The intent of the mobile GIS applications is (1) take GIS out of the office and into the field; and (2) provide source code to other potential end users.

The Mississippi Department of Environmental Quality has been acquiring, processing and assessing the QA/QC of over 1,507 square miles of LIDAR data for two counties (Lamar, Forrest) and the southern two-thirds of Perry County in southern Mississippi. MDEQ has also developed high-resolution (1:4800) hydrography in part or all of ten (10) HUC8 watershed basins covering 8,634 square miles in coastal and southern Mississippi counties. The completed LIDAR and hydrography databases are made available to the public through the Mississippi Department of Environmental Quality (MDEQ), the website of the Mississippi Automated Resources Information System (MARIS) and the U.S. Geological Survey.

Significant Research Results, Protocols Developed and Research Transitions:
This project is focused on outreach, education and data acquisition. There is not a research component.

The Extension Service model of the land-grant university is used to assist in technology transfer. Workshops, presentations and on-site assistance have been proven to be effective in

educating the citizens of Mississippi. A network of county extension offices and state-level specialists provide efficient support in a wide range of areas, such as crop production, youth development through 4-H and geospatial technologies.

Collaborators/Partners:
Name of collaborating organization: Mississippi Department of Environmental Quality
Date collaborating established: July 1, 2009
Does partner provide non-monetary (in-kind) support? Yes
Description of collaboration/partnership relationship:
The Mississippi Department of Environmental Quality (MDEQ) has been given the charge by the State of Mississippi to develop the 7 National Spatial Data Infrastructure (NSDI) layers for the Mississippi Digital Earth Model (MDEM). A subcontract was issued from this project to support MDEQ with their tasks.

Outreach Activities:
Workshops and training: The GEO Project curriculum consists of 5 courses in GIS applications and geospatial database management. Ten, 2- day workshops with 104 participants were held at 4 locations across the state.

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

Related NOAA Enterprise Objectives: Engagement

NGI FILE #15-NGI2-133: Hypoxia National Office Support Activities

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

Project objectives and goals

1. Advance the science underpinning management of the large annual hypoxic zone ("dead zone") in the northern Gulf of Mexico;

2. 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;
3. 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; and

4. 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

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 two focus areas during the reporting period: (1) a mid-summer hypoxic zone monitoring survey that generates the metric (hypoxic zone areal extent) used by the Gulf Hypoxia Task Force to assess their progress toward meeting their hypoxia mitigation goals; and (2) planning a hypoxia research coordination workshop that aims to establish a cooperative hypoxic zone monitoring program.

Hypoxic zone monitoring survey: 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 was conducted in July 2015 by LUMCON and utilized the MIDAS and ADCP data collection systems of the Pelican. MIDAS (Multiple Instrument Data Acquisition System) is an integrated GPS navigational, meteorological (wind speed and direction, barometric pressure, air temperature, relative humidity and photosynthetically active radiation (PAR)), and sea surface hydrographic (temperature, conductivity, % transmission, fluorescence) data acquisition system. The ADCP (acoustic Doppler current profiler) package is a dual operating 25 KHz 300 KHz with a 60 KHz system to be installed soon.

Hydrographic profiles were collected with a SeaBird 911+ CTD unit equipped with pressure sensor, altimeter, redundant pumped temperature, conductivity and dissolved oxygen sensors, % transmissometer, PAR and *in vivo* fluorometer. Additional data were collected with a YSI 6820 (optical probe for dissolved oxygen), which can be lowered to the seabed and used to capture surface thin layers. The YSI 6820 records depth, temperature, conductivity, dissolved oxygen, chlorophyll, and pH. Standard procedures included calibration, determination of oxygen concentration by Winkler titrations, alignment procedures for SeaBird data, and confirmation of salinity with a PortaSal. Phytoplankton community biomass will be determined by fluorometry with an AU Turner Designs fluorometer. Nutrients (NO3+2, NH4, PO4 and SiO4 were determined on unfiltered samples (consistent with data from 1985) with a Lachat nutrient analyzer. The inorganic and organic contribution to the total suspended sediments was determined using pre- and post-ashed GG/F filters.

NGI also supported a survey cruise planned for July/August 2016 that will be conducted onboard a NOAA vessel, as a pilot toward possible future operationalization of the mid-summer monitoring survey.

Hypoxia research coordination workshop: Currently a 6th annual workshop co-led by NGI and NOAA is being planned and will be conducted in September 2016. The purpose of the 6th Annual NOAA/NGI Hypoxia Research Coordination Workshop: Establishing a Cooperative Hypoxic Zone Monitoring Program is 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.

A cooperative monitoring program would benefit many agency programs. Meeting the monitoring program goals would mean that model development and validation would no longer suffer severe data limitation; competitive research resources would be freed up to support improvements of models and other management tools; data turnaround and accessibility would be improved with the goal to make data access real- or near-real time. Also, the metric generated in support of assessing progress toward the Hypoxia Task Force Coastal Goal to mitigate hypoxia would be developed in a structured, consistent, and robust manner.

Workshop Goal

Identify and coordinate partner interests for establishing an adaptive monitoring program for the Gulf hypoxic zone that pursues multiple monitoring objectives.

Workshop Outputs

- Pre-workshop financial, programmatic, and logistical monitoring program strategy to inform proceedings.
- A workshop report identifying mechanisms and resources for likely and potential operational commitments to a Gulf Hypoxic Zone monitoring program and steps required for implementation.

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
Name of collaborating organization: The Steering Committee members for the workshop were all collaborators on this project. The membership of the committee is: Steve Ashby (Northern Gulf Institute), Alan Lewitus (NOAA NCCOS), Dave Scheuer (NOAA NCCOS), Steve Giordano (NOAA OHC) Trevor Meckley (NOAA Affiliate), 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)
Date collaborating established: July 2009
Does partner provide monetary support to project? Amount of support? None Reported
Does partner provide non-monetary (in-kind) support? Yes
Short description of collaboration/partnership relationship: Workshop co-sponsor

Information on any outreach activities
Invited Talks:

- Turner, R. E. "Corn-Soy, Landscapes, and the Hypoxia of the Gulf of Mexico" The True Cost of American Agriculture, San Francisco, CA. 15-16 April 2016.
- Turner, R. E. "Gulf Hypoxia Task Force – Science Approach" Illinois Association of Wastewater Agencies - Mini Conference, Springfield, IL. 24 March 2016.
- Turner, R. E. "Hypoxia update" Hypoxia Workshop. University of New Orleans, Louisiana. 13 August 2015.
- Turner, R. E. Louisiana and the 2015 Gulf Hypoxia Action Plan (Co-Chair; with Doug Daigle and John Westra), (p. 35 participants); Session moderator: 'Quantitative measures' in: "Hypoxia for the Future" (with D. Daigle and J. Westra), Louisiana State University, Baton Rouge, LA, 9 March 2016.
- Rabalais, N.N., presented by Donald F. Boesch, Coastal Hypoxia in the Northern Gulf of Mexico: The Benefits of Long-Term Study. National Conference on Ecosystem Restoration, Coral Springs, FL, April 2016.
- Rabalais, N.N., Ocean/Coastal Resilience & Science, Consortium for Ocean Leadership, Public Policy Forum, Washington, DC, March 2-16
- Rabalais, N.N., R.E. Turner, L.M. Smith, The 'dead zone' is a lesson in complexities and what should be done. Gulf of Mexico Oil Spill and Ecosystem Science Conference, Tampa FL, February 2016.
- Rabalais, N.N. "Our rivers are too large to have nutrient problems and dead zones" Bahia Blanca, Argentina, near Rio Paraná, LOICZ Special Session, Coastal and Estuarine Research Federation, Portland OR, November 2015
- Rabalais, N.N. Climate Change and Coastal Hypoxia. Theme Session R, Causes and Consequences of Hypoxia, International Council for the Exploration of the Seas, ICES Annual Science Conference, Copenhagen, September 2015.

- Rabalais, N.N. Paleoindicators tell the history of hypoxia. Theme Session R, Causes and Consequences of Hypoxia, International Council for the Exploration of the Seas, ICES Annual Science Conference, Copenhagen, September 2015.

Invited Seminars: Rabalais, N.N., Report from 2015 Gulf hypoxia mapping cruise, Public Workshop on Hypoxia in the Gulf of Mexico, LITE Center, University of Louisiana at Lafayette, October 2015

Other professional and educational service:

- R.E. Turner continues as a member of the Support Team and participant for 'Fish Story' at "Memphis Social"
- Turner serves on the Green Lands, Blue Waters, Executive Committee. GLBW (http://www.greenlandsbluewaters.org/) which has a goal of improving agricultural practices in ways that would benefit water quality within the watershed, thereby reducing the nutrient load to the Gulf of Mexico.
- Turner attends monthly meetings of the Hypoxia Task Force, Louisiana.
- Rabalais continues working on the NOAA Hypoxia Monitoring Plan, with GCOOS on their build-out plan, with GOMUC, GCOOS, FIO and GOMA on a coordinated coastal ocean observing system for the northern Gulf of Mexico, and with GCOOS and CSCOR on the use of AUVs for studying hypoxia.

Media examples (these and more posted on http://www.gulfhypoxia.net)

- Wendel, J. (2015), Connecticut-sized dead zone expected in Gulf of Mexico, Eos, 96,doi:10.1029/2015EO031745. Published on 18 June 2015.
- VIMS modeler joins 2015 Hypoxia Forecast Ensemble; http://www.vims.edu/newsandevents/topstories/gomex_hypoxia.php
- Baton Rouge ADVOCATE, predicted size; http://theadvocate.com/news/12677803-123/gulf-of-mexico-dead-zone
- TIMES PICAYUNE, predicted size; http://www.nola.com/environment/index.ssf/2015/06/average_dead_zone_predicted_fo.html
- University of Michigan, predicted size; http://www.ns.umich.edu/new/multimedia/videos/22957-average-dead-zone-for-gulf-of-mexico-in-2015-u-m-and-partners-predict
- Tulane University, $1M prize; http://tulane.edu/news/releases/tulane-officially-opens-dead-zones-challenge.cfm
- The Conversation, predicting dead zones and algal blooms; http://theconversation.com/forecasting-dead-zones-and-toxic-algae-in-us-waterways-a-bad-year-for-lake-erie-43747
- TIMES PICAYUNE 2015 dead zone size; http://www.nola.com/environment/index.ssf/2015/08/2015_gulf_dead_zone_larger_tha.html
- THE ADVOCATE 2015 dead zone size; http://theadvocate.com/news/13093134-123/dead-zone-off-louisiana-coast
- Wendel, J. (2015), Gulf of Mexico dead zone largest since 2002, Eos, 96,doi:10.1029/2015EO033929. Published on 6 August 2015.

- Tulane University; file:///C:/Users/nrabalais/Downloads/TUWaterWays%20August%206%202015.pdf
- interview, Al Jazeera; Dahr Jamail <dahrjamail@gmail.com
- Chicago magazine interview; Bernstein, David dbernstein@chicagomag.com
- Nick Caiazza, Video interview, health of the MO/MS rivers, Nicholas Ciazza, nicholas.caiazza@gmail.com
- NPR, Radio story on Indiana Zoo and TNC work on Hypoxic Zone; http://wrkf.org/post/dolphins-aid-gulf-conservation
- Mississippi River receives D-; http://abcnews.go.com/US/wireStory/report-card-mississippi-river-basin-34463152
- Washington Post, low grade for Mississippi River; http://www.washingtonpost.com/news/energy-environment/wp/2015/10/16/were-totally-mismanaging-the-mi
- Interview, Diane Eastabrook, Al Jazeera, 11-2-2015; Diane.Eastabrook@aljazeera.net
- Mother Nature Network; http://www.mnn.com/earth-matters/wilderness-resources/stories/upside-down-world-gulfs-dead-zone
- Interview, Orlan Love, The Gazette in Cedar Rapids, Iowa
- Video interview, Charles Marsala, New Orleans; https://www.youtube.com/watch?v=0iInKbtOus8&feature=youtu.be
- PBS NewsHour seeks information on jellyfish populations in low oxygen areas
- 2016 predicted size, press release postings http://www.gulfhypoxia.net

Education outreach, numerous information requests are granted secondary-level students, undergraduates and graduates complete projects. A few are provided:

- Hannah Burnet, PhD student in anthropology at the University of Chicago
- 2 student semester project, St. Joseph's Academy, St. Louis, MO, Katie Lodes, Science Teacher, UTube product
- Secondary School Science Project, first Environmental Science category at the Herndon High School Science Fair
- Numerous email interviews with secondary school students for water, earth, geography and social sciences

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-NGI2-134: Telepresence, Information Management, and Data Product Development for Stennis ECC

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

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 *Okenaos 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 (formerly NCDDC), 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 four live ocean exploration activities:

July-September 2015: Okeanos Explorer / Hohonu Moana (Hawai'i)

February-March 2016: Okeanos Explorer / Hohonu Moana (Hawai'i)

March-April 2016: Okeanos Explorer / Wake Island Unit of the Pacific Remote Islands Marine National Monument

April-July 2016: Okeanos Explorer / Marianas Trench Marine National Monument and the Commonwealth of the Northern Mariana Islands

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: Research Conducted/Milestones for Goal 2:
Caitlin Ruby, who was previously identified, recruited, and accepted to Mississippi State University (MSU) to fill the master's level graduate assistantship position specified in the project narrative, matriculated on August 17, 2017. She is presently a research assistant with the Northern Gulf Institute completing her master's degree in the Mississippi State University Department of Geosciences under the direct advisement of Co-PI Skarke. Her academic concentration is geospatial sciences and her graduate research is focused on developing geospatial tools for the visualization and analysis of video data collected with the NOAA remotely operated vehicle Deep Discoverer.

Ruby's graduate research at Mississippi State University directly supports the milestones identified in goal two of the project narrative and leverages her expertise in geographic information systems, the focus of her undergraduate degree. Ruby is making good progress toward the projected completion of her master's degree anticipated to occur in May 2017. She has completed 15 of 24 required course hours and has maintained a 4.0/4.0 grade point average. She has completed a research proposal for her master's thesis and anticipates assembling a full graduate committee by August 1, 2016.

A second research planning meeting focused on detailing a workflow for project goal two was held to at the MSU Exploration Command Center at Stennis Space Center on May 29, 2016 with Sharon Mesick. The meeting focused on additional details of interweaving Caitlin's graduate research with existing data management and accessibility efforts being conducted by the NCEI group at Stennis.

On March 18 – April 15, Ruby participated on NOAA Okeanos Explorer cruise EX1604. Through this participation, she was able to learn the standard operating procedures for data collection on the Okeanos Explorer. She also was able to discuss research efforts with OER mapping lead Derek Sowers, who is currently completing a doctoral degree at the University of New Hampshire focused on applying the CMECS standard to Okeanos Explorer mapping data. Ruby's participation in the unique field opportunity directly related to her master's research was highlighted in the following press release:
http://www.msstate.edu/newsroom/article/2016/03/ocean-exploration-msu-grad-student's-expedition-chance-lifetime/

In support of Ruby's research, a laptop computer was purchased with project funds in May 2016.

On May 30 - June 2, 2016 Ruby participated remotely in a video data management conference hosted by the University of Rhode Island.

Research Conducted/Milestones for Goal 3:
During this reporting period, the data and information sharing infrastructure was utilized for the storage of over 3.3 Terabytes of web-accessible data that is referenced from the NCEI catalog. This web-accessible data consists of 69 Okeanos mission data sets. The infrastructure served data to 2,963 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 collaborators/partners: Not applicable

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

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

Related NOAA Enterprise Objectives: Science and Technology

NGI File #15-NGI2-135: 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

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 FY 16. The certificate program will consist of 5 courses, 15 hours total. Training program students will learn how to interpret social science research, as well as how to conduct basic social science research in their field discipline. Training program students will complete 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 FY 16 for future delivery of the courses.

Description of research conducted during the reporting period and milestones accomplished and/or completed
The course content for all five courses has been developed and presented to OCLO 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 is presently underway. This involves the recording of the content and the placement of the recordings in the eLearning environment.

Description of significant results, protocols developed, and research transitions
1. Development of course content for five courses containing multiple modules of instruction.
2. 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.
3. The course content has been modified to reflect that feedback.
4. Audio recordings of the course content have been completed and are currently being 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.

Information on collaborators / partners:
Vankita Brown, National Weather Service

Information on any outreach activities: None reported

Related NOAA Strategic Goals: Weather-Ready Nation

Related NOAA Enterprise Objectives: Science and Technology

NGI File #16-NGI2-139: 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, NDBC

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 require 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 will develop 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. The code performs the following tasks:

1. Connects to a NDBC MySQL database;
2. Creates data directories and transfer data;
3. Concatenates Tube data;
4. Gets required metadata & data calibration files;
5. Creates processing event logs;
6. Converts and concatenates data to usable format;
7. Trims data;
8. Previews time-series data graphically;

9. Provides edit and quality-control edit data;

10. Flags data;

11. Calculates derived data; and

12. Saves and exports data and metadata.

Description of significant results, protocols developed, and research transitions
A unified user-friendly Java GUI as seen below 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 sections (Figure 76). The top section displays user name, current selected station and deployment information, and 5 convenient buttons. These buttons allow user to look at summary log, transfer final data files to web-staging area, read spreadsheet, email to TAO group members, and clear message area. The middle section is the main processing area. It consists of a group of tab pages. Each tab represents an existing processing task with all available options. Data processing operator no longer needs to interactively type in command-line options serially for each task. All options are now presented on each task page for easy access. Once the user selects a site and deployment, working directories will be created if necessary, and applicable task tabs will be enabled for processing. The bottom section has a message area which displays GUI status and all program output messages.

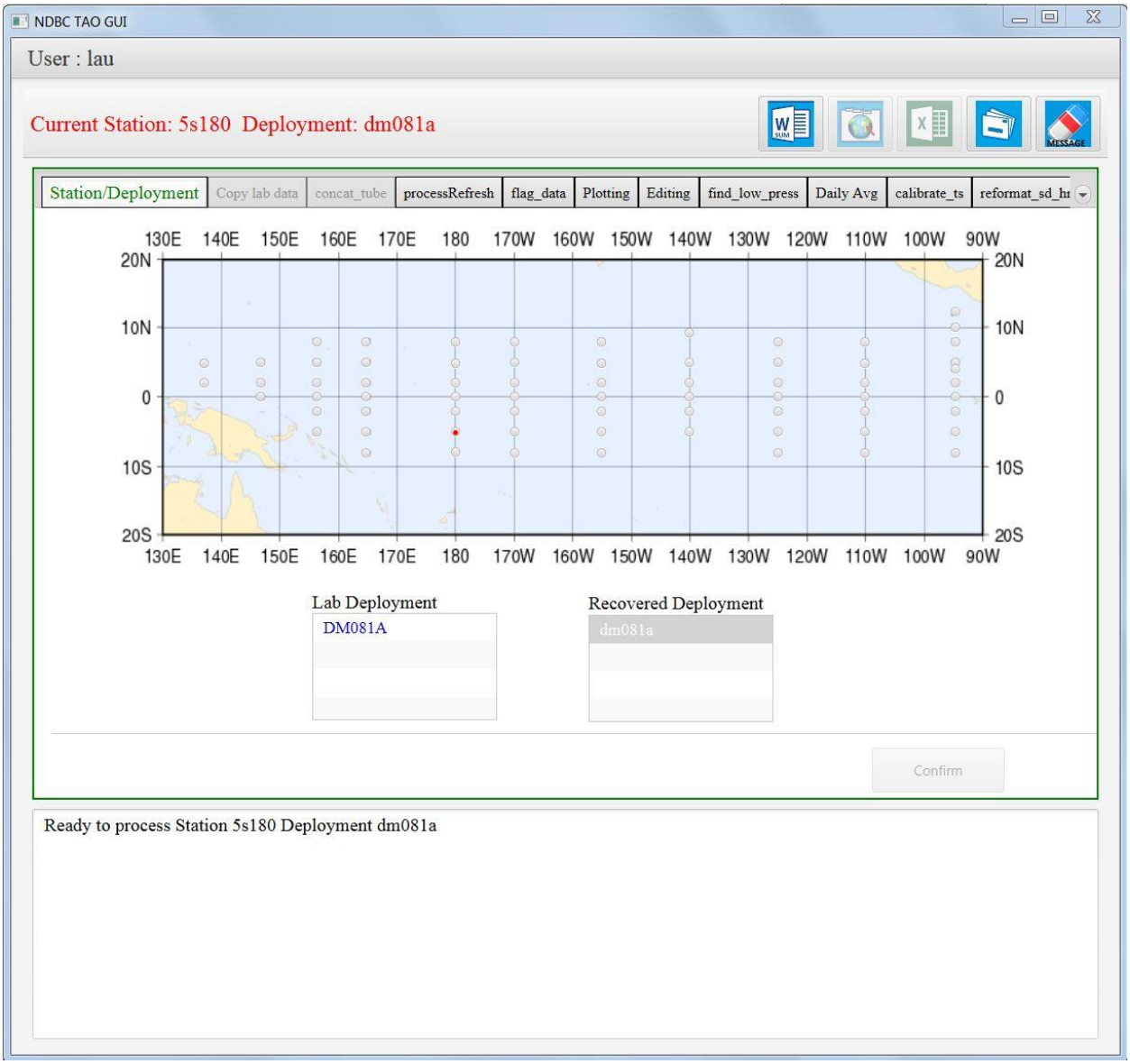

Figure 75 A screenshot of the three sections of the Java GUI

For new site or deployment data from the lab, two task tab pages are available

- "Copy lab data" – copies tube data and sensor data from lab directories to the cruise data directory (Figure 76)
- "concat_tube" – displays the deployment and recovery date and time, concatenates individual tube data files in cruise data directory into one file with processing log, and transfers all relevant data files into the "rawdata" directory (Figure 77)

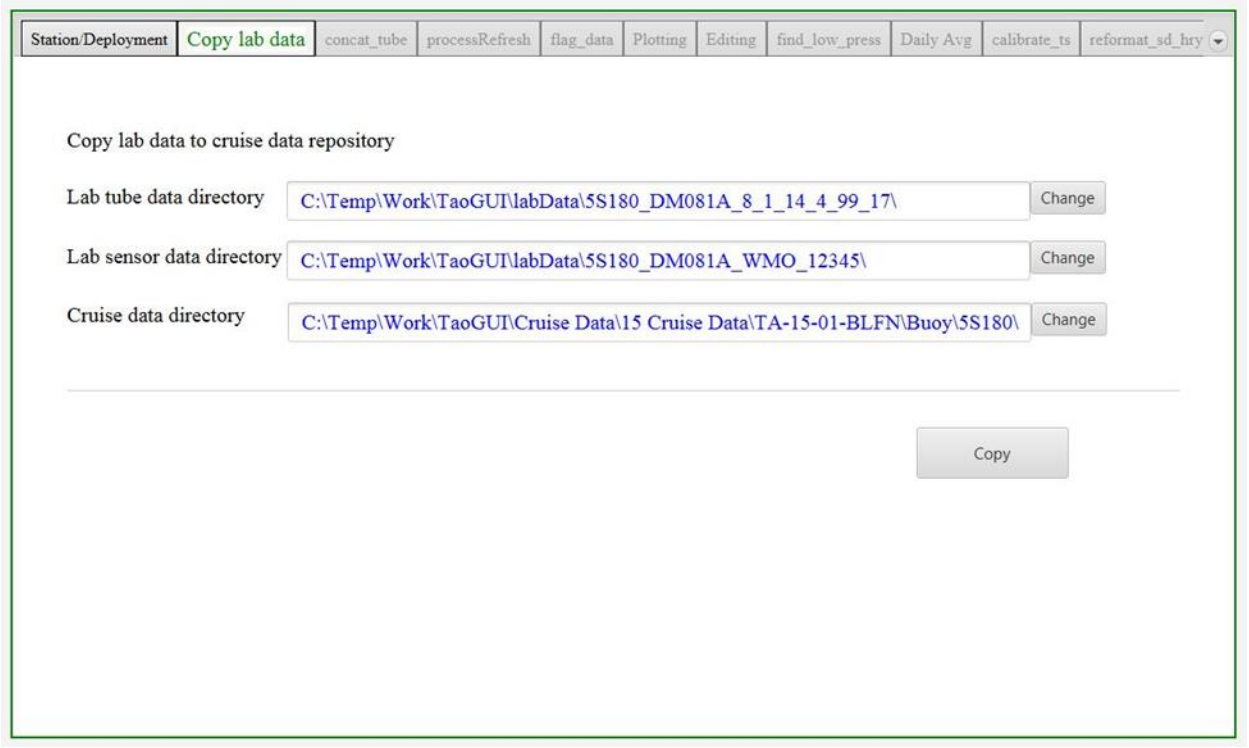

Figure 76 Screenshot of the "Copy lab data" tab of the Java GUI.

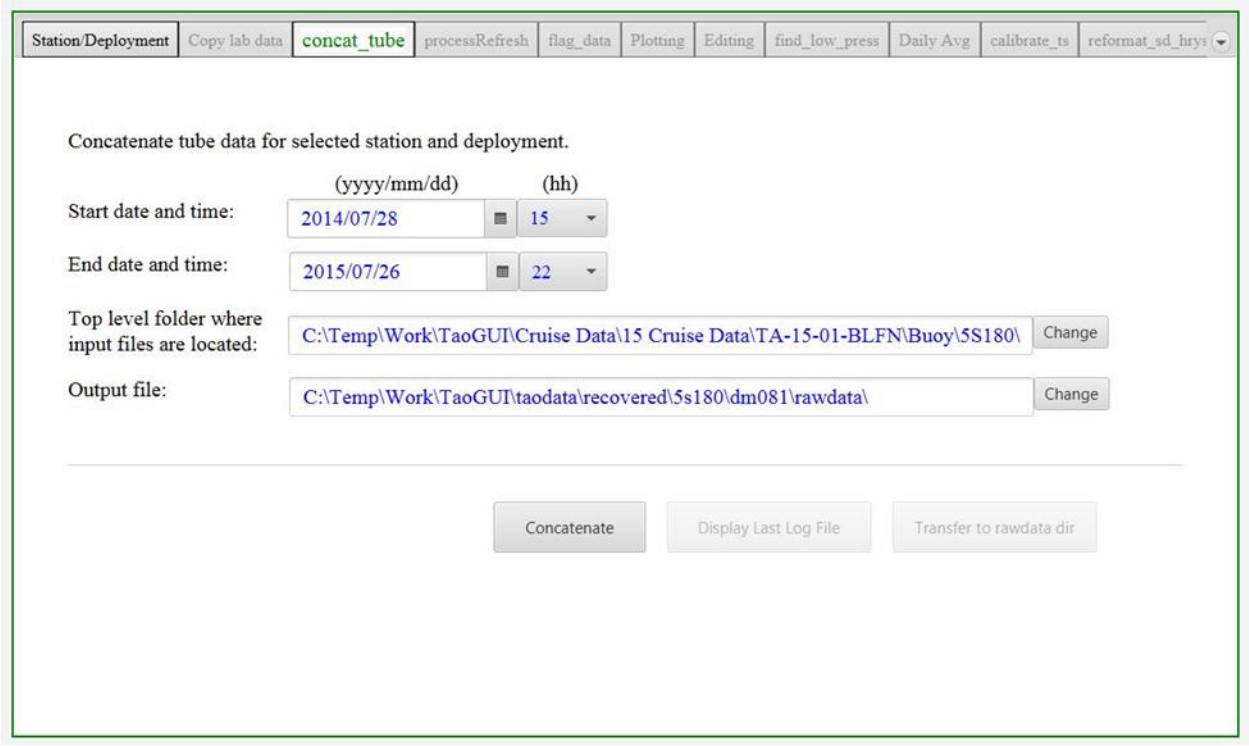

Figure 77 Screenshot of the "concat_tube" tab of the Java GUI.

For existing site and deployment data, eight task tab pages are available.

1. “processRefresh” – a java class which converts raw data (AMPS *.THP file and sensor download files) to the Legacy *.ram data format so that Legacy processing system can be used (Figure 78).

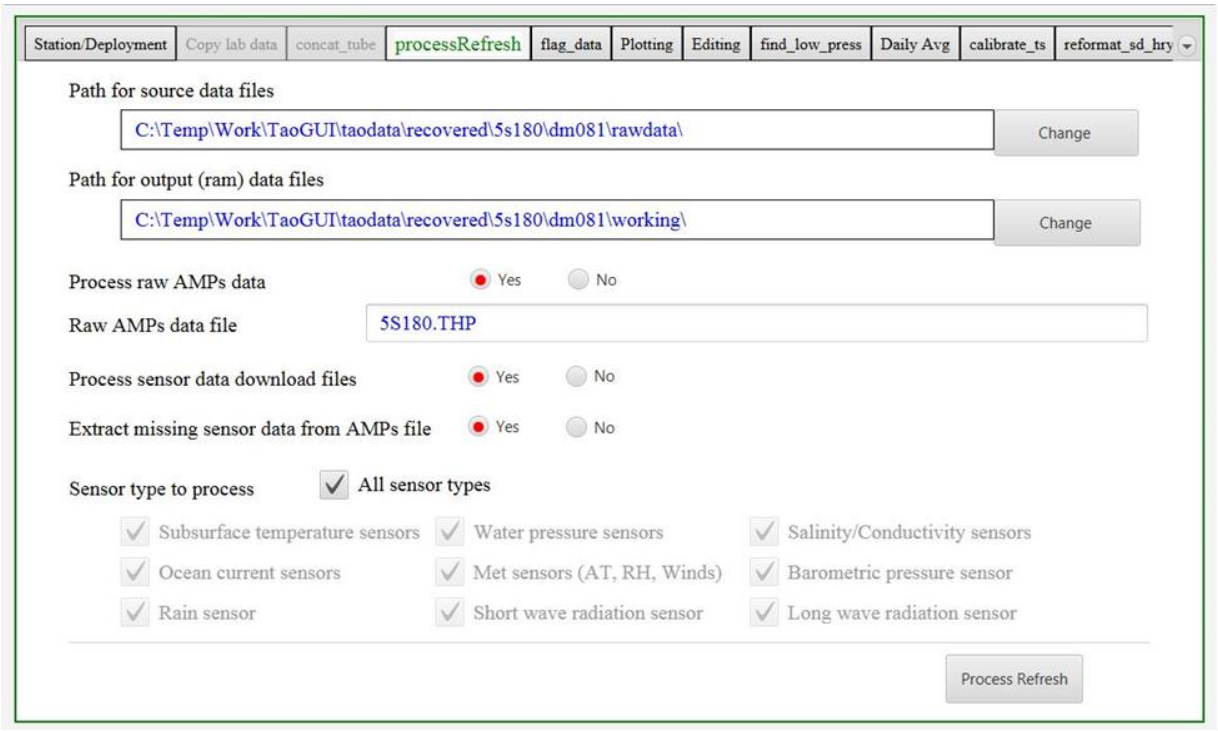

Figure 78 Screenshot of the “processRefresh” tab for the Java GUI

2. “flag_data” – perl script which trims data to the deployed time interval [deployment time + 2 hours, release time], and remove some diagnostic columns of data using flag assignments from flag file(s) (Figure 79)

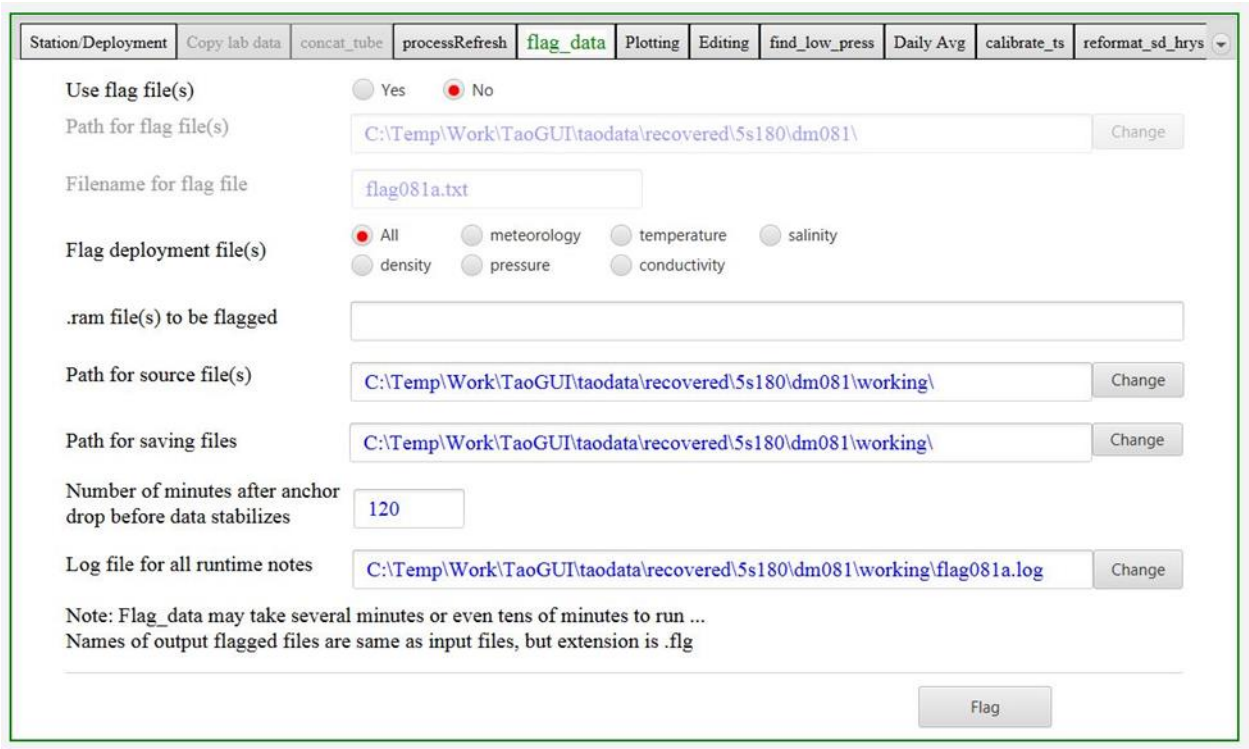

Figure 79 Screenshot of the “flag_data” tab for the Java GUI.

3. “Plotting” – this main plotting tab page is further divided into 3 separate plotting pages, namely “plotmod”, “plottube”, and “plotsontek”. All plots are drawn by existing MATLAB programs.
    - “plotmod” – plots ocean parameters including temperature, salinity, pressure and density (Figure 80)

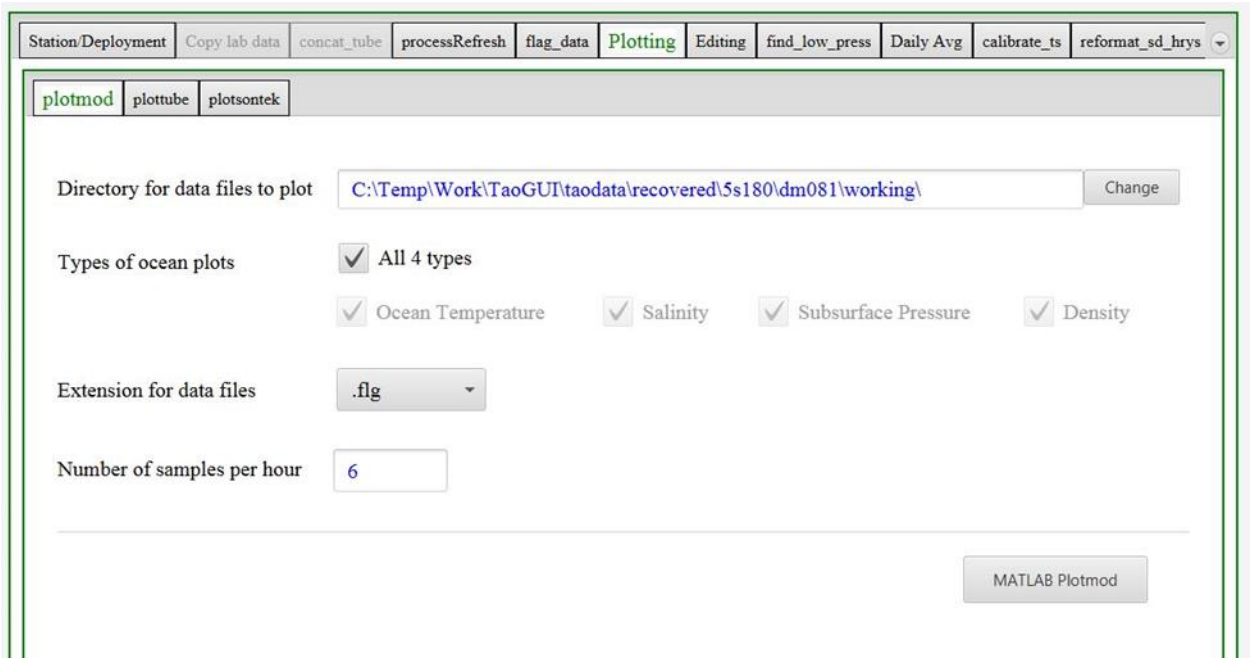

Figure 80 Screenshot of the “plotmod” tab for the Java GUI.

- “plottube” – plots meteorological parameters including wind, air temperature, relative humidity, barometric pressure, short wave radiation, long wave radiation, rain accumulation and rain rate (Figure 81)

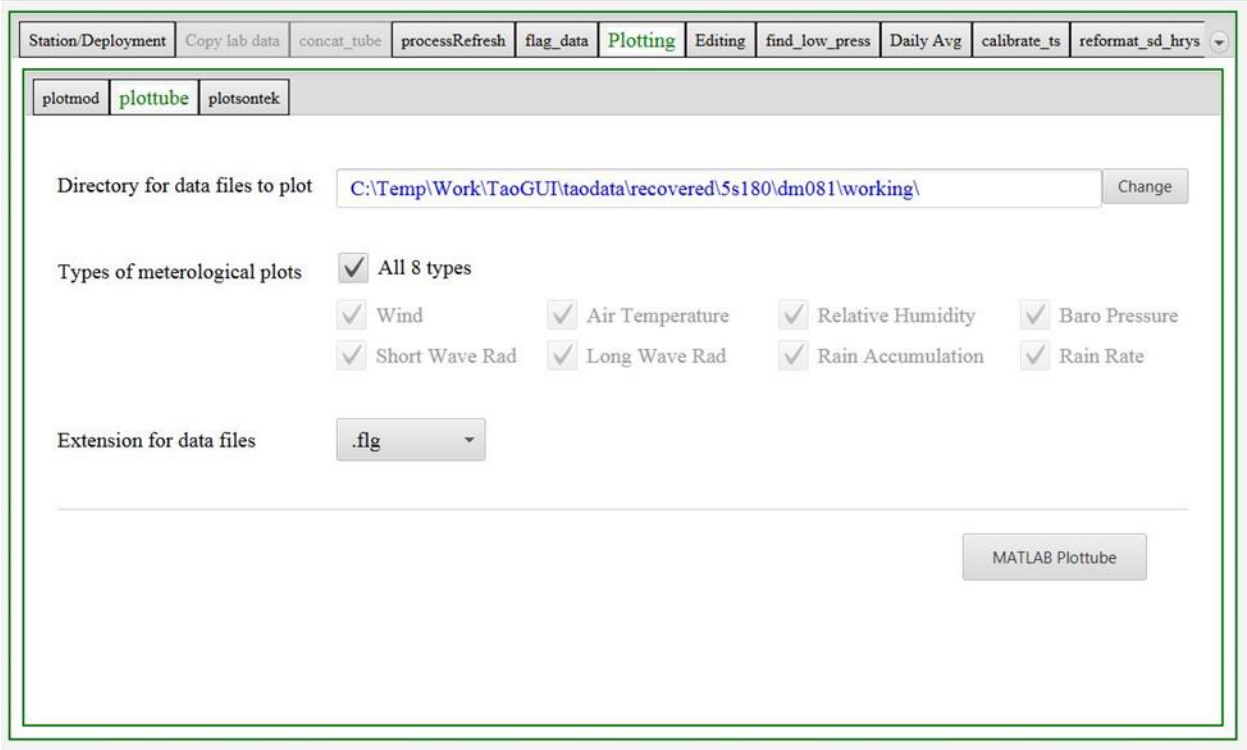

Figure 81 Screenshot of the “plottube” tab for the Java GUI.

- “plotsontek” – plots flux data (Figure 82)

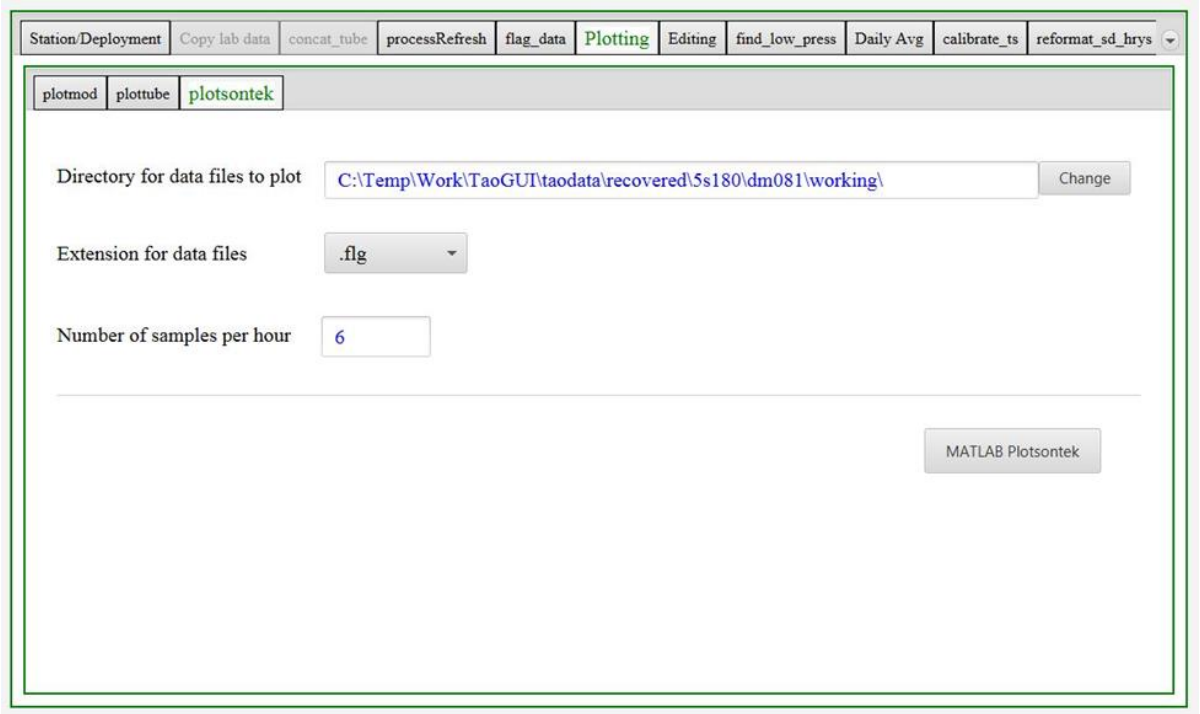

Figure 82 Screenshot of the “plotsontek” tab for the Java GUI.

4. “Editing” – this main editing tab page is further divided into 2 separate editing pages, namely “taoedit” and “editRainData” Each editing page utilizes NDBC’s existing popup MATLAB GUI.
    - “taoedit” – this page pops up existing MATLAB GUI to edit data. Suspicious data can be flagged, and subsequently removed using flag_data (Figure 83)

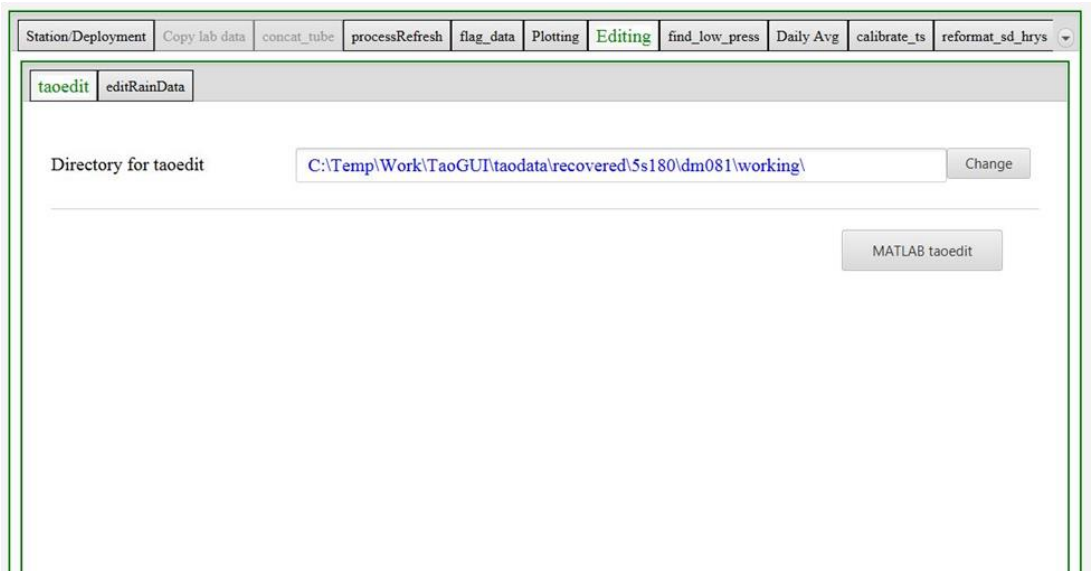

Figure 83 Screenshot of the "Taoedit" tab for the Java GUI

- “editRainData” – this page pops up existing MATLAB GUI to edit rain data (Figure 84)

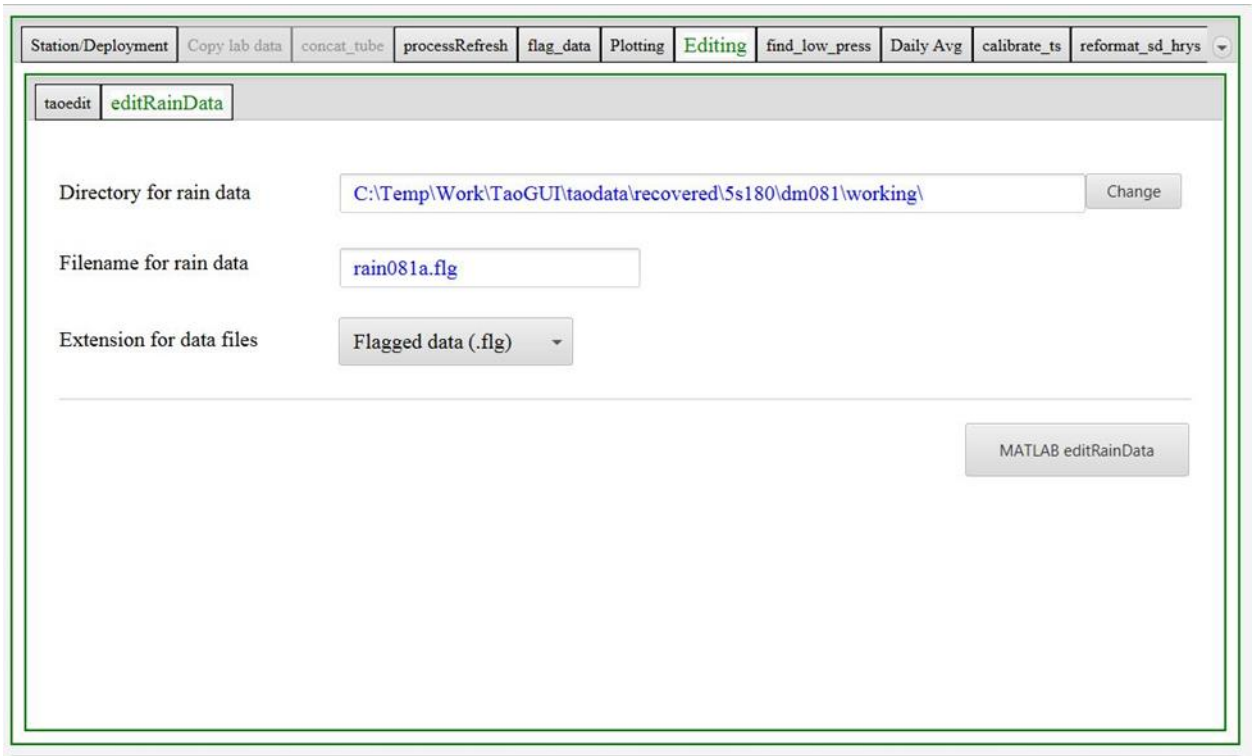

Figure 84 Screenshot of the “editRainData” tab for the Java GUI

5. “find_low_press” – perl script to look for times where the 300 and 500 meter pressure data are outside 293-305 and 488-508 dbar respectively, and flag them (Figure 85)

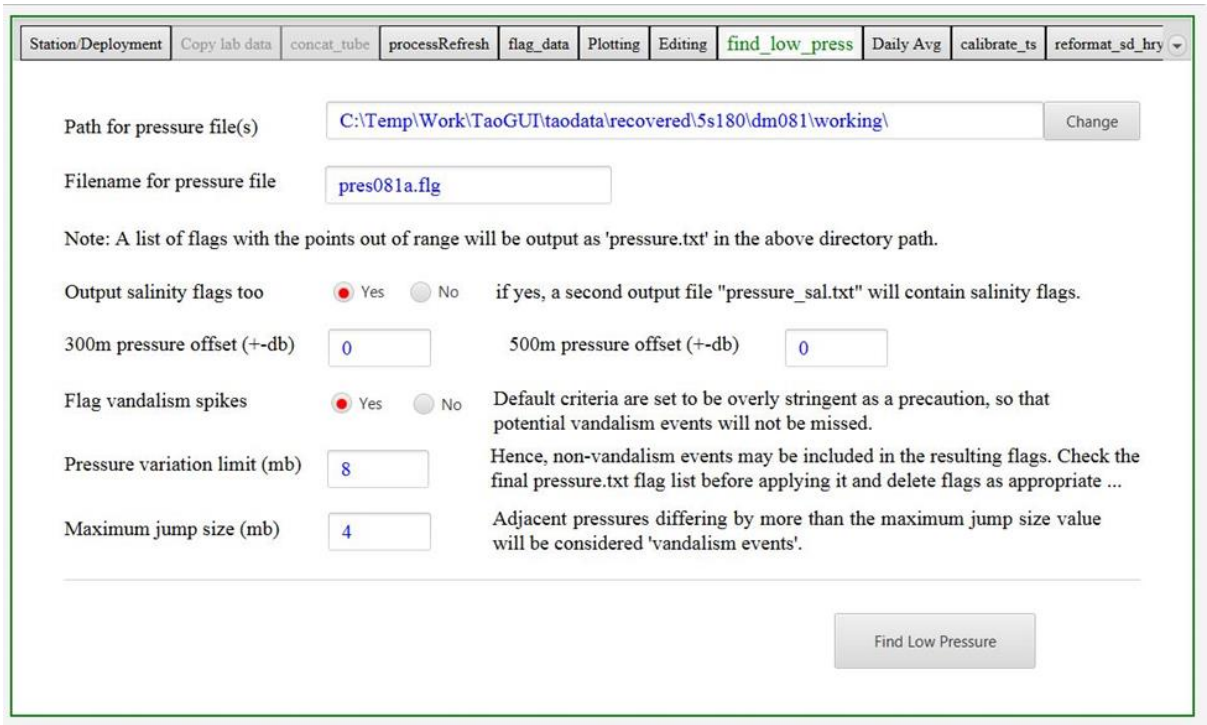

Figure 85 Screenshot of the "find_low_press "tab of the Java GUI

6. “Daily Avg” – perl script to create daily averages for all data except salnity/conductivity/density (Figure 86)

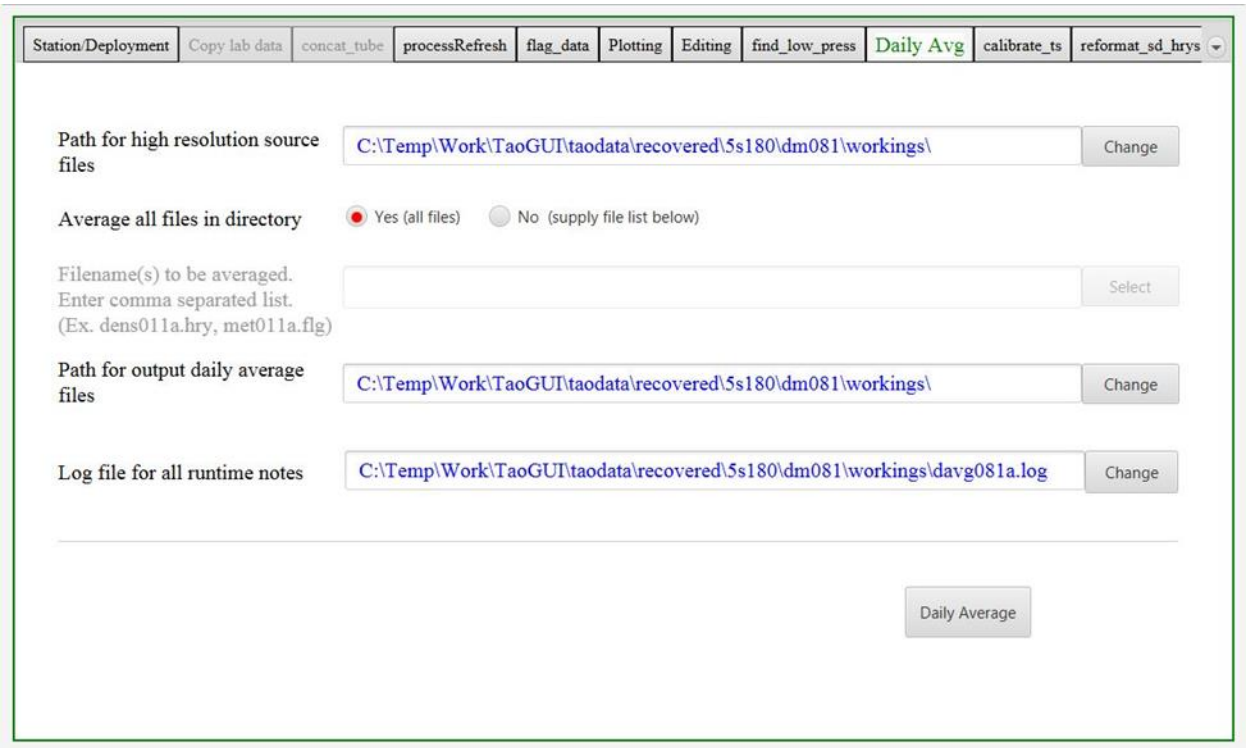

Figure 86 Screenshot of the "Daily Avg” tab for the Java GUI

7. “calibrate_ts” – perl script to interpolate between files with pre-cruise and post-cruise calibrations applied, smooth the resulting time series, and resample to an hourly resolution (Figure 87).

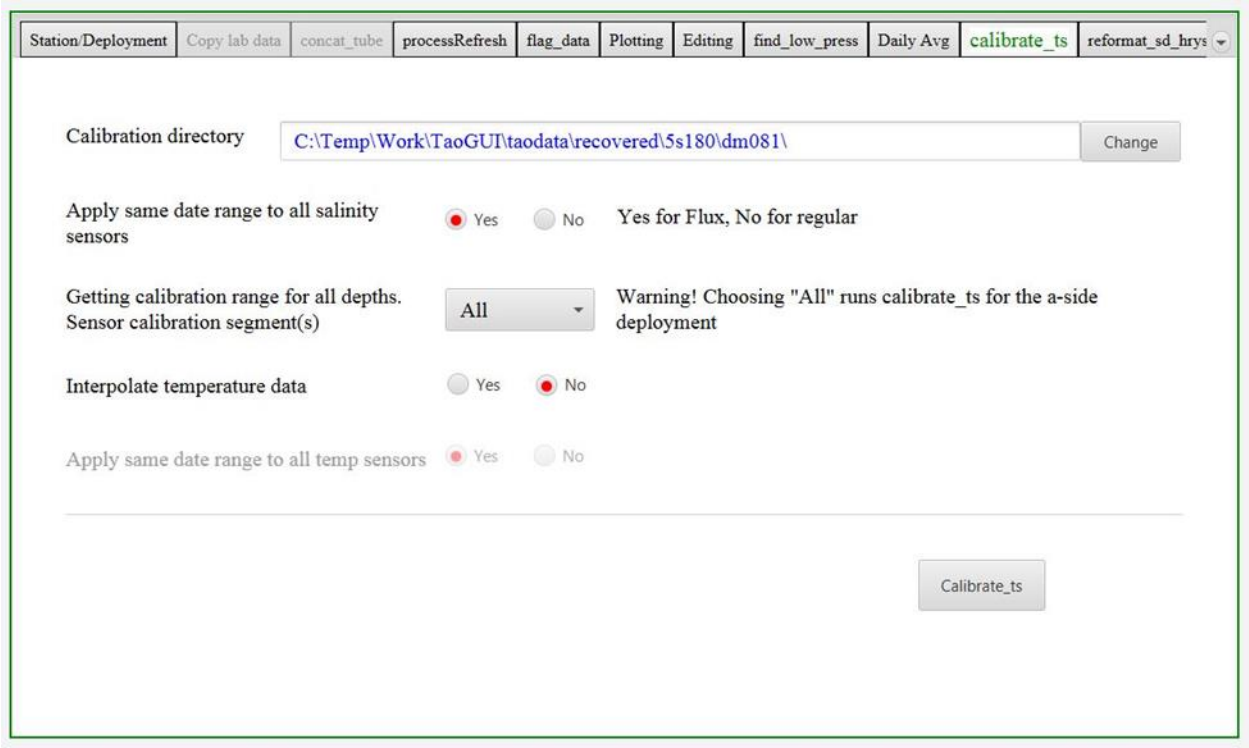

Figure 87 Screenshot of the “Calibrate_ts” tab for the Java GUI.

8. “reformat_sd_hrys” – perl script to combine the hourly salinity and density files (from calibrate_ts) together into a “salc” file (salcXXXX.hry) to be averaged (Figure 88).

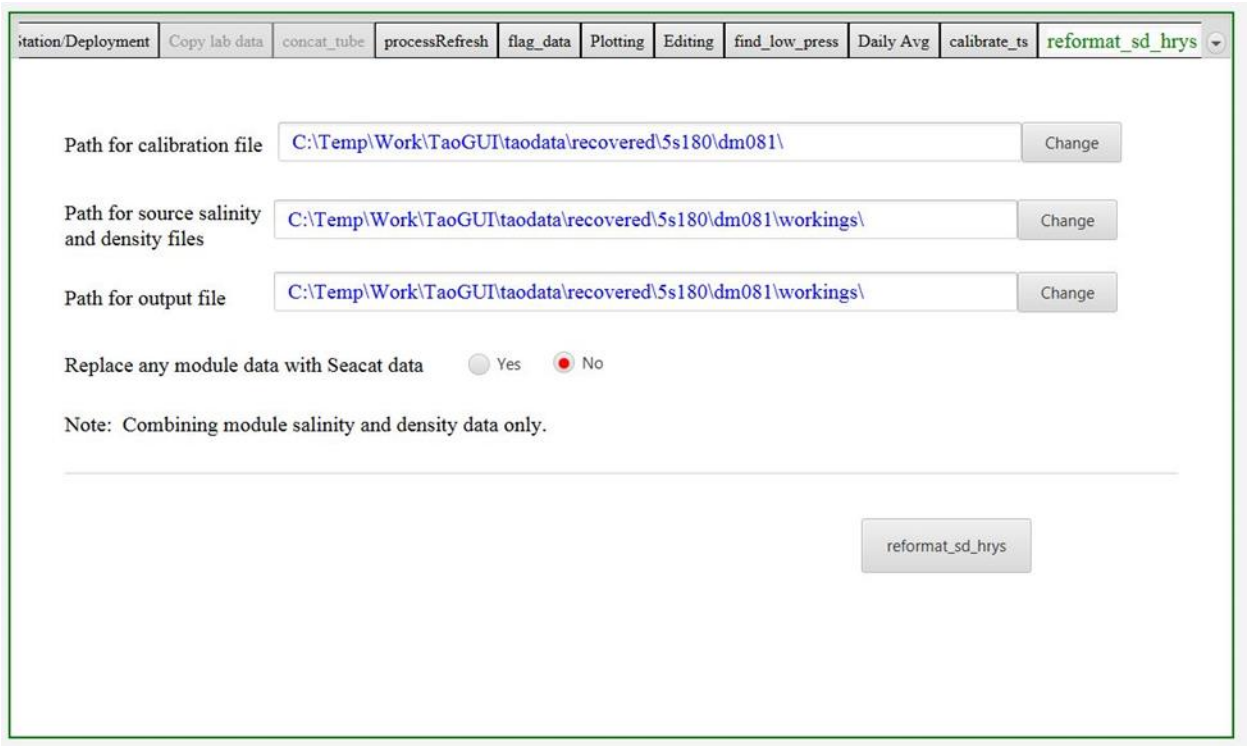

Figure 88 Screenshot of the “reformat_sd_hrys” tab for the Java GUI.

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

Information on any outreach activities: None reported

Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Organization and Administration

NGI File #16-NGI2-140: Digital Surface Model Creation

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, NOAA/CWPPRA

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 .jpg 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; and
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.

Information on collaborators / partners: None reported

Information on any outreach activities: None reported

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

Related NOAA Enterprise Objectives: Science and Technology

NGI File #16-NGI2-141: Bias Characterization and Hurricane Initialization using ATMS, SSMIS, and AMSR-2

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

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

Project objectives and goals

The objectives of this project are to carry out bias characterization and hurricane initialization using ATMS, SSMIS, and AMSR-2 derived products. We aim at deriving hurricane warm core structures from ATMS temperature sounding channels, sea surface temperature, sea surface wind speed, soil moisture, total cloud liquid and ice water, and total precipitable water vapor from AMSR-2.

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

During the time period from July 1, 2015 to June 30, 2016, an “optimal” striping noise mitigation algorithm was developed and applied to ATMS SDR brightness temperatures. The striping noise was visually discernable for the temperature sounding channels as along-track strip features with random intensity of differences of ATMS brightness temperature between observations and simulations based on numerical weather predictions (i.e., O-B). The magnitude of the ATMS striping noise in the earth-scene brightness temperature is about 0.3 K and 1.0 K for the temperature and humidity sounding channels, respectively. The same magnitudes of the striping noise were found in the brightness temperature measurements of the cold space when the SNPP satellite made its pitch-over maneuver on February 20, 2012.

The “optimal” striping noise mitigation algorithm consists of the principal component (PC) analysis (PCA) decomposition followed by an “optimal” symmetric filter with its weighting coefficients determined by fitting the filter results to an Ensemble Empirical Mode Decomposition (EEMD) obtained results. The striping noise is contained in the PC coefficient of the first PCA mode, which captures mostly the scan-dependent feature of cross-track radiometer measurements including the striping noise. The optimal filter was applied to remove the striping-noise-induced highest-frequency oscillatory components of the first PC coefficient. The striping noise disappeared in the global distribution of O-B for ATMS temperature sounding channels 1-16 by after applying the “optimal” striping noise mitigation algorithm.

Another study conducted during the reporting period was testing the impacts from assimilation of one data stream of AMSU-A and MHS radiances on quantitative precipitation forecasts. Since the launch of NOAA-15 satellite in 1998, the observations from microwave temperature and humidity sounders have been routinely disseminated to user communities through two separate data streams. In the Advanced Microwave Sounding Unit-A (AMSU-A) data stream, brightness temperatures at 15 channels are available primarily for profiling atmospheric temperature from the earth surface to low stratosphere. In the Advanced Microwave Sounding Unit-B (AMSU-B) or Microwave Humidly Sounder (MHS) data stream, the brightness temperatures at five channels are included for sounding water vapor in the low troposphere. Assimilation of

microwave radiance data in numerical weather prediction systems has also been carried out with AMSU-A and AMSU-B (MHS) data in two separate data streams. A new approach is to combine AMSU-A and MHS radiances into one data stream for their assimilation. The National Centers for Environmental Prediction Gridpoint Statistical Interpolation analysis system and the Advanced Research Weather Research and Forecast model are employed for testing the impacts of the combined datasets. It is shown that the spatial collocation between MHS and AMSU-A field of views in the one data stream experiment allows for an improved quality control of MHS data, especially over the conditions where the liquid-phase clouds dominate. As a result, a closer fit of analyses to AMSU-A and MHS observations is obtained, especially for AMSU-A surface-sensitive channels. The quantitative precipitation forecast skill is improved over a 10-day period when Hurricane Isaac made landfall. A journal article of this research was submitted to QJRMS in May 2016 (see publication list).

The third study conducted during the reporting period was the development and testing of a modified hurricane warm core retrieval algorithm. The ATMS is a cross-track microwave radiometer. Its temperature sounding channels 5-15, which are the same as channels 4-14 from its predecessor — Advanced Microwave Sounding Unit-A (AMSU-A), are located in an oxygen absorption line near 60 GHz, and they provide measurements of thermal radiations emitted from different layers of the atmosphere. In this study, a traditional AMSU-A temperature retrieval algorithm is 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. The warm core structures derived for Hurricane Sandy when it moved from tropics to middle latitudes are examined. It is 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 larger and 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 in the upper troposphere during both its intensifying stage and when it was located in the tropics, but it extended to the entire troposphere when it moved into subtropics and middle latitudes and stopped its further intensification. A journal article of this research was submitted to JGR-Atmosphere in March 2016, and the revision of this article was completed and submitted on June 26, 2016 (see publication list).

Description of significant results, protocols developed, and research transitions
The ATMS optimal filter removing the striping noise in the ATMS SDR data was transitioned to NOAA/STAR/SMCD, who then produced 45 days de-striping ATMS SDR to different operational NWP centers including ECMWF and NCEP for them to test the impacts of striping noise on NWP.

Information on collaborators / partners: None reported

Information on any outreach activities:
Hosted speakers, workshops and/or any training: Yes
Type: Speaker
Name of event

1. The 96th Annual Meeting of America Meteorology Society

2. NOAA Workshop on JPSS Life-Cycle Data Reprocessing to Advance Weather and Climate Applications

Date

1. AMS: 11-14 January 2016
2. NOAA Workshop: 17-18 May 2016

Location

1. AMS: New Orleans, Louisiana
2. NOAA Workshop: ESSIC, University of Maryland, 5825 University Research Court, College Park, Maryland

Description

1. An oral presentation entitled “SNPP ATMS Striping Mitigation and Its Impacts on Numerical Weather Prediction” was given at the 12th Annual Symposium on New Generation Operational Environmental Satellite Systems. The paper number was: 13.4.
2. An oral presentation entitled “Comparing Impacts between ATMS and AMSU-A/MHS on NWP”

Approximate Number of Participants: None reported

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

Related NOAA Enterprise Objectives: Science and Technology

NGI File #16-NGI2-142: Northern Gulf of Mexico Sentinel Site Cooperative Intern

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

NOAA sponsor and NOAA office of primary technical contact: Kristen Laursen, NMFS

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:

1. Work with partners to develop a survey to help identify parameters for Continuously Operating Reference Stations (CORS) inventory;
2. 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);
3. Develop a list of points of contact for elevation data in the region;
4. With assistance from partners, identify a list of standards to apply to elevation data sets;
5. Complete an elevation data inventory within the boundaries of the Cooperative;
6. Time permitting, the intern may work with DOI partners to conduct a gap analysis of the CORs and elevation data; and
7. 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 started in June 2016, and initial data compilation and coordination is ongoing.

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

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? Amount of support? None reported
Does partner provide non-monetary (in-kind) support? Yes, technical input/review
Short description of collaboration/partnership relationship – GOMA has a date management team that is a source of data for this project.

Information on any outreach activities: None reported

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-NGI2-143: Continuing Secure Archival for NOAA/NMFS Preserved Specimens at USM's Plankton Archival Facilities

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

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

Project objectives and goals
USM provided secure archival for NMFS in two bunkers during years one and two of an existing arrangement.

Description of research conducted during the reporting period and milestones accomplished and/or completed
USM provided secure archival for NMFS in two bunkers during years one through three of an existing arrangement

Description of significant results, protocols developed, and research transitions
Not applicable

Information on collaborators / partners: Not Applicable

Information on any outreach activities: Not applicable

Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Climate Adaptation and Mitigation

NGI File #16-NGI2-144: Processing of Side-Scan Sonar and Multibeam Sonar Data

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

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

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:

1. Inspect navigation and altitude data, remove any errors and interpolate;
2. Organize and inspect soundspeed profiles, apply soundspeed corrections;
3. Clean errors and outliers from multibeam sounding;
4. Generate bathymetry surfaces;
5. Export bathymetry to GIS;
6. Generate backscatter surfaces and classify seabed; and
7. Export backscatter maps to GIS.

Task 2. Process side-scan data:

1. Inspect/correct navigation and layback data;
2. Inspect/correct altitude data;
3. Adjust TVG, Gain, Equalization, and other parameters where necessary;
4. Produce mosaics;
5. Digitize seabed to indicate bottom type; and
6. 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

This project was delayed due to the time it required to find a qualified individual. Software and a computer have been ordered and work will begin in July 2016.

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

Information on collaborators / partners: None reported

Information on any outreach activities: None reported

Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology

NGI File #16-NGI2-145: NOAA Weather Radio All Hazards Network Transformational Change Stakeholder Engagement Phase One

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: Luis Cano, NWS

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

Description of research conducted during the reporting period and milestones accomplished and/or completed
Dr. Myers has developed a strategy to obtain NWR user needs from relevant stakeholders to provide input on future system requirements, on potential technologies to augment and/or replace obsolete equipment, and on 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.

Description of significant results, protocols developed, and research transitions

1. Engaged with Tyra Brown and her team to strategize data collection methods for specific stakeholder groups;
2. Created a template for developing background knowledge and strategy choices for stakeholder group leads; and
3. Currently working with leads to select samples and strategies for data collection.

Information on collaborators / partners:
Tyra Brown, National Weather Service; Vankita Brown, National Weather Service

Information on any outreach activities: Not applicable

Related NOAA Strategic Goals: Weather-Ready Nation

Related NOAA Enterprise Objectives: Engagement

NGI File #16-NGI2-147: Northern Gulf Institute Diversity Internship Program

Project Lead (PI) name, affiliation, email address: Samuel Clardy, Gulf Coast Research Laboratory, samuel.clardy@usm.edu

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

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 10 2016 NOAA-NGI Diversity Internship 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.

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

Information on collaborators / partners: None reported

Information on any outreach activities: Not applicable

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

APPENDIX A. PUBLICATION DOCUMENTATION

All items listed are under award number NA11OAR4320199.

Publications completed during the reporting period:

Amend Number	Journal	Date	Vol.	Pages	Citation
71	**Diagnosing Atlantic Basin Tropical Cyclone Rapid Intensification with Artificial Intelligence and Composite Techniques**				
	Complex Adaptive Systems Conf Proceedings	In press			
105	**Climate Variability in Ocean Surface Turbulent Fluxes**				
	Geoscience Data Journal	6/8/16			10.1002/gdj3.34
	Journal of Geophysical Research: Atmospheres	5/30/16	121	5631-5647	10.1002/2016JD025135
109	**Evaluation of VIIRS AOP/IOP Products**				
	Applied Optics	2/1/16	55	1738-1750	10.1364/AO.55.001738
	Remote Sensing of Enviornment	12/1/15	1696	139-149	10.1016/j.rse.2015.08.002
110	**Improving ATMS SDR Data Quality for Weather and Climate Studies**				
	Journal of Meteorlogical Research	1/1/16	30	12-37	10.1007/s13351-016-5076-4
	IEEE Trans. Geo. Remote Sensing	4/1/16	54	3856-3860	10.1109/TGRS.2016.2529504.
	Journal of Geophysical Research: Atmospheres	5/13/16	121	4933-4950	10.1002/2015JD024278
111	**Calibration and Validation of NPP VIIRS-Color and SST Ocean Products for Monitoring Oceans**				
	Earth System Science Data Discussions	6/3/16	8	235-252	10.5194/essd-2015-37
118	**Sensing Hazards with Operational Unmanned Technology for the River Forecasting Centers (SHOUT4Rivers)**				
	International Journal of Remote Sensing	Accepted			
121	**U.S. Research Vessel Surface Meteorology Data Assembly Center**				
	Geoscience Data Journal	5/1/16	3	9-19	10.1002/gdj3.34
	Journal of Atmospheric Oceanic Technology	4/1/16	33	409-428	10.1175/JTECH-D-15-0052.1
124	**Assimilation of GOES-R ABI Radiance in GSI-NAM/HWRF**				
	Journal of Atmospheric Oceanic Technology	Submitted			
	Journal of Geophysical Research: Atmospheres	Submitted			
125	**Data Management in Support of NOAA's Integrated Ecosystem Assessment for the Gulf of Mexico through the NGI**				
	Earth and Space Science (AGU)	In review			
	Earth and Space Science (AGU)	In review			
131	**Infrastructure Development, Initial Data Analysis, and Field Campaign Activities**				
	Monthly Weather Review	In revision			
	Weather Forecasting	In revision			
141	**Bias Characterization and Hurricane Initialization using ATMS, SSMIS, and AMSR-2**				
	Quarterly Journal of the Royal Meterological Society	Submitted			
	Journal of Geophysical Research: Atmospheres	Revised			

Summary of publications reported above:

	Institute Lead Author	NOAA Lead Author	Other Lead Author
Peer-Reviewed	20	0	13
Non Peer-Reviewed	30	8	16

APPENDIX B. EMPLOYEE SUPPORT

Northern Gulf Institute Employee Support July 1, 2015 - June 30, 2016 Personnel (all schools combined)				
Category	**Number**	**B.S.**	**M.S.**	**Ph.D.**
>= 50% Support				
Research Scientist	6	1	3	2
Visiting Scientist	1	0	0	1
Postdoctoral Fellow	4	0	0	4
Research Support Staff	9	3	4	2
Administrative	1	1	0	0
Total (>= 50% support)	**21**	**5**	**7**	**9**
Category	**Number**	**B.S.**	**M.S.**	**Ph.D.**
Employees w/ <50% support	34	4	10	16
Category	**Number**	**B.S.**	**M.S.**	**Ph.D.**
Undergraduate Students	14	8	0	0
Graduate Students	28	0	12	16
Category	**Number**			
# of employees / students that are located at the Lab (include name of lab)	3	NMFS Pascagoula, NMFS Pascagoula/SSC, and AOML		
# of employees / students that were hired by NOAA within the last year	1			

APPENDIX C. OTHER AGENCY AWARDS

Principal Investigator	Prime Sponsor	Project Title	Funding Amount
Fitzpatrick, Patrick	Gulf of Mexico Alliance	CONsortium for oil spill exposure pathways in COastal River-Dominated Ecosystems (CONCORDE)	$114,434.00
Moorhead, Robert	Mississippi Department of Marine Resources (MDMR)	Grand Bay NERR Data Collection	$4,965.00
Moorhead, Robert	Naval Research Laboratory (NRL) (DOD)	Modeling and Ocean Color Remote Sensing in Oceanic and Coastal Waters	$10,000.00
Moorhead, Robert	Mississippi Department of Marine Resources (MDMR)	Proposal for Collection of High Resolution Imagery for Deer Island	$10,000.00
Moorhead, Robert	State of Mississippi - Office of the Governor	Promoting and Mapping Deer Island	$17,364.00
Moorhead, Robert	Mississippi Department of Marine Resources (MDMR)	Phase I: Geospatial Framework for DMR Decision Report	$31,631.10
Ritchie, Jarryl B	BP America	GOMA BP Gulf of Mexico Research Initiative Web Support Project	$545,260.00
		Total	**$733,654.10**