NGI
Northern Gulf Institute
a NOAA cooperative institute

Annual Progress Report

Reporting Period
July 1, 2014 - June 30, 2015

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

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INTRODUCTION

This Northern Gulf Institute (NGI) Annual Progress Report reviews and summarizes the research and the education and outreach activities accomplished during the reporting period of July 1, 2014 to June 30, 2015. The items in this report cover the research conducted under NOAA award NA11OAR4320199. The report consists of two (2) sections and appendices. The first section provides the General Description of NGI, the NGI Direction, Organization and Operations, NGI Research Focus Areas and Highlights, Summary of Economic Impact, and Distribution of funding to NGI 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 several workshops during this reporting period. The NGI Education and Outreach Program disseminates content and reports of research accomplishments through a multi-media approach including listserv emails, Twitter, Facebook, and continual updates to the institution's website with NGI audience relevant news. Content includes recent information about research activities and transitioned results, essential components of the collaboration, operation updates, and other outreach items of interest (*see:* www.NorthernGulfInstitute.org).

The NGI Education and Outreach Program strives to enhance NOAA workforce development by including students in several aspects of the cooperative institute. They are involved in research project performance and reporting, internships, career fairs, NGI associated volunteer opportunities, and network support. NGI staff is currently exploring the development of distance learning degree and certificate programs targeted at NOAA professionals working on Gulf of Mexico related programs.

NGI Management, Mission, and Vision

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

Mission and vision statements

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

Organizational structure

The NGI Program Office's strategic location at the Stennis Space Center, MS, facilitates close interactions with multiple NOAA activities and key stakeholder groups including the NOAA Gulf of Mexico Regional Collaboration Team, regional Sea Grant programs, and the Gulf of Mexico Alliance. The Mississippi State University Science and Technology Center at Stennis Space Center, which houses NGI and NOAA activities, provides NGI with the foundation and the building blocks to maintain and grow its role in northern Gulf of Mexico environmental research and education. NGI continued its international engagement in the Gulf of Mexico by participating in several meetings 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 in NGI's active projects totals over $18 million. NGI continues to use this NOAA investment to contribute to the recovery and future health, safety, resilience and productivity of the Northern Gulf of Mexico region, through sustained research and applications

in a geospatial and ecosystem context. NOAA cooperative institute metrics summarizing published research and staffing support are provided in the appendices.

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

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

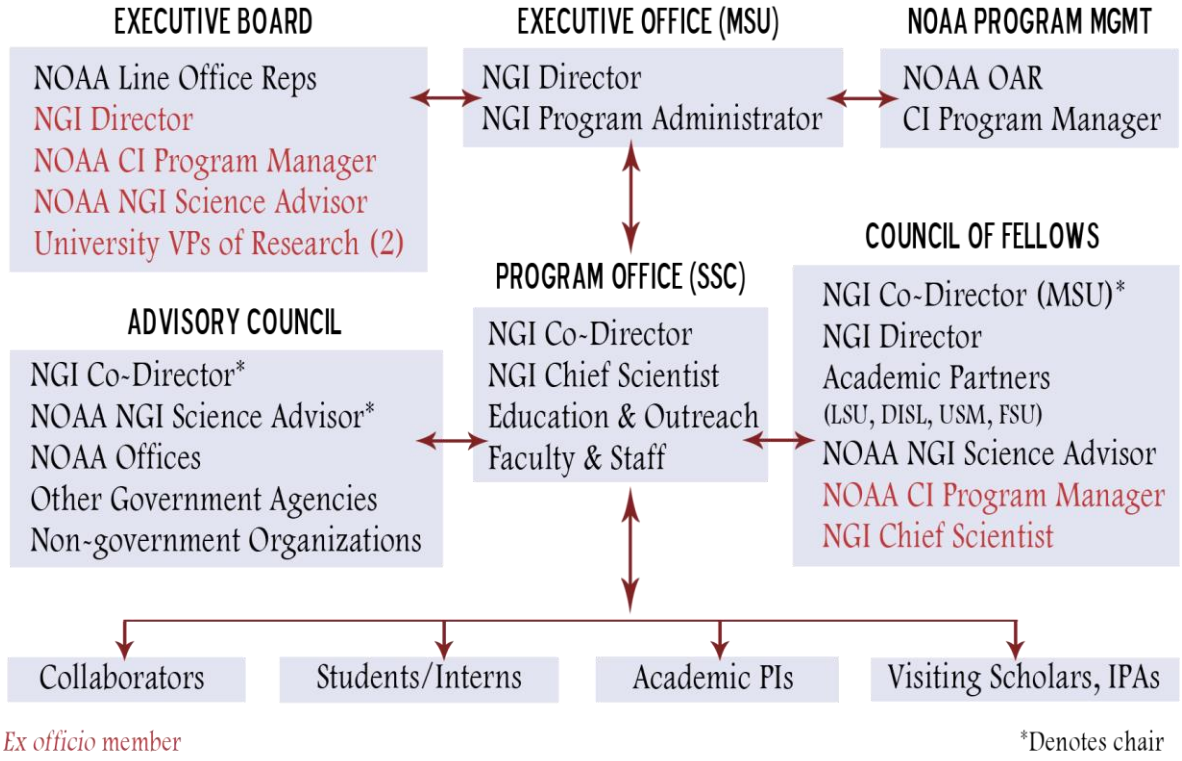


Figure 1 NGI organization diagram

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

Atmospheric Research, National Marine Fisheries Service, National Environmental Satellite Data and Information Service, and the National Ocean Service.

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

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

The Council of Fellows

For period of July 1, 2014 through June 30, 2015, the NGI Council of Fellows consisted of:

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

The Fellows participate in regular teleconferences to remain up to date between face-to-face meetings.

The NGI Executive Council

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

Bonnie Ponwith, Ph.D., Director, NOAA SE Fisheries Science Center (Chair)
Margaret Davidson, Acting Director, Office of Ocean and Coastal Resource Management

Louisa Koch, Director, NOAA Office of Education
Al Powell, Ph.D., Director, Center for Satellite Applications and Research
Alan Leonardi, Ph.D., NOAA 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
Cynthia Decker, Ph.D., OAR CI Program Manager (Acting, Special Advisor, *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
Russ Beard, NOAA National Coastal Data Development Center
David Brown, Ph.D,, NOAA National Weather Service, Southern Region
Miles Croom, NOAA National Marine Fisheries Service
Alyssa Dausman, USGS Gulf Coast & LMV
Todd Davison, NOAA Gulf Coast Services Center
Lisa Desfosse, NOAA National Marine Fisheries Service
Kristen Fletcher, Coastal States Organization
Judy Haner, The Nature Conservancy
Karl Havens, Ph.D., Florida Sea Grant College Program
Julien Lartigue, Ph.D., NOAA 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
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

Research activities 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 habitat assessments, and product development to transition research to operations.

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

- Methods for correcting biases in satellite-derived temperature trends due to orbital drift and orbital differences were developed to generate climate-quality observations to better our understanding of the climate variations at global and regional scales.
- Improving long-term time series satellite measurements by identifying inter-sensor biases, orbital drift, and orbital differences between Microwave Sounding Unit (MSU) and Advanced Microwave Sounding Unit-A (AMSU-A).
- Bias characterization of satellite data of ATMS, SSMIS and AMSR-2 to improve hurricane vortex initialization. A set of 22 “optimal” filters was designed and tested for striping mitigation for noise and satellite television signals, etc.
- A cloud mask (CM) algorithm was developed and tested then applied to Advanced Himawari Imager (AHI) on board Himawari-8 data for assessing AHI data biases based on the O-B statistics in clear-sky conditions.
- Improved tropical storm forecasts with GOES-13/15 imager radiance assimilation and asymmetric vortex initialization in Hurricane Weather Research and Forecasting (HWRF) was accomplished.
- Improved forecasting of tropical cyclone rapid intensification (RI) by developing a complementary system to the SHIPS-RII currently in use was also accomplished. The new system will utilized more advanced statistical and artificial intelligence techniques.
- The effects of ocean forcing functions on two ocean models (HYCOM and POM) was evaluated. The evaluations indicated that HYCOM water temperature was more responsive to tropical cyclone forcing than POM.
- Research on climate variability on ocean surface turbulent fluxes included continued operation and production of the 2˚ Tropical Pacific and 1˚ Tropical Indian Ocean FSU wind products (e.g., a fusion of in situ wind observations for the Pacific product and a largely in situ wind product for the Indian Ocean).
- Visible Infrared Imaging Radiometer Suite (VIIRS) data were used to characterize and evaluate the ocean color data quality in both turbid waters and oligotrophic ocean through match-up comparisons between satellite and in situ measurements.
- Unmanned aerial systems were used for determining water surface elevations in remote areas and applications were expanded to include measurements of suspended solids and colored dissolved organic matter, both of which can be related to harmful algal blooms.

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.

- Activities continued to 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 apply an individual-based methodology, coupled with the physical-biogeochemical model, to simulate variability in larval recruitment for key species.

- Pilot-scale microbial genomic observatories from representative Gulf of Mexico habitats are ongoing to establish baseline information in the Gulf about interactions between microbial features such as community structure, diversity, relative abundance, ecosystem functions, and the influence of environmental factors such as ocean acidification, land-based pollution, global climate change, and sea level rise. An OSD Handbook that serves as a best practice guide describing procedures and policies on the marine sample collection, logistics and bioinformatics by the Micro B3 (Biodiversity, Bioinformatics, Biotechnology) Consortium is now available.
- Project habitat layers developed with hydrographic survey techniques (e.g., multibeam and side scan sonar) were delivered to NMFS for inclusion into their existing GIS database, allowing enhancement of the layers value through correlation to other habitat metrics.
- An additional study was initiated to determine past habitat use of juvenile to adult Gulf sturgeon through trace element and isotopic analyses.
- Collection and tagging of adult smalltooth sawfish continued to determine habitat use and movement patterns.
- 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 is being used to characterize untrawlable habitats such as coral reefs as part of the Untrawlable Habitat Strategic Initiative (UHSI).
- Methods to process fisheries acoustics data were developed to 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 for species identification and biomass estimates.
- Impacts of marine debris are being studied with a survey of marine debris on barrier islands in the northern Gulf of Mexico and assessing microplastic ingestion by Sargassum-associated fish in a pilot study which discovered the presence of debris in all of the samples.
- Expansion of the Integrated Ecosystem Assessment (IEA) in the northern Gulf of Mexico to identify ecosystem management needs and evaluate possible management actions associated with restoration and management of oyster communities in several estuaries. Emphasis was placed on “translating” ecosystem services to indicators of human well-being.

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:

- An environmental index to identify the preferred environmental conditions for Bluefin tuna spawning.
- 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 CO2.

- Data collected by the *Okeanos Explorer* such as routine conductivity, temperature, depth (CTD) data, and bathymetric mapping is made available through the *Digital Atlas.*

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

- Over 100 researchers and representatives from state and Federal agencies attend the 5th Annual Hypoxia Research Coordination Workshop. The workshop is conducted to update scientific understanding of hypoxic zone causes and impacts, and coordinate Gulf hypoxic zone research, monitoring and modeling activities. Participants focused on the tools and models used to examine the impacts of hypoxia on Gulf fisheries and their habitats in an ecosystem context, including humans. A proceedings paper entitled **"**Advancing Ecosystem Modeling of Hypoxia and Diversion Effects on Fisheries in the Northern Gulf of Mexico" was prepared (Ashby et al. 2015).
- The Geospatial Education and Outreach (GEO) Project continued to deliver 21 workshops that focused on both commercial and open source GIS applications and reached over 200 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 of 2014.
- The NOAA-NGI Diversity Internship Program supported 6 interns at 6 universities across the Gulf coast. The undergraduate and graduate students from underrepresented groups participated in NOAA activities at NOAA labs or on NOAA-funded projects or interest areas.
- Both oral presentations and posters were presented at significant meetings such as the American Meteorological Society Conference, the International Geoscience and Remote Sensing Symposium, and the Bays and Bayou Conference.
- 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 state and local resource management agencies.

Executive Summary of Economic Impact

The Northern Gulf Institute has several projects contributing to the economic development of our region. Examples include:

- Two versions of a hurricane parametric wind model under a BSD license have been released. This code has potential use to NOAA for forcing of ocean and storm surge models. The code is being included in Aquaveo's SMS software (http://www.aquaveo.com/), and other private industry has expressed interest in the code. (13-NGI2-54)
- Residents are concerned about marine debris, and it significantly influences their decisions to go to the beach. They will likely avoid littered beaches and spend additional time and money getting to a cleaner beach or pursuing other activities. Avoiding littered beaches costs local residents millions of dollars each year. Reducing marine debris on beaches can prevent financial loss and provide economic benefits to residents (NOAA MDP 2014). Marine debris can harm three important components of our economy: tourism, fishing, and navigation. Economic impacts are felt through loss in tourism dollars and catch revenue, as well as costly vessel repairs (EPA 2012). (14-NGI2-74)
- The FSU Fluxes project produces the 'FSU Winds' which are input to El Nino Southern Oscillation (ENSO) forecasts. ENSO forecasts are used as input to hurricane predictions and agricultural forecasts, each of which has economic consequences. (14-NGI2-77)
- The Mississippi Digital Earth Model (MDEM) project provided training in geographic information systems (GIS) for 216 participants in 21 multi-day workshops between July 1, 2014 and June 30, 2015. External funding from NOAA covered the costs of the training, resulting in a savings to Mississippi of approximately $500,000. MDEM also provided GIS training to employees and contractors to the Naval Research Laboratory and the Naval Oceanographic Office located at NASA Stennis Space Center. The training enhanced the technical expertise in geospatial systems of the local labor market. (14-NGI2-86)
- The Research Vessel Data Assembly Center at FSU collects, evaluates, distributes, and archives marine meteorological and surface oceanographic data from research vessels that are foundational with regards to our understanding and predicting marine weather and climate. The observations are used to ground truth similar observations made by space-based satellites which, in turn, are used in numerical weather prediction models. Additionally, the research vessel data are used to evaluate the performance of the numerical models. These prediction models are used by many agencies and private sector companies to support forecasts and decisions that impact economic sectors including, but not limited to, agriculture, fisheries, tourism, energy, transportation, etc. (14-NGI2-87)
- By Identifying important habitats for smalltooth sawfish and providing guidance to decrease interactions between commercial fisheries and this endangered species, we are providing an indirect economic benefit to fisheries.(14-NGI2-90)
- The observation and monitoring of coral reefs benefits the tourism industry. (14-NGI2-91)
- MSU worked with Altavian to develop a hand-launched UAS for data collection in riverine and near-shore environments. The research and development has helped the FAA to see the economic advantages of small UASs in environmental intelligence. (14-NGI2-93)

- The SNPP VIIRS satellite sensor for ocean color and sea surface temperature are providing an important contribution to the commercial fishing industry. NGI has developed algorithms to process the satellite date. Companies are using the VIIRS satellite data to inform fisherman of locations for most probable catch. (14-NGI2-102)

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 (Figs. 2 and 3).

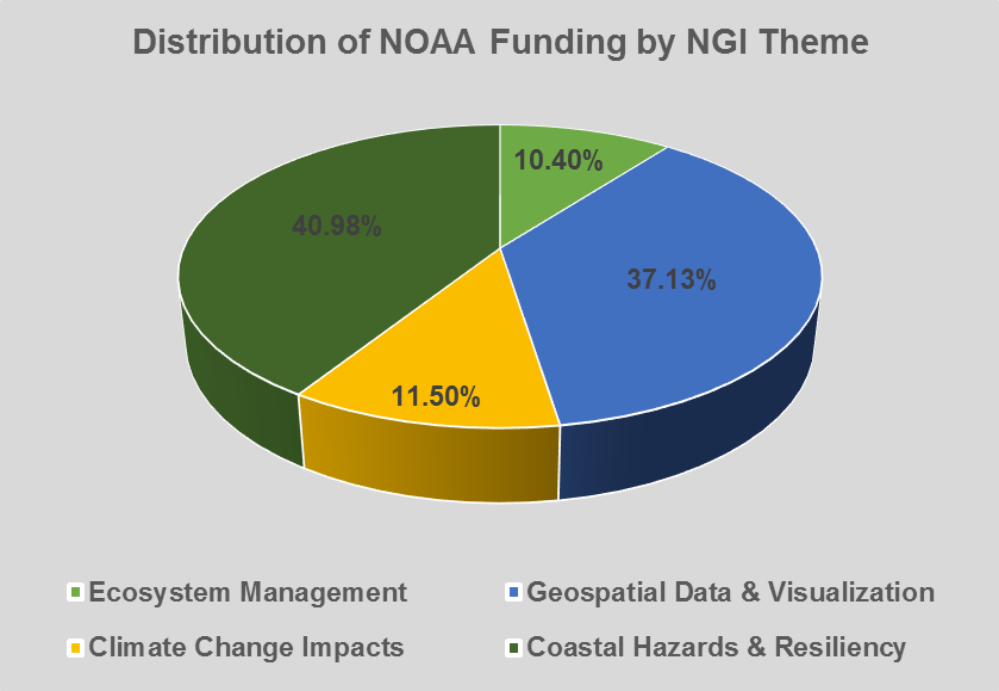


Figure 2 Distribution of NOAA funding by the four NGI themes.

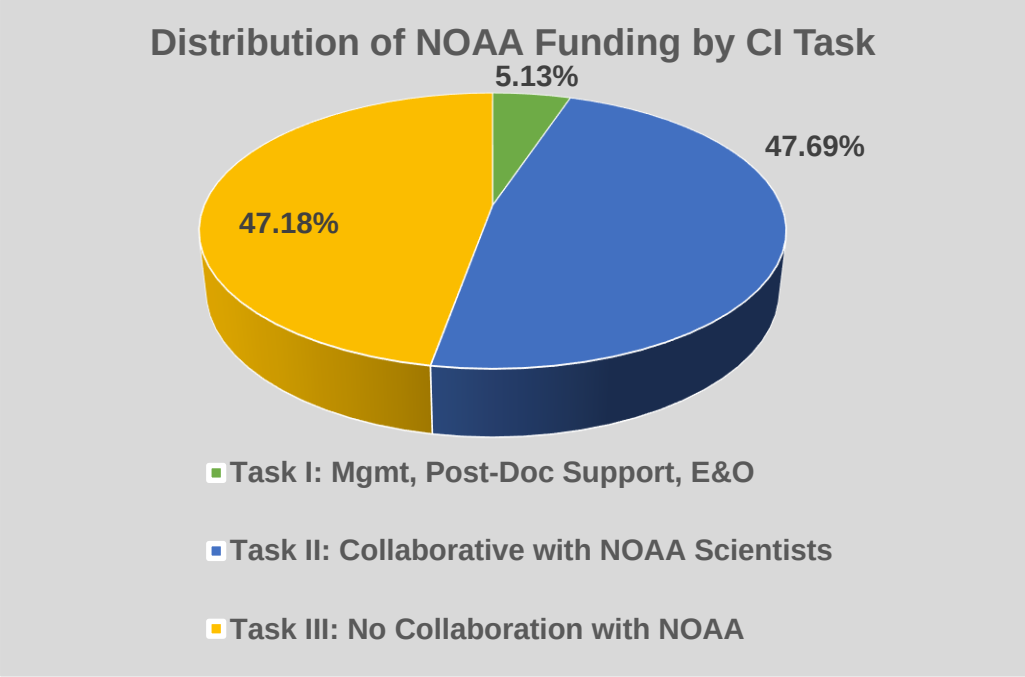


Figure 3 Distribution of NOAA funding by the three cooperative institute task categories.

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 (Fig.4). Administration included leading the efforts of the CI as well as program and project management on each of the traditional CI projects that were active during the funding period.

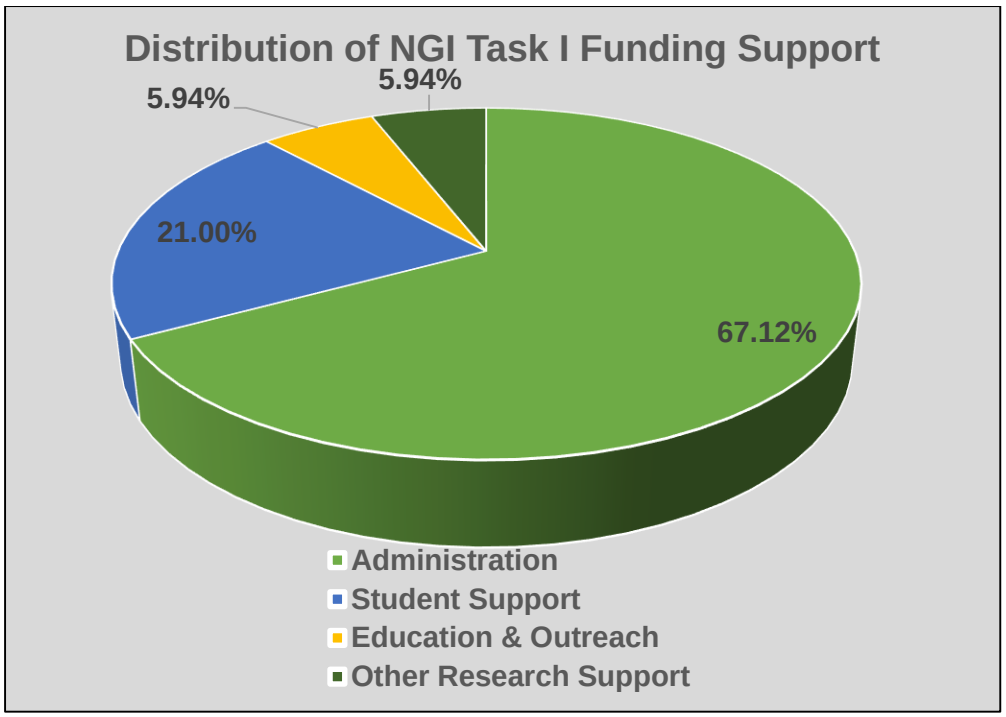


Figure 4 Distribution of NGI Task I funding.

PROJECT REPORTING (Note that the last 2 digits of the NGI File # correspond with the amendment # to NA11OAR4320199)

NGI File #12-NGI2-33: 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: Gustavo Goni, 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 to also 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 #13-NGI2-42: Applications of Advanced Satellite Microwave Radiances and Retrieval Products to NWP and Climate Studies

Project Lead (PI) name, affiliation, email address: Ming Cai, Florida State University, mcai@fsu.edu

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

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

Project objectives and goals

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

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

Biases in satellite-derived temperature trends due to orbital drift and orbital differences and their corrections.

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

The measurements from Microwave Sounding Unit (MSU) and Advanced Microwave Sounding Unit-A (AMSU-A) have been extensively used for atmospheric temperature trend study during last several decades. The existences of inter-sensor biases and orbital drift, orbital differences among different satellites are two major challenges for climate study using long-term time series of satellite measurements. In this study, the impacts of orbital drift and orbital differences of satellites on AMSU-A derived temperature trends over Amazon rainforest are investigated. The AMSU-A near-nadir observations from NOAA-15, NOAA-18, NOAA-19, and MetOp-A during 1998 - 2014 are employed. The double difference method is firstly applied to obtain the estimates of inter-sensor biases for each paired AMSU-A instruments, in which NOAA-18 is used as a reference satellite. The inter-calibrated observations from the four satellites mentioned above are used to calculate monthly mean diurnal cycles of brightness temperature for each of the 15 AMSU-A channels. The diurnal correction method is then applied to all AMSU-A data using the estimated diurnal-cycle variations in order to obtain corrected data valid at the same local time. Finally, it is shown that the inter-sensor bias correction and diurnal correction have significant impacts on the AMSU-A derived long-term atmospheric temperature trends.

Information on collaborators / partners (if applicable):

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

Information on any outreach activities:
General Description: During the reporting period, we attended 2014 AMS annual meeting to present our recently research results.
Hosted speakers, workshops and/or any training: None reported
Type (speaker, workshop, training): Speaker
Name of event: 2014 American Meteorological Society (AMS) annual conference; 2014 the 19th International TOVS Study (ITS) conference
Date: AMS annual conference: February 2-6, 2014; ITS conference: 26 March – 1 April 2014
Location: Atlanta, GA for the AMS meeting; Jeju Island, South Korea for the ITS conference
Description: One oral and two poster presentations at AMS meeting; Three oral presentations at ITS conference
Approximate Number of Participants: For AMS annual meeting, there were about 2,000 meteorologist; For ITS conference, there were about 100 participants.

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

Related NOAA Enterprise Objectives: Science and Technology

NGI File #13-NGI2-53: Pilot and Genomic Observatories to Characterize Gulf of Mexico Microbial Populations

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

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

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

Project objectives and goals

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

The value of the work is highly leveraged by the acquisition of microbial metagenomic information provided to us for free as participants of international Ocean Sampling Day efforts (see www.microb3.eu/osd). The information obtained is in the form of next-generation sequencing data that will form an extremely large microbial DNA sequence baseline data set that normally would be very expensive to obtain. It is anticipated that the genomic observatories established by this project will serve as a proof of concept for other sentinel sites in the Gulf of Mexico, and that the acquisition of other future funding will permit the long-term continuation of these observatories once they are established with this project. This project will serve to address a variety of NOAA mission goals including healthy oceans and resilient coastal communities and economies, and to conserve and manage coastal and marine ecosystems and resources.

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

Seawater samples were obtained during summer and winter solstices in 2014 and 2015, and processed according to Ocean Sampling Day guidelines. Samples were obtained from three sites in Florida (Site 37 - Port Everglades, Site 38 - Long Key, and Site 45 – Tampa Bay) and one site in the Northern Gulf (Site 46 – Horn Island). Samples from Mississippi were shipped on dry ice to NOAA in Miami, FL for consolidation and all samples were shipped to the Max Planck Institute for Marine Microbiology in Germany, the lead institution responsible for DNA extraction and sequencing.

Samples from the 2015 summer solstice have been collected and will be shipped to Germany before July 10th. Sample metadata and DNA sequence data from samples collected during the 2014 summer and winter solstices are now available through the European Nucleotide Archive at www.ebi.ac.uk/ena/. The amount of data is extremely large and we are now in the process of accessing processed sequence data, including 16S and 18S amplicon data as well as

metagenomic data. From the 16S amplicon data, we are identifying microbial features such as community structure, diversity and relative abundance and whether differences in such features are associated with habitat and environmental factors such as temperature, salinity and land-based pollution. From metagenomics data, we are identifying key ecosystem functions performed by dominant microbes at different sites.

Description of significant research results, protocols developed, and research transitions
Significant progress was made in the project this past year. An OSD Handbook that serves as a best practice guide describing procedures and policies on the marine sample collection, logistics and bioinformatics by the Micro B3 (Biodiversity, Bioinformatics, Biotechnology) Consortium is now available. Microbial genomic data from samples collected during the 2014 summer and winter solstices are being made available. We are now making the transition from sample collection/processing and DNA sequencing to data mining and bioinformatic analysis.

Information on collaborators / partners (if applicable):
Name of collaborating organization: NOAA OAR
Date collaborating established: September 1, 2013
Does partner provide monetary support to project? No, not directly. Support is through NOAA cooperative agreement # NA11OAR4320199 to NGI. Amount of support? $24,500 per year for two years.
Does partner provide non-monetary (in-kind) support? Yes, partner coordinates research activities associated with project and provides samples.
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. Efforts are now underway to enable bioinformatics analysis of the large amount of genomic data being made available. This includes the identification of specific locations of processed sequence and metagenomics data and establishment of pipelines to make the data more useable.

Information on any outreach activities: Not applicable

Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology

NGI File #13-NGI2-54: An Examination of Ocean-Forcing Issues in HWRF-POM and HWRF-HYCOM

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

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

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

Project objectives and goals

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

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

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

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

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

Description of significant results, protocols developed, and research transitions

HYCOM water temperature was more responsive to TC forcing than POM, especially on the eastern side "cold swath" region. This is a favorable attribute.

POM response, in contrast, was rather stiff, perhaps by design to restrict temperature drift and for operational consistency. Other issues to consider include: 1) POM's use of diffusive mixing, which means the shear-instability driven mixing is omitted; 2) POM has a weak diurnal signal, since initial conditions are based on daily GFS SST; and/or 3) POM's mixed layer can be too thick due to the coarser vertical resolution near the ocean surface

HYCOM exhibited a positive bias, especially after the tropical cyclone has passed. There may be a tendency to recover from mixing processes faster than observed. It may also be due to a peak wind stress negative bias, as typically the modeled hurricane was less intense than observed in HWINDS.

Future work will include collaborations with HRD and Hyun-Sook Kim, with the following goals:

- To properly assess ocean processes, uncertainty from wind forcing needs to be removed. We propose running HYCOM forced with an atmospheric reanalysis field. These include HRD's HEDAS data, MSU parametric hurricane wind scheme, MSU's 3DVAR reanalysis code, and RTMA
- Obtaining accounts on nJet, Theia, and HRD's mass storage unit to run the operational HWRF versions and have access to datasets not available on NOMADS.
- Interact with AOML researchers with frequent 7-10 day visits to Miami, and participate in conference calls and seminars, especially to study Hurricane Isaac's intensification near landfall.
- Repeat the research on Hurricane Edouard (2014)

Information on collaborators / partners:
We have with Hyun-Sook Kim, a contractor for NOAA's Modeling and Observing Integration Branch. She has been very helpful, providing model data, and feedback. The PI also visited AOML in June 2015 to share the results and discuss next steps.

Information on any outreach activities:
We have collaborated with Hyun-Sook Kim, Sue Chen from the U.S. Naval Research Laboratory, and Richard Yablonsky from the University of Rhode Island, and presented the results at:

Fitzpatrick, P. J., Y. Lau, and H.-S. Kim, 2014: Case study validation of HWRF-HYCOM and HYCOM-POM ocean coupling for Hurricane Isaac (2012). International Conference on Mesoscale Meteorology and Tropical Cyclones, September 15-18, 2014, Boulder, CO.

These results were also presented at the National Hurricane Center June 4, 2015.

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

Related NOAA Enterprise Objectives: Science and Technology

NGI File #13-NGI2-57: Lagrangian Based Habitat Assessment for Bluefin Tuna (Thunnus thynnus) Spawning in the Gulf of Mexico

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

Co-PI(s) name, affiliation, email address: Jerry Wiggert, University of Southern Mississippi, jerry.wiggert@usm.edu

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

Project objectives and goals

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

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

The FATE project organized data obtained during SEAMAP surveys (2009 - 2013) that have co-occurring AMSEAS and HYCOM ocean model data.

The research incorporated three coordinated approaches:

Backtrack modeling was employed to derive larval drift paths from likely spawning sources to net capture, through transport pathways identified through the use of current velocity fields from oceanographic model outputs (HYCOM and AMSEAS). The backtrack method was validated through comparison with available drifter data which showed a substantial decline in accuracy and an increase in system noise at backtracks beyond roughly 10 days.

Environmental indices associated with Bluefin tuna spawning were identified through the backtrack effort. Comparison with existing habitat models generally showed only a slight improvement in defining larval habitat. Several areas in the NW Gulf of Mexico were also identified as potential “hotspots” for spawning.

Emerging knowledge on the ecology of Bluefin tuna from the drift paths and apparent along path conditions revealed by the backtrack model effort do suggest spawning may be associated with the edges of anti-cyclonic features and along features of neutral ocean curl.

Description of significant results, protocols developed, and research transitions

Backtrack model results:

The comparison between the drifters and the model highlight that the longer the backtracking is the greater the error. After 10 days of backtracking the error is expected to be greater than 50% of the displacement. This indicates that for optimal results the backtracking should be used for less than 10 days. However because many larvae (about ½) are greater than 10 days old the analysis was forced with backtracks up to 20 days.

Environmental indices results:

This phase of the project was completed. Source code to reveal information on the preferred environmental conditions for spawning was developed and delivered to the NOAA PI. These routines determine the ocean conditions (temperature, salinity, currents, curl, mixed layer depth) at each potential spawning location. Subsequent routines extract environmental indices from the backtracking of sample locations where larvae are captured, based on their location and (size-based) age. A comprehensive view of the preferred conditions for spawning was developed by accumulating the indices at sampling locations where larvae are observed as well as where no larvae are obtained. However comparison of variables between backtracked samples with larvae in comparison to those without larva show only a slight effect. The lack of strong signal in this analysis may be due to the large amount of noise introduced in the backtracking that extended beyond 10 days.

Information on collaborators / partners:
Name of collaborating organization: NOAA/NMFS, SEFSC
Date collaborating established: 02/03/2014
Does partner provide monetary support to project? Amount of support? $57,258
Does partner provide non-monetary (in-kind) support? Not applicable
Short description of collaboration/partnership relationship: This project was carried out as a close collaboration between the NOAA/NMFS project scientist (Dr. Woody Nero) and the USM-DMS project team (Drs. Jerry Wiggert and Cléa Denamiel). Drs. Nero and Denamiel carried out the day-to-day project tasks, which was facilitated by the close proximity of the NMFS and DMS sites at Stennis. Dr. Wiggert met regularly (bi-monthly) with the USM-DMS postdoctoral scholar (Dr. Denamiel) to oversee the project's progress, provide guidance on research tasks, and facilitate access to any resource needs.

Information on any outreach activities: None reported

NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology

NGI File #13-NGI2-59: Toward Operational Uses of Geostationary Imagery & FY-3-Polar Orbiting Microwave Radiance Data in the GSI Analysis System

Project Lead (PI) name, affiliation, email address: Ming Cai, Florida State University, mcai@fsu.edu

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

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

Project objectives and goals

This project will refine data-related components that are important for assimilation of GOES imager radiance and FY-3 polar-orbiting microwave radiance data in National Centers for Environmental Prediction (NCEP) Gridpoint Statistical Interpolation (GSI) systems. The goal is to incorporate these data into NCEP operational forecast systems and to use them as preparation.

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

Developed and tested a cloud mask (CM) algorithm and applied to Advanced Himawari Imager (AHI) on board Himawari-8 data for assessing AHI data biases based on the O-B statistics in clear-sky conditions.

FY-3C MWTS striping noise diagnosis, mitigation and root-cause analysis.

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

Preliminary O-B results of AHI on board-

Himawari-8 Advanced Himawari Imager (AHI) is on board Himawari-8 that was successfully launched on October 7, 2014. AHI is comparable to the Advanced Baseline Imager (ABI) on board GOES-R, which is scheduled to launch in March 2016. Different from all earlier and other currently available GOES imagers, AHI provides a total of 16 channels, with 10 infrared channels (AHI channels 7-16, Table 1 and Fig. 5) to provide multiple atmospheric sounding channels that are especially important for numerical weather prediction (NWP) models for the first time. Codes were developed for eight infrared-channel-based cloud mask (CM) tests. The eight CM tests were applied to AHI full disk data at 0230 UTC January 25, 2015 to separate clear-sky pixels from cloudy pixels. Using AHI full disk data at 0230 UTC January 25, 2015, biases and standard deviations in clear-sky conditions for AHI channel 7-16 were finally obtained (Fig. 6) and provided to and presented at NOAA GOES-R team meeting on May 25, 2015 in a timely manner.

Table 1 Central wavelengths of the AHI channel 7-16 onboard Himawari-8.

Channel number	Central wavelength (μm)
7	3.9
8	6.2
9	6.9
10	7.3
11	8.6
12	9.6
13	10.4
14	11.2
15	12.4
16	13.3

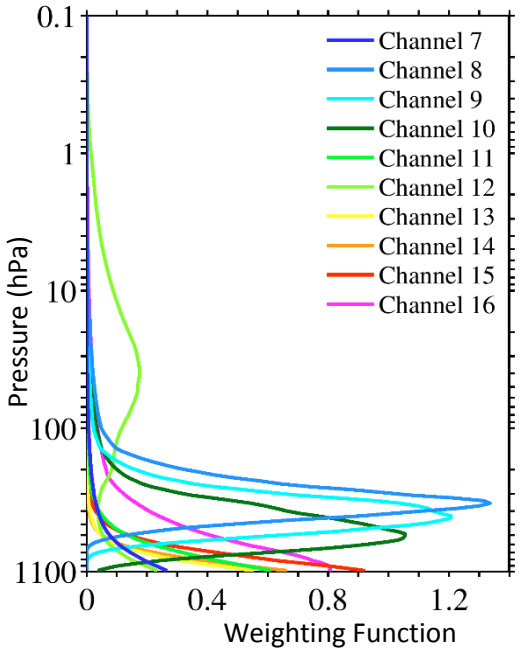


Figure 5 Weighting functions of AHI onboard Himawari 8 by using U.S. standard atmosphere as the input to CRTM.

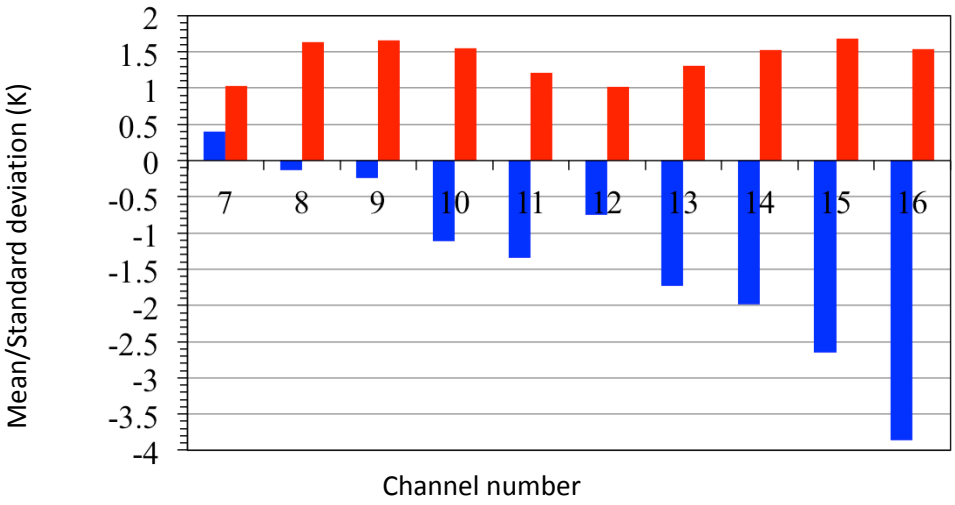


Figure 6 Mean (K, blue) and standard deviation (K, red) of (O-B) for AHI channel 7-16 of clear-sky observations (85,561 observations).

FY-3C MWTS striping noise diagnosis, mitigation and root-cause analysis-
Striping noise is a general problem for microwave sensors. It is identified within observations of a recent FY-3C microwave temperature sounder (MWTS). Striping noise within MWTS observation is with a magnitude of 1K, which is much larger than in ATMS. A transfer function is employed to explain the root cause of the striping noise. This transfer function is controlled by instrument parameters such as scan cycle, calibration integration time and scene integration time. Instrument noise is simulated by a white noise series with and without adding flicker noise. Power spectral analysis of this instrument noise is then forced by transfer function to produce the power spectral density of output noise. It is shown that flicker signal is the source of striping noise, and transfer function can modify the striping noise in terms of magnitude and peak frequency.

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

Information on any outreach activities: None reported

Related NOAA Strategic Goals: Weather-Ready Nation

Related NOAA Enterprise Objectives: Science and Technology

NGI File #13-NGI2-60: Development of Detailed Habitat Maps along the Continental Shelf of the Gulf of Mexico using Previously Collected Multibeam Sonar Data

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

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

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

Project objectives and goals

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

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

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

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

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

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

Detailed georeferenced habitat layers have been processed for ME70 multibeam sonar data collected by the National Marine Fisheries Service (NMFS) from the *NOAA Ship Pisces*. The habitat layers were generated using Fledermaus Geocoder in the form of geotiffs and ESRI ASCII files. Layers included normalized and beam-pattern corrected acoustic backscatter maps and bottom properties estimates including characterization, seabed roughness, and phi (grain size) attributes produced by Geocoder. These layers represent the current capabilities of remote acoustic backscatter interpretation and can be integrated with addition information sources to produce habitat characterization maps.

Multibeam datasets were also downloaded from the National Centers for Environmental Information (NCEI) within the northern Gulf of Mexico and acoustic backscatter maps were generated to infer areas of common habitat. These files were in the form of geotiffs.

To supplement the *Pisces'* ME70 data, habitat layers were generated for EM3002 multibeam data that was provided by David Narr at the University of South Florida. These layers were processed using the same methodology as the ME70 data. Deliverables included geotiffs and ESRI ASCII files of the habitat layers, including normalized and beam-pattern corrected acoustic backscatter and bottom properties including characterization estimates, seabed roughness, and phi (grain size) attributes.

An additional request by NMFS to further process data from the USGS to extract additional habitat layers is currently being investigated. This processing is underway for four sites and will be complete before the end of calendar year 2015. Deliverables will be similar to those of the previous ME70 and EM3002 processing efforts.

All completed project habitat layers were delivered to NMFS for inclusion into their existing GIS database, allowing enhancement of the layers value through correlation to other habitat metrics.

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

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

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-NGI2-66: Establishing Secure Long-Term Archival for NOAA/NMFS Preserved Specimens at USM's Plankton Archival Facilities

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

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

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

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
We acquired and maintained secure and controlled storage at USM facilities at Stennis Space Center for preserved plankton specimens.

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

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

Information on any outreach activities: Not applicable

Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Organization and Administration

NGI File #14-NGI2-69: Bias Characterization and Hurricane Initialization Using ATMS, SSMIS, and AMSR-2

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

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

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

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

Description of research conducted during the reporting period and milestones accomplished and/or completed
A spectral difference method is used for RFI detection method over land of satellite AMSR2 imager data using a newly added 7.3 GHz AMSR2 channel

A set of the 22 “optimal” filters was designed and tested for striping mitigation directly in ATMS brightness temperature observations

Optimal filters for striping noise mitigation within ATMS calibration counts

TFI detection over ocean

Description of significant research results, protocols developed, and research transitions
AMSR2 RFI Detection over Land-

RFI signal in satellite microwave imager radiances over land must be detected and removed from the contaminated data before the radiance data are used for retrieving geophysical parameters such as soil moisture content. In order to mitigate the RFI in C-band channels, two new C-band channels centered at 7.3GHz are added to AMSR-2. In this paper, we evaluated the results of a spectral difference method for detecting RFI signals in AMSR-2 data over North and Central Americas. For the study cases of AMSR-2 data, a strong RFI is detected at the AMSR-2 C-band channels at 6.925GHz at both horizontal and vertical polarization over North America. The RFI signals are populated near the metropolitans of the United States. However, the newly added C-band channels at 7.3 GHz are mostly RFI-free except in Mexico, Washington D. C. and New York. There are no RFI over Mexico at 6.925GHz for both polarization states. The only places where RFI occur at both C-bands of AMSR-2 are Washington D. C. and New York for the horizontal polarization state. It is thus concluded a successful mitigation of RFI is achieved in AMSR-2 observations over North America.

Striping Noise Mitigation in ATMS Brightness Temperatures and Its Impact on Cloud LWP Retrievals-

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.

Optimal Filters for Striping Noise Mitigation within ATMS Calibration Counts-

Advanced Technology Microwave Sounder (ATMS) has been flying on the Suomi National Polar-orbiting Partnership (NPP) satellite since October 28, 2011. A striping phenomenon contained in the global distribution of O (observations) minus B (model simulations) difference was detected in different ATMS channels. In this study, optimal filters are designed for smoothing out the striping noise in warm counts, cold counts, warm load temperatures and scene counts. The optimal filters are developed based on the striping noise free results obtained by a combined method of the principal component analysis (PCA) and the Ensemble Empirical Mode Decomposition (EEMD). 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 that from the PCA/EEMD method. It is further demonstrated 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.

TFI Detection over ocean-

The geostationary satellite television (TV) signals that are broadcasted over various continents could be reflected back to space when they reach ocean surfaces. If reflected TV signals are intercepted by an antenna view of microwave imager on board polar-orbiting satellites, they are mixed with the thermal emission from the Earth and result in direct contamination on the satellite microwave imager measurements. This contamination is referred as Television Frequency Interference (TFI) and can result in erroneous retrievals of oceanic environmental parameters (e.g., sea surface temperature and sea surface wind speed) from microwave imager measurements. In this study, a principal component analysis (PCA)-based method is applied for detecting the TFI signals over oceans from the Advanced Microwave Scanning Radiometer (AMSR-E) on board the Earth Observing System (EOS) Aqua satellite. It is found that the third principal component of the data matrix of the AMSR-E spectral difference indices from each AMSR-E swath captures the TFI contamination. The TFI-contaminated data on AMSR-E descending node at both 10.65 and 18.7 GHz frequencies can be separated from un-contaminated data over oceanic areas near the coasts of Europe and United States continents based on the intensity of the data projection onto the third PC. Compared to the earlier methods, the proposed PCA-based algorithm works well on the observations without a priori information and is thus applicable for broader user applications.

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

Information on any outreach activities:
General Description: During the reporting period, we attended 2015 AMS annual meeting to present our recently research results.
Hosted speakers, workshops and/or any training: None reported
Type (speaker, workshop, training): Speaker
Name of event: The 95th AMS Annual Meeting
Date: January 4-8, 2015
Location: Phoenix, AZ
Description: A poster presentation
Approximate Number of Participants: For AMS annual meeting, there were about several hundred participating scientists.

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

Related NOAA Enterprise Objectives: Science and Technology

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

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

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. Towards this end, we completed four research cruises off the coast of Alabama on board the *R/V EO Wilson* in 2014 (May 21, June 17 and 27, and July 23). After July 2014, *Sargassum* was seldom reported, therefore funds were reserved for additional surveys in 2015 (see below). Using a variety of sampling gear (e.g., neuston net, plankton purse seine, dip nets, hook-and-line sampling) we collected approximately 618 kg of *Sargassum* algae which was sorted for fishes (402 larvae, juveniles and adults) and decapods (53,298 larvae, juveniles and adults), as well as 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 a portion of the 2010 samples. We anticipate completing the gut dissections from 2010 and 2011 samples by the end of the project period. Additional samples were collected on June 9, 2015; these are currently being sorted for fishes, invertebrates, and debris. We are currently exploring the possibility of yet an additional trip, pending a review of our current budget.

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. The associated fish community was dominated by relatively few taxa (Table 2). Pipefishes (*Syngnathus* spp.), filefishes (*Stephanolepis* spp.) and the Sargassumfish (*Histrio histrio*) comprised approximately 85% of the total catch. Gut contents from samples collected in 2014 contained mostly natural prey items, including copepods, other zooplankton, Sargassum shrimp, hydroids, and fishes, depending on predator size. In some instances, small bits unidentifiable particles were taken

from fish guts, and are presumed at this point to be debris. Of these particles removed from fish guts, most resembled small, threadlike pieces (Figure 7) of the type also found among other debris in the *Sargassum* sample. Overall, our initial observations suggest that there is some ingestion of small debris by fishes associated with Sargassum, though the frequency of occurrence is relatively low. We have to increase our sample size of fish dissections to examine this further.

Table 2 Total number, size range, and percentage of total catch for Sargassum-associated fishes collected in 2014 using a variety of samplers (dip net, plankton purse seine, neuston net, and hook and line).

Common Name	Scientific Name	Total Number	Size Range (mm)	% Total Catch
Sargassumfish	*Histrio histrio*	73	9.1 - 47.5	18.34
Unknown Needlefish	Belonidae	1	31	0.25
Unknown Pipefish	Syngnathidae	1		0.25
Unknown Pipefish	*Syngnathus sp.*	116	19 - 159	29.15
Unknown Jacks	*Caranx sp.*	3	11.2 - 31.9	0.75
Blue Runner	*Caranx crysos*	9	11.9 - 129.6	2.26
Atlantic Bumper	*Chloroscombrus chrysurus*	5	7.1 - 13	1.26
Round Scad	*Decapterus punctatus*	1	41.1	0.25
Unknown Amberjacks	*Seriola sp.*	3	45.9 - 152	0.75
Common Dolphinfish	*Coryphaena hippurus*	8	37.4 - 590	2.01
Unknown Snapper	*Lutjanus sp.*	1	11.8	0.25
Bermuda Sea Chub	*Kyphosus sectatrix*	4	21.2 - 52.9	1.01
Unknown Damselfish	Pomacentridae	1	10.6	0.25
Sergeant Major	*Abudefduf saxatilis*	15	13.4 - 31	3.77
Ocean triggerfish	*Canthidermis sufflamen*	2	10.2 - 78.5	0.5
Unknown Filefishes	*Monacanthus sp.*	1	12.9	0.25
Unknown Filefishes	*Stephanolepis sp.*	52	6.1 - 25.2	13.07
Planehead Filefish	*Stephanolepis hispidus*	96	11.4 - 64.9	24.12
Pygmy Filefish	*Stephanolepis setifer*	6	8.1 - 26.3	1.51

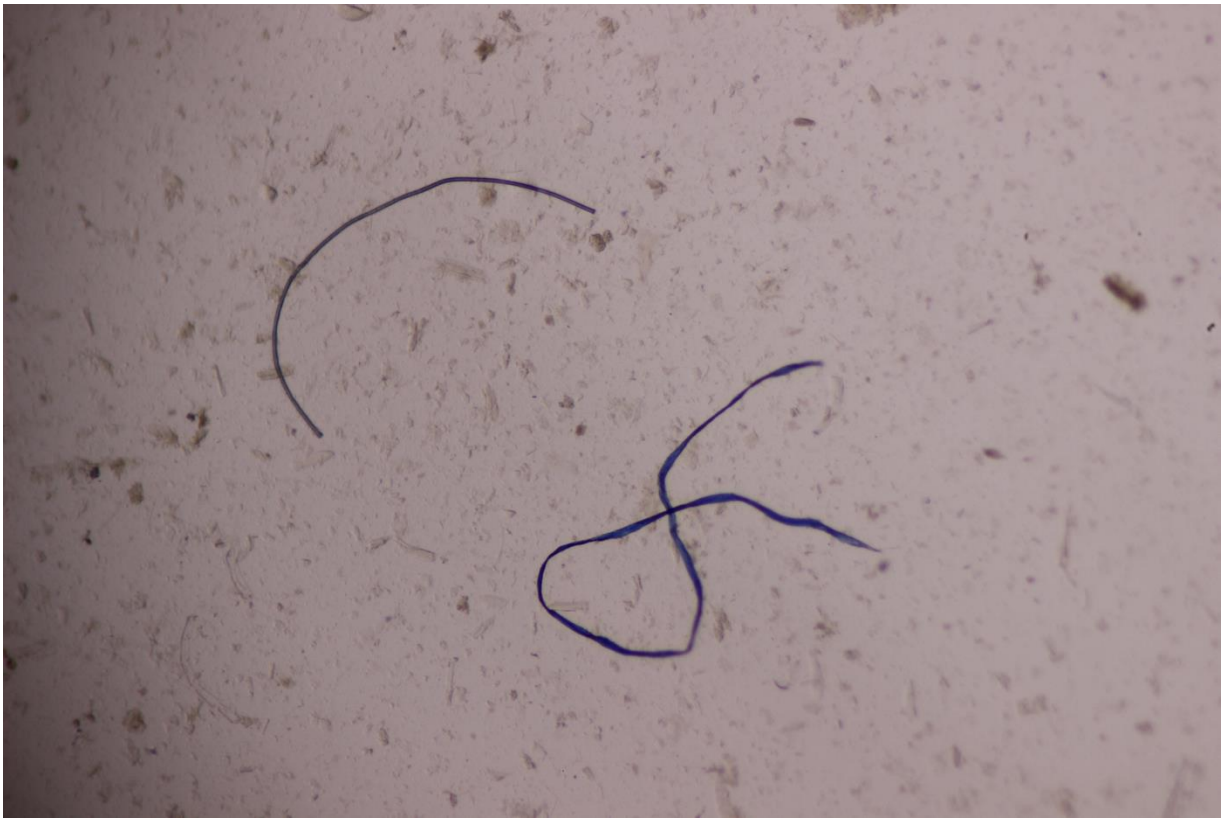


Figure 7 Two unidentified debris filaments dissected from the stomach of a juvenile Seriola sp. (amberjack species).

Information on collaborators / partners: Not applicable

Information on any outreach activities: Because this is only a pilot effort, we did not anticipate a large outreach component. However, we have been able to incorporate a relatively large educational aspect. Two summer internships (one high school, one undergraduate) were funded by this project; these student participated on field collection cruises and worked on sample sorting during summer 2014. In addition, a M.S. graduate student's stipend has been funded through the project as well. This student has also 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. In addition to these students, numerous other interns (3, including 2 funded by the NGI Diversity Program), graduate students (2), research technicians (7), and a postdoc (1) have participated in the field and 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, Mississippi State University, mercer@gri.msstate.edu

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

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 is 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 shows the anticipated progress on the project through the end of year 1 (Table 3). A brief summary of the activities up to this point is provided as well. *As of this annual report, tasks 1-3 are completed, with task 4 ongoing.*

Table 3 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:

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.

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 resulted in composite fields such as provided in Fig. 8.

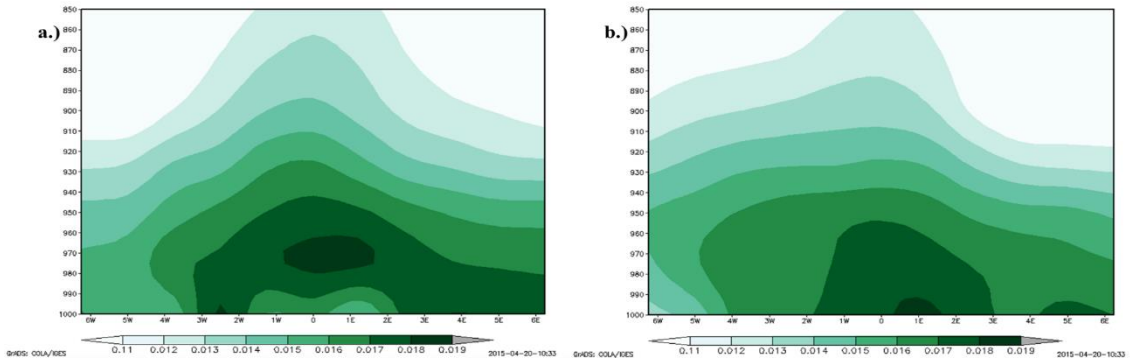
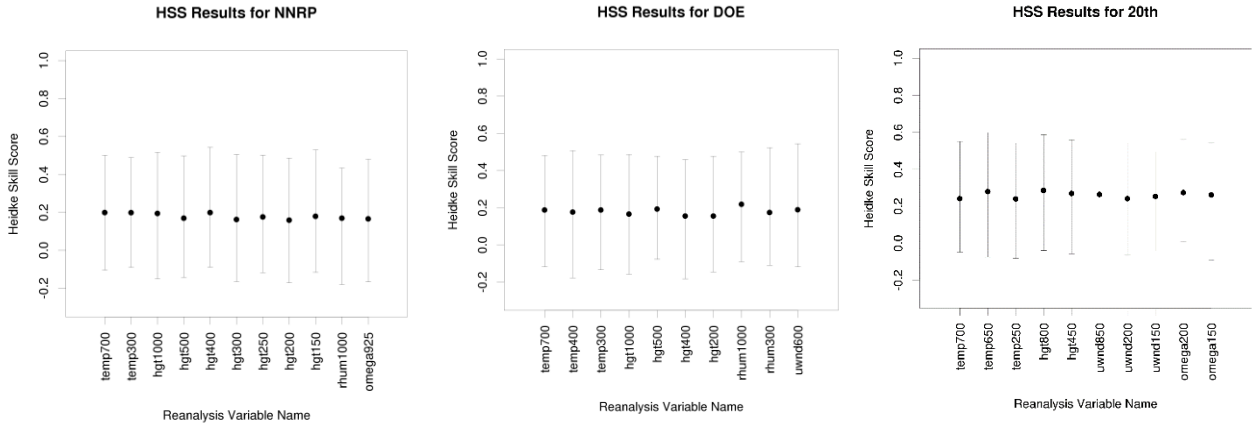


Figure 8 Composite specific humidity data from GEFS reforecast data for a RI storm (left panel) and a non-RI storm (right panel).

S-mode RPC score fields were evaluated for further aid in identifying dominant patterns in the group of variables mentioned above. The S-mode work is currently ongoing, and a publication on these results will be submitted soon.

Additional S-mode work looking at the important variables for RI has been completed by utilizing multiple reanalysis datasets (NCEP/NCAR reanalysis, NCEP/DOE reanalysis, MERRA reanalysis, and the 20th century reanalysis). Results have been largely inconclusive, but seem to suggest low and mid-level temperature and humidity are important, and that generally speaking, kinematic fields have much less skill in classifying storm type than thermodynamic fields. The results have been submitted for publication in Procedia Computer Science for the Complex and Adaptive Systems conference. Some results are provided below in Fig. 9

Work on the remaining tasks will begin this summer, and a trip to AOML to discuss these preliminary results is tentatively planned for Fall 2015.



(a) (b) (c)

Figure 9 HSS results for the NCEP reanalysis (panel a), the NCEP/DOE reanalysis (panel b), and the 20th century reanalysis (panel c). The variable and level that was best is shown on the x-axis for each reanalysis set (the top 10 ranked variables are shown for each).

Description of significant results, protocols developed, and research transitions:
At this stage, model development is still ongoing, so no final product to be transferred into research operations is yet available. However, the work up to this point has identified some interesting and important findings for the larger goals of the project, namely:

The dry slot, a distinguishing characteristic between RI and non-RI storms in previous work using MERRA reanalysis, is largely missing from the GEFS composite fields.

However, multiple reanalysis fields still suggest the importance of the low-level moisture fields in distinguishing RI from non-RI.

Major conclusions from previous work suggested that the vertical stackedness of the vertical velocity fields in the composite RI maps was important as a distinguisher. These results were largely shown to not be the case in the reanalysis work.

The importance of vertical and horizontal information in the reanalysis fields, as well as horizontal and vertical resolution of the datasets, is very important for classification. This suggests the need for more higher-resolution datasets and that other model datasets may need to be considered in future work.

Information on collaborators / partners:
Name of collaborating organization: NOAA/AOML
Date collaborating established: Not reported
Does partner provide monetary support to project? Amount of support? Not reported
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 year 2 to discuss the intermediate results and to discuss transition into operations upon completion of the project.

Information on any outreach activities: None

Related NOAA Strategic Goals: Weather-Ready Nation

Related NOAA Enterprise Objectives: Science and Technology

NGI FILE #14-NGI2-72: Expanding the Integrated Ecosystem Assessment for the Northern Gulf of Mexico Estuaries

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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 (c.f. Coen et al. 2007). Thus, by focusing on oysters we can implement an ecosystem approach to management by evaluating how mandated and proposed management actions regarding a keystone species will alter the delivery of ecosystem services. NGI collaborators and the NOAA Gulf of Mexico IEA have already identified ecosystem services potentially provided by the Gulf of Mexico marine, coastal, and estuarine ecosystem (Carollo et al. 2013). 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 (Monitoring Well-being and Changing Environmental Conditions in Coastal Communities: Development of an Assessment Method, Dillard et al., 2013) and incorporated into the IEA.

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

A literature review was conducted to develop provisional list of ecosystem services associated with oyster reefs in the Gulf of Mexico. A list of ecosystem services was developed for oyster reefs and refined for use in this project. TroSim was selected as a suitable model for evaluating impacts of varied freshwater inflows on ecosystem services of oyster reefs. TroSim was set up for scenario analysis using oyster reef data for the MS Sound.

Team members participated in a series of workshops conducted by the MS Department of Marine Resources (MDMR) in response to an Executive Order from MS Governor Phil Bryant to form an Oyster Council and develop a Restoration and Resiliency plan. The council included scientists, state agency personnel, community leaders, elected officials, seafood industry representatives, and local citizens. Three committees (Oysters in the Environment, Oysters in the Economy, and Aquaculture and Emerging Technologies) meet on numerous occasions from February to May in 2015 and a final report was released in June of 2015. These workshops provided a detailed assessment of management needs.

In addition to numerous team conference calls, a team meeting was conducted in June of 2015 to discuss a planned demonstration of TroSim modeling for participants in the Oyster Council to receive additional input on the use of TroSim for management applications.

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

The following list includes the top five potential ecosystem services that could be provided by oyster reefs in the Gulf of Mexico:

Food/Fisheries: provided by oysters is related to the harvest of the oyster itself. Oyster commercial harvesting in the Gulf of Mexico exceeds all other regions of the country, with Louisiana and Texas ranking first and second in terms of pounds and commercial value of landings according to the NOAA National Marine Fisheries Service

Water Quality: is the role oyster reefs play (and the value people place) in maintaining or improving water quality. This attribute is directly linked to services such as nutrient regulation and pollutant attenuation, which lead to clearer and cleaner water and to improved aesthetic and recreational opportunities as more people are interested in recreating and enjoying places with clean water versus polluted and murky water.

Biological Interactions: indicate species interactions and biodiversity and are embedded within every coastal and marine ecosystem. These have a fundamental role in maintaining the services provided by coastal and marine ecosystems, and some do not consider them services per se but rather basic processes that contribute to an ecosystem's own functioning.

Natural Hazard Moderation/storm protection/disturbance regulation: is the role of oyster reefs in reducing the effects of extreme weather events such as floods, droughts, or hurricanes by slowing wave energy and fast moving waters.

Aesthetics and Existence; aesthetics is the appreciation of natural scenery for its beauty and visual sense. In the case of oyster reefs, the aesthetic quality is based upon elements such as structural diversity, quality of the water, “greenness”, and tranquility. Existence is the value people place in knowing these three habitats exist.

Other potential services are:

Nutrient Regulation: indicates the maintenance of major nutrients within acceptable bounds.

Raw Materials: include materials for building and manufacturing, fuel and energy, soil and natural fertilizers.

Spiritual and Historic sites.

Science and Education: indicates the use of natural areas for scientific and educational enhancement.

Soil and Sediment Retention: is Erosion control and sediment retention.

Recreational Opportunities: Opportunities for rest, refreshment, and recreation such as recreational fishing.

Ornamental Resources: Resources for fashion, handicraft, jewelry, decoration, worship, and souvenirs.

Missing from these lists is the service described as habitat, which indicates oyster reefs’ provision of habitat for fish species, crustaceans, and other living marine resources.

Based upon GecoServ.org the most valued services provided by oyster reefs are: recreational opportunities; nutrient regulation; food; and habitat. Several methods are used to value these services: Willingness to Pay, Market Price, Travel cost method, Productivity method, Replacement cost, Damage cost avoided, and Benefit transfer.

To explore changes in ecosystem state resulting from various oyster reef management scenarios and predict changes in ecosystem service provision, the following TroSim parameters for daily output should be considered:

Biomass, for all producer and consumer species – To determine changes in food provision.

Habitat Suitability Indices (HSI's) for Temperature, Salinity, Dissolved Oxygen, Current Velocity, Water Depth (for all producer and consumer species) – To determine changes in habitat provision.

Producer Biomass Increment (separated into daily estimates of primary production, grazing, dark respiration, photo-respiration, non-predatory mortality, sinking) – To possibly determine carbon sequestration.

Nutrient Recycling (calculated as %error from daily environmental read-in data, relative to model estimates of autochthonous nutrient recycling) – To determine nutrient regulation and water quality.

Additional information such as changes to the three-dimensional structure of oyster reefs would be useful to determine changes in the provision of storm protection and habitat (which can be linked to recreational opportunities).

Ecosystem Modeling

In coastal MS waters, there are a variety of environmental stressors which can affect the productivity of ecologically- and commercially-important shellfish species, such as oysters. Managers of the MS living resources are often burdened with the difficult task of managing stressors like fresh-water diversions, seasonal hypoxia, and the timing/intensity of harvest pressure. Current efforts have been devoted to developing a modeling approach, specifically within the IEA framework, to explore a variety of management scenarios which can be tested first in model-space to estimate potential impacts on target shellfish species (oysters), so the appropriate management decisions can be made and ultimately applied in the field.

TroSim being developed for this management task has already been developed for use in MS coastal marine ecosystems and is a derivation of the Chesapeake Bay TroSim model originally developed by Fulford et al. (2010) using the Comprehensive Aquatic Simulation Model (CASM) framework from Bartell (2003) et al. (1999). TroSim is a carbon budget model which uses a modular "functional group" approach, where any number of species can be added/removed from the model and grouped by species function, such that the competition parameters and food web connectivities between and among modeled species may vary in space and time, but the fundamental equations defining production, consumption, and growth do not. Unlike classic fisheries models (e.g. Ecopath with Ecosim, or EwE) which are typically used to provide multi-decadal ecosystem simulations with annual temporal resolution, TroSim is specifically designed to explore aquatic food web dynamics which operate over much shorter time-scales (1-5 years) but with daily resolution, thus allowing its use to test management strategies which become manifest within days or weeks, not years.

The environmental stressors which can be manipulated within TroSim (temporally and spatially) to test various management scenarios under the IEA framework include:

Thermal gradients/extremes
Salinity gradients/extremes
Light availability (either as a function of microalgal production or suspended sediment load)
Eutrophication/nutrient mitigation (using nitrogen, phosphorus, and/or silica)
Sediment delivery/resuspension
Detrital delivery/deposition
Seasonal hypoxia (as a function of frequency and intensity)

Research efforts in the current evaluation year have focused on: 1) an exhaustive literature review and justification of each competition parameter for each of the species listed below; 2) acquisition and analysis of 2009 trawl data from MDMR to determine fish/invertebrate population densities for various oyster reefs within the MS Sound (for model initialization and calibration); 3) acquisition and analysis of 2009 oyster "square meter" assessments from MDMR to determine Sack, Seed, and Spat population densities for various oyster reefs within the MS Sound (for model initialization and calibration); and 4) extensive model code revisions and calibration for 2009 (pre-oil) oyster reef ecosystems. The modeled species within the oyster reef food web include:

Oyster Reef (Oysters as target)
Primary Producers
Phytoplankton
Macroalgae/Periphyton
Crustacean Zooplankton
Mesozooplankton
Microzooplankton
Benthic Invertebrates
Blue Crab
Mud Crab
Oyster Drill
Oyster (Spat, Seed, & Sack)
White Shrimp
Brown Shrimp
Grass Shrimp
Molluscs (Generic Bivalves)
Zoobenthos (Generic Meiofauna)
Pelagic Omnivorous Fishes
Bay Anchovy
Silversides
Killifish
Minnow
Gulf Menhaden
Striped Mullet
Pelagic Carnivorous Fishes
Red Drum (Juvenile & Adult)
Sea Trout (Juvenile & Adult)
Demersal Omnivorous Fishes
Black Drum (Juvenile & Adult)
Catfish (Juvenile & Adult)
Sheepshead (Juvenile & Adult)
Pinfish (Juvenile & Adult)
Toadfish (Adult)
Goby/Blenny (Generic Adult)
Demersal Carnivorous Fishes
Atlantic Croaker (Juvenile & Adult)
Spot (Juvenile & Adult)

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 water quality model (Water Quality Analysis Simulation Program, WASP) to simulate these parameters in space and time.

EFDC is a state-of-the-art hydrodynamic model that simulates three-dimensional aquatic systems. The model has been in use for over 20 years and is one of the most widely used

hydrodynamic models world-wide. It uses a stretched or sigma vertical axis and a Cartesian or curvilinear horizontal plane. The model solves vertically hydrostatic; free surface; turbulent averaged equations of motion for a variable-density fluid; dynamically-coupled transport equations for turbulent kinetic energy; and turbulent length scale, salinity, and temperature.

WASP was originally developed in 1983 and is now one of the most widely used water quality models in the US and throughout the world. WASP simulates three-dimensional dynamic compartments in aquatic systems. It included both the water column and the benthos. Time varying advection, dispersion, mass loading, and boundary exchange are all simulated.

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 and the index of agreement was 0.93. We have access to this model and grid (Figure 10) and are currently running the model for the Bay St. Louis area.

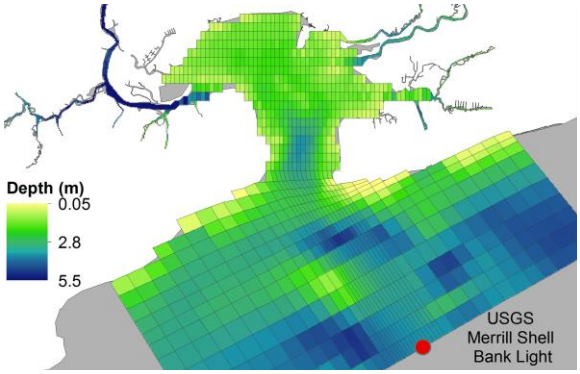

Figure 10 Bay St. Louis EFDC grid. Taken directly from Camacho et al. (2014).

An EFDC/WASP model of the lower Pearl River has also been developed (Jackson, 2013). This model simulates flow, N, P, BOD, chl *a*, and DO. The model achieves excellent results with a correlation coefficient to observed flows ranging between 0.91-0.99. These models can be used to improve input variables to TroSim applications and provide more robust hydrodynamics and water quality interactions.

Management Needs

The MS Department of Marine Resources (MDMR) manages 17 natural oyster reefs (Oysterman's Guide to Mississippi Gulf Coast Oyster Reefs. 2013). Approximately 97% of the commercially harvested oysters in Mississippi come from the reefs in the western Mississippi Sound, primarily from Pass Marianne, Telegraph and Pass Christian reefs. Harvesting oysters is done primarily by tonging or dredging. Due to heavy damage to the reefs in 2005 when Hurricane Katrina hit the MS Gulf Coast, MDMR, developed a 5 year plan for restoration, enhancement, and monitoring of oyster reefs. In 2012, the Gulf States Marine Fisheries Commission released a regional management plan for the oyster fishery (VanderKooy, S. (editor), 2012). These two activities provided detailed information on stressors to the reefs and recommended management needs.

The Oyster Council identified a number of management needs (in agreement with previous findings) that can be informed by scenario analysis using TroSim (and EFDC/WASP). Water

quantity and water quality were major concerns identified (The Governor's Oyster Council for Restoration and Resiliency, Final Report, June 2015). Additionally, recommendations included the formation of organizations and partnerships for improved reef management activities and reef restoration, enhancement, and expansion associated with restoration funding from the oil spill of 2010. The recommendations also focused on changes in leasing and aquaculture activities that will require changes regulations. Inclusion of ecosystem services and valuation of these services can be used to inform decision makers.

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?
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 Ecosystem Integration and Assessment, Habitat Conservation and Restoration, and Environmental Education. There are many areas in common with the IEA project that allow technical exchanges.

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

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Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology

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Camacho, R.A.; Martin, J.L.; Watson, B.; Paul, M.J.; Zheng, L.; and Stribling, J.B., 2014. Modeling the Factors Controlling Phytoplankton in the St. Louis Bay Estuary, Mississippi and Evaluating Estuarine Responses to Nutrient Load Modifications. *Journal of Environmental Engineering*.

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VanderKooy, S. (editor), 2012. The Oyster Fishery of the Gulf of Mexico, United States: A Regional Management Plan – 2012 Revision. Publication No. 202. Gulf States Marine Fisheries Commission, Ocean Springs, Mississippi

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, jcebrian@disl.org

Co-PI(s) name, affiliation, email address: Caitlin Wessel, Dauphin Island Sea Lab, 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
Shoreline marine debris monitoring has occurred for 5 monthly periods during this reporting period (Table 4).
Initial clean-ups- Feb. 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 28th

Table 4 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 ID'd, 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 11).

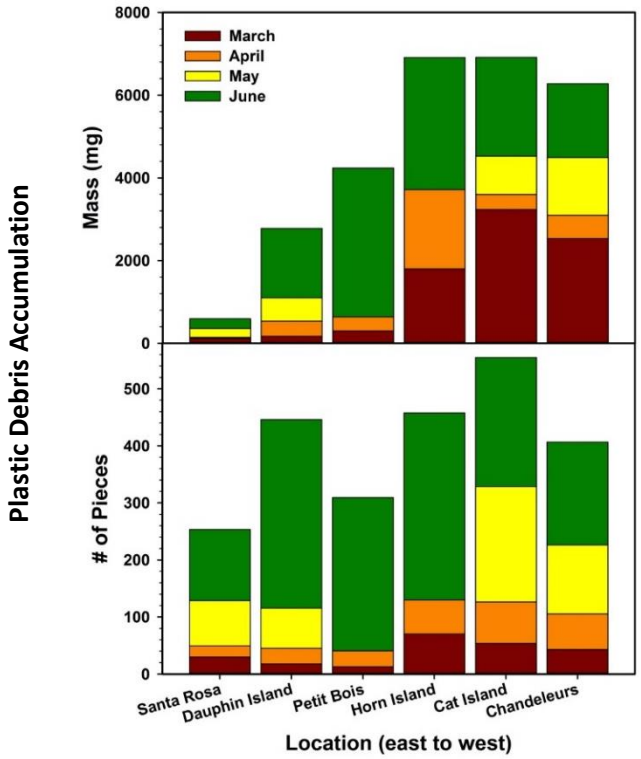

Figure 11 Preliminary results of the amount of plastic debris collected from the ocean side of barrier islands during March, April, May, and June 2015.

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, Mississippi State University, peter.allen@msstate.edu

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

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:

Objective 1: Quantify water chemistry changes within the Choctawhatchee River Basin

Objective 2: Analyze fin ray samples for trace element changes corresponding to different ages of the fish

Objective 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 overlayed 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-NGI2-76: 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

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

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

Project objectives and goals
This project aims at refining the GOES and GOES-R satellite data assimilation part of the NCEP GSI/ARW for improved coastal quantitative precipitation forecasts (QPFs). The radiance observations from current GOES imager and future GOES-R Advanced Baseline Imager (ABI) instruments will be incorporated into the GSI/ARW system, along with scientifically sound, physically based, and operationally workable algorithms for bias correction, cloud detection, data thinning and quality control.

Description of research conducted during the reporting period and milestones accomplished and/or completed
Improved tropical storm forecasts with GOES-13/15 imager radiance assimilation and asymmetric vortex initialization in HWRF

Improved quality control of GOES 3.9 □m channel associated with the effect of sunlight

Description of significant results, protocols developed, and research transitions
GOES-13/15 Imager Radiance Assimilation in HWRF-

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

Improved quality control of GOES 3.9 □m channel associated with the effect of sunlight-

A careful diagnosis of the convergence of GOES data assimilation revealed a divergence of GOES 3.9 □m channel when observations of this channel are assimilated in the current NCEP GSI system. It was found that areas of the largest O-B (i.e., differences between observations and model background) after GSI quality control correspond to areas of small sunlight angle at 1800 UTC, 0000 UTC, and 1200 UTC (see Fig. 12). At these regions the absolute values of O-A (i.e., differences between observations and analyses obtained from GOES data assimilation) are larger than the absolute values of O-B, which is defined as a divergent phenomena. An improved quality control was proposed and implemented into the HWRF GSI system.

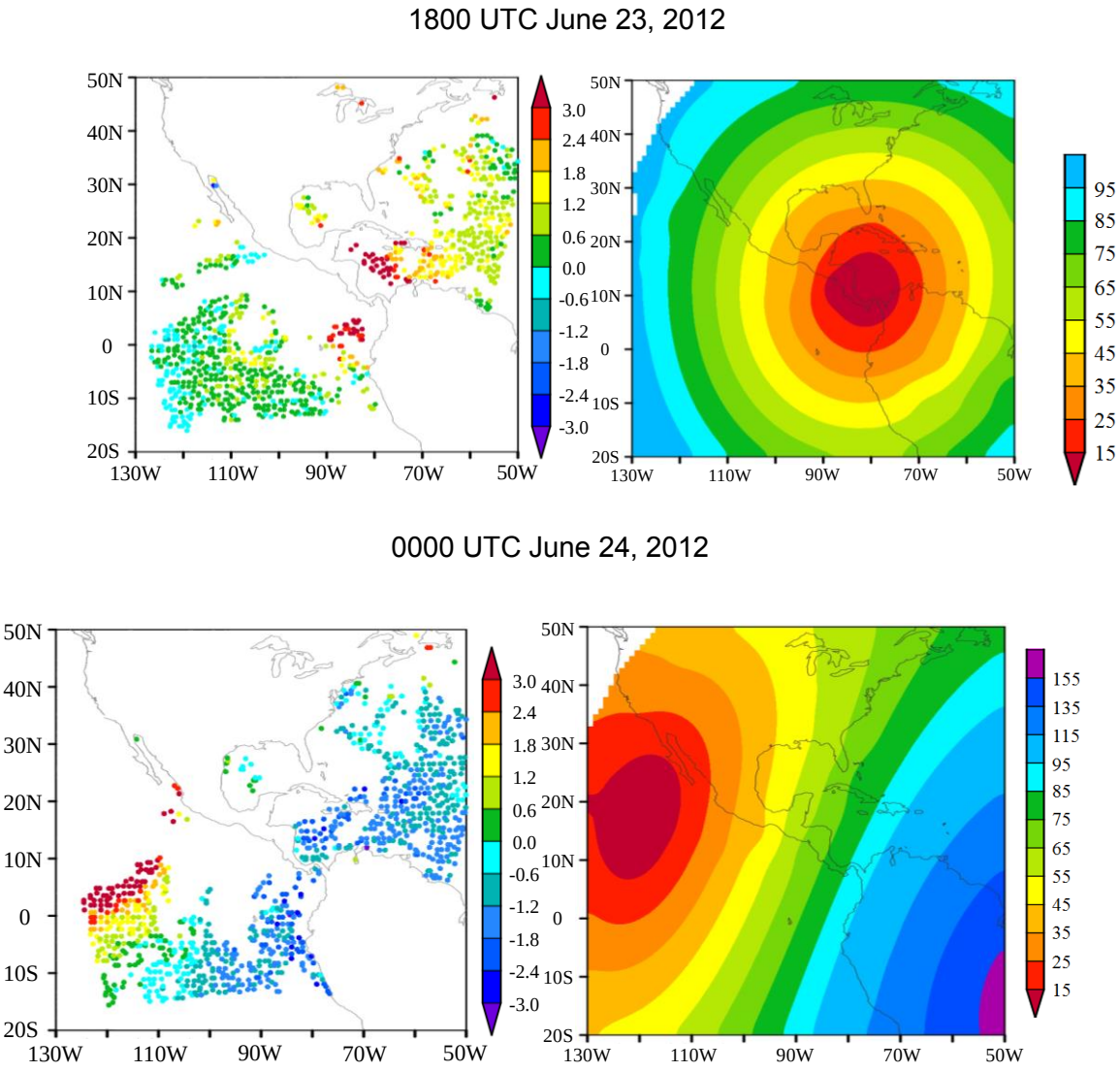

Figure 12 Spatial distribution of O-B (left panels) and sunlight (right panels) for GOES-13 channel 2 (3.9□ m) during on June 24, 2012.

Information on collaborators / partners:
Name of collaborating organization: NOAA/NESDIS
Date collaborating established: August 2010

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

Information on any outreach activities:
Hosted speakers, workshops and/or any training: None reported
Type (speaker, workshop, training): Speaker
Name of event: 1) 2014 The Joint International Geoscience and Remote Sensing Symposium (IGARSS), 2) The 95th AMS Annual Meeting
Date: 1) July 13-18, 2014, 2) January 4-8, 2015
Location: 1) Quebec, Canada, 2) Phoenix, AZ
Description: 1) An oral presentation entitled "Impacts of Assimilation of GOES-13/15 Imager Radiance in HWRF on Track and Intensity Forecasts of Debby." 2) An oral presentation entitled "Improved Tropical Storm Forecasts with GOES-13/15 Imager Radiance Assimilation and Asymmetric Vortex Initialization in HWRF"
Approximate Number of Participants: About 1,000 participants at each event.

Related NOAA Strategic Goals: Weather-Ready Nation

Related NOAA Enterprise Objectives: Science and Technology

NGI File #14-NGI2-77: Climate Variability in Ocean Surface Turbulent Fluxes

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

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

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

We examine these fluxes on the basis of in situ data (funded solely by NOAA) and satellite data (leveraged from several NASA projects and from the PI being the NASA Ocean Vector Winds Science Team Leader). The in situ product is well suited for long time scale studies, and comparisons to reanalyses[1]. We find that the variability between flux products is far greater than the accuracy need to resolve climate variability[2] (e.g., interannual time scales and larger), indicating that a great deal more work is needed to make products that are well suited to ocean process studies where the processes are sensitive to the fluxes (as is often the case). We have also found that it is very important to consider high frequency variability[3] (e.g., finer scale synoptic variability) in the calculation of longer-term average fluxes (particularly the ocean uptake of CO_2), and in the case of the Gulf of Mexico's West Florida Shelf, for correctly modeling the regional ocean climate[4]. This is very important for the local ecosystem including some important finfish and shellfish. These studies add to the evidence demonstrating the importance of considering the ocean and the atmosphere as coupled for climate applications.

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[1] Smith, S., P. Hughes, and M. Bourassa, 2011: A comparison of nine monthly air-sea flux products. *Int. J. Climatology,* 31, 1002-1027, doi: 10.1002/joc.2225.

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[4] Morey, S. L., D. S. Dukhovskoy, and M. A. Bourassa, 2009: Connectivity between variability of the Apalachicola River flow and the biophysical oceanic properties of the northern West Florida Shelf. *Continental Shelf Research*, doi:10.1016/j.csr.2009.02.003.

The same physics was applied on smaller scale to examine how an oil slick modifies air/sea interaction and thereby modifies its motion.

The FSU activity is motivated by a need to better understand interactions between the ocean and atmosphere on daily to interdecadal time scales. Air-sea exchanges (fluxes) are sensitive indicators of changes in the climate, with links to floods and droughts[5] and East Coast storm intensity and storm tracks[6]. On smaller spatial and temporal scales they can be related to the storm surge[7], and tropical storm intensity. On longer temporal scales, several well-known climate variations (e.g., El Niño/Southern Oscillation (ENSO); North Atlantic Oscillation (NAO), Pacific Decadal Oscillation (PDO)) have been identified as having direct impact on the U.S. economy and its citizens. Improved predictions of ENSO phase and associated impact on regional weather patterns could be extremely useful to the agricultural community. Agricultural decisions in the southeast U.S. sector based on ENSO predictions could benefit the U.S. economy by over $100 million annually[8]. A similar, more recent estimate for the entire U.S. agricultural production suggests economic value of non-perfect ENSO predictions to be over $240 million annually[9]. These impacts could easily be extended to other economic sectors, adding further economic value. Moreover, similar economic value could be foreseen in other world economies, making the present study valuable to the global meteorological community. By constructing high quality fields of surface fluxes we provide the research community the improved capabilities to investigate the energy exchange at the ocean surface. We have traditionally examined the distributions of weather, with more emphasis on typical weather conditions. However, recent work on extremes strongly suggests that climate cycles also influence the likelihood and magnitude of extreme events[10].

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

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[6] Hurrell, J.W., and R.R. Dickson, 2004: Climate variability over the North Atlantic. Marine Ecosystems and Climate Variation - the North Atlantic. N.C. Stenseth, G. Ottersen, J.W. Hurrell, and A. Belgrano, Eds. Oxford University Press, 2004.

[7] Morey, S. L., S. Baig, M. A. Bourassa, D. S. Dukhovskoy, and J. J. O'Brien, 2006: Remote forcing contribution to storm-induced sea level rise during Hurricane Dennis. *Geophys. Res. Letts.*, 33, L19603–19607, doi:10.1029/2006GL027021.

[8] Adams, R. M., K. J. Bryant, B. A. McCarl, D. M. Legler, J. O'Brien, A. Solow, and R. Weiler, 1995: Value of improved long-range weather information. *Contemporary Economic Policy*, 13, 10-19.

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[10] Vose, R. S. S. Applequist, M. A. Bourassa, S. C. Pryor, R. J. Barthelmie, B. Blanton, P. D. Bromirski, H. E. Brooks, A. T. DeGaetano, R. M. Dole, D. R. Easterling, R. E. Jensen, T. R. Karl, K. Klink, R. W. Katz, M. C. Kruk, K. E. Kunkel, M. C. MacCracken, T. C. Peterson, B. R. Thomas, X. L. Wang, J. E. Walsh, M. F. Wehner, D. J. Wuebbles, and R. S. Young, 2013: Monitoring and Understanding Changes in Extremes: Extratropical Storms, Winds, and Waves. *Bull. Amer. Meteor. Soc*. (in press).

month. The flux-related variables are useful for ocean forcing in models, testing coupled ocean/atmospheric models, ENSO forecasts, and for understanding some aspects of climate related variability.

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

The flux project at FSU targets the data assimilation milestones within the Program Plan. Our assimilation efforts combine ocean surface data from multiple Ocean Observing System networks (e.g., VOS, moored and drifting buoys, and satellites). One set of performance measures targeted in the Program Plan is the Air-Sea Exchange of Heat, Momentum, and Fresh Water. These fluxes can be related to Sea Surface Temperature and Ocean Heat Content. Additional targets are Ocean Transport and Thermohaline Circulation. Surface winds (stress) contribute to upper ocean and deep ocean transport. The heat and moisture fluxes also contribution to the thermohaline circulation. Ocean Carbon Uptake is highly dependent on wind speed. We plan to work with other members NOAA climate observing team to estimate the importance of SST-related variability in surface winds in the context of Ocean Carbon Uptake (see related material in accomplishments). The FSU flux project also strives to understand the strengths and weaknesses of our flux product relative to operational assimilation systems[11,12] (e.g., NCEP and ECMWF reanalyses) and continues to provide timely data products that are used for a wide range of ENSO forecast systems.

The 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:

Continue operation production of the 2˚ Tropical Pacific and 1˚ Tropical Indian Ocean FSU wind products.
Develop a multi-satellite wind product
Design a satellite-based flux product, based on (2)
Engage new users of (2) and (3)
Continue interaction with national and international satellite and in situ wind groups
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

[11] **Smith, S.**, P. Hughes, and **M. Bourassa**, 2010: A comparison of nine monthly air-sea flux products. *Internat. J. Climatol*., **30**, 26pp., DOI: 10.1002/joc.2225.

[12] **Bourassa, M**., S. Gille, C. Bitz, D. Carlson, I. Cerovecki, M. Cronin, W. Drennan, C. Fairall, R. Hoffman, G. Magnusdottir, R. Pinker, I. Renfrew, M. Serreze, K. Speer, L. Talley, G. Wick, 2009: High-Latitude Ocean and Sea Ice Surface Fluxes: Requirements and Challenges for Climate Research. *Bull. Amer. Meteor. Soc*. *Bull. Amer. Meteor. Soc*. **94**, 403 - 423. http://dx.doi.org/10.1175/BAMS-D-11-00244.1.

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[13].

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). Last year our satellite wind product suffered from the limitation that the technique worked only poleward of 20°. We have now improved the physics and can produce the winds poleward of 15°. We are now in the process of adding physics that will bring similar capability to the tropics. The satellite sensible and latent heat fluxes will continue to be in a development phase. We have addressed many key issues in producing a high quality product, and 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.

Specific examples of progress include examination of how small scale sea surface temperature (SST) gradients modify the surface winds (Fig. 13), which in turn modify the surface turbulent fluxes and vertical and horizontal ocean transport[14,15]. Our model for assimilating ocean observations accounts for these coupling processes, allowing us to capture the small scale changes in fluxes in the gridded flux product that we are developing. Traditional reanalysis techniques based on weather forecasting greatly smooth features with spatial scale less than six times the grid spacing. These small scale processes result in seasonally and regionally varying systematic errors in air-sea exchanges of heat, momentum, and freshwater based on these overly smooth products[15]. In winter months these biases (Fig. 14) are sufficiently large to modify the temperature and salinity characteristics of near surface water, which will impact sea surface temperature as well as ocean heat content and transport.

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[14] Hughes, P. J., 2014: The Influence of Small-Scale Sea Surface Temperature Gradients on Surface Vector Winds and Subsequent Impacts on Oceanic Ekman Pumping. Ph.D dissertation, Florida State University, Tallahassee, FL 32306

[15] Steffen, J. 2014: The Effects of Sea Surface Temperature Gradients On Surface Turbulent Fluxes. MS Thesis, Florida State University, Tallahassee, FL 32306

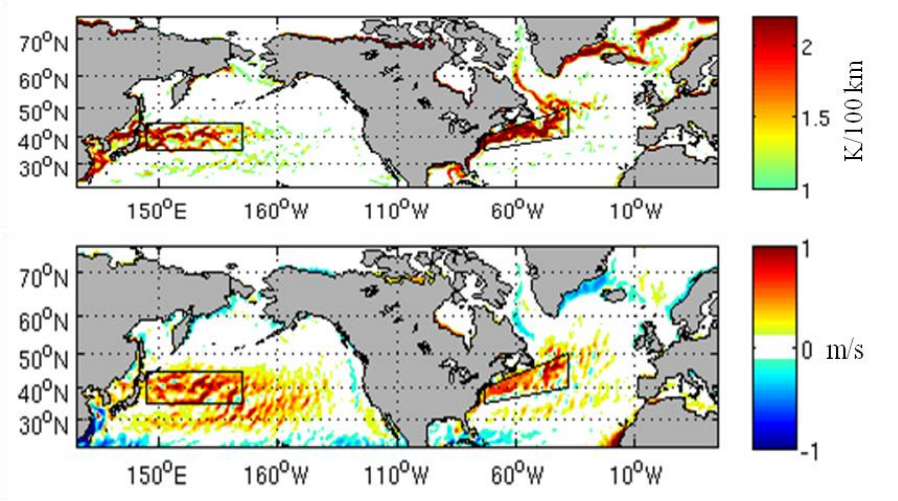


Figure 13 (Top) winter (DJF) seasonal SST gradients (> 1 K/100 km) and data subset regions located over the Gulf Stream and the Kuroshio Extension, and the associated seasonally averaged changes in wind speed (bottom) associated with these small spatial scale SST gradients.

These same changes in surface winds modify currents in the upper ocean including the surface currents and wind forced vertical motion[14] (Fig. 15). This extra vertical mixing will also impact the thickness of the mixed layer and hence presumably modify the ocean heat content in that layer and the surface temperature. We have found that the magnitude of these changes in motion at the bottom of the ocean's mixed layer is larger for smaller spatial scales (Fig. 16).

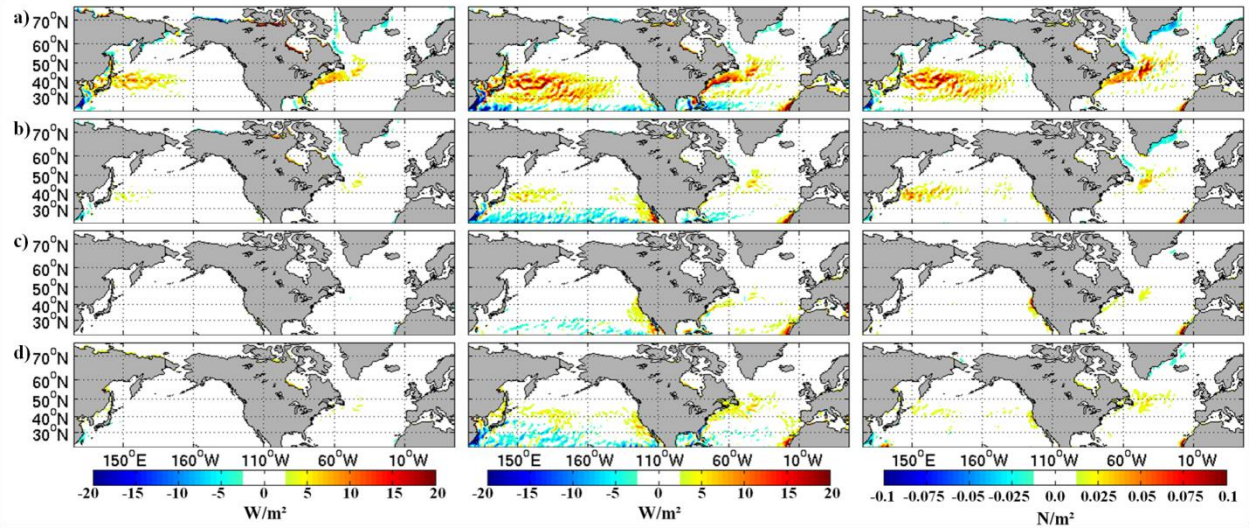


Figure 14 Seasonal biases in sensible heat flux (left), latent heat flux (center) and stress (right). From top to bottom seasons are winter, spring, summer and fall. On daily or six-hourly time scales the changes can by roughly a factor of ten greater.

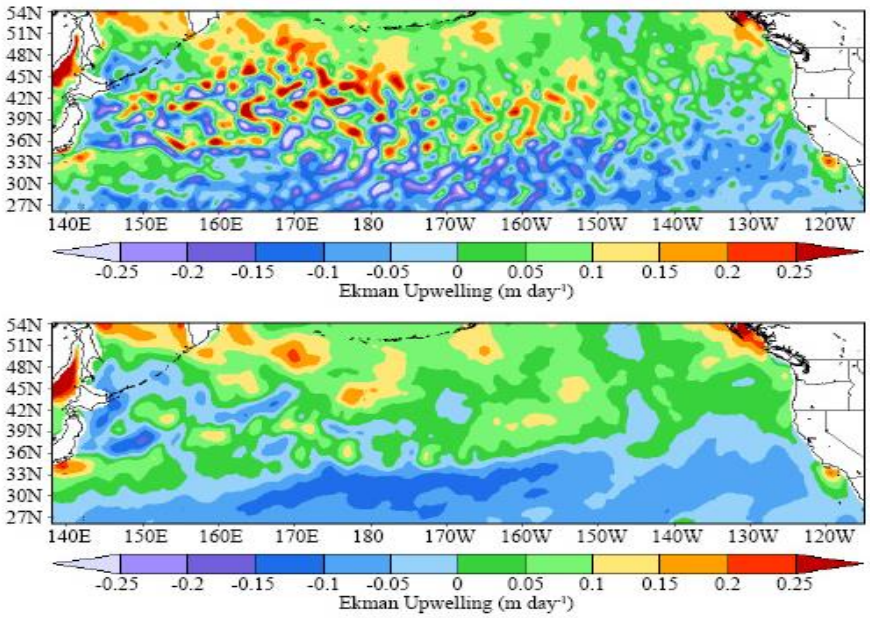


Figure 15 The Ekman upwelling (the wind-induced vertical motion at the bottom of the ocean's mixed layer) calculated for one winter day when surface winds respond to SST gradients (top) and this small scale wind variability is ignored (bottom). Changes are often greater than 30%.

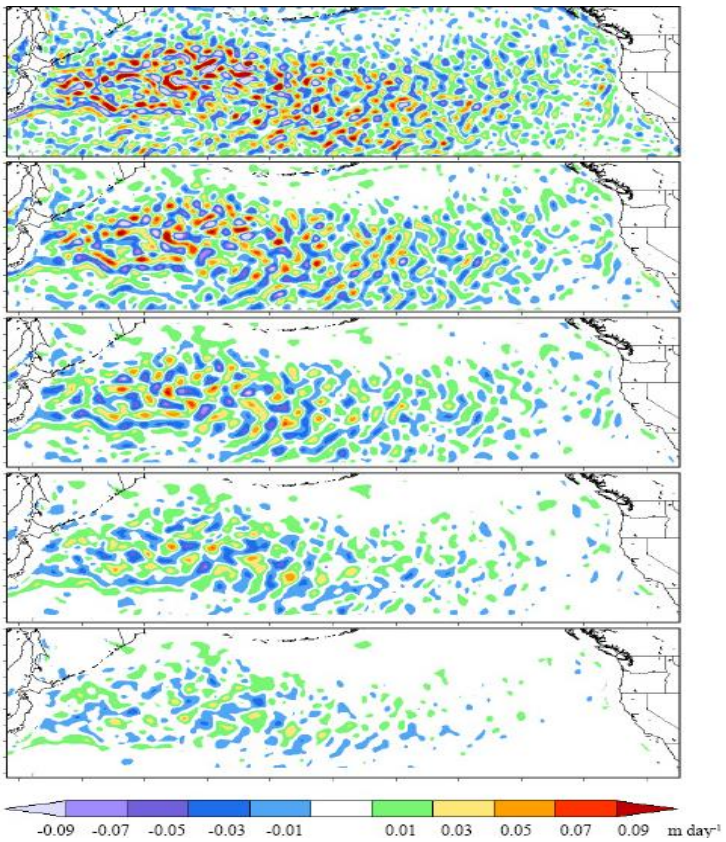


Figure 16 Changes in Ekman upwelling filtered by spatial scale. The greatest changes occur on smaller spatial scales (top). The top scales are between 1 and 2 degrees, 2nd from 2 to 3 degrees, and so on to the bottom image at 5 to 6 degrees

The results shown in the above figures are based on observed sea surface temperatures combined with reanalysis surface pressures, near surface air temperature and near surface humidities. The winds are determined through the physical model used in our data assimilation technique. In one case the SST-gradient influence on winds is removed, and in a second case it is included. These images show the differences in fluxes and Ekman upwelling due to ignoring the small scale variability. This approach is done on the same grid we will use to assimilate winds and other flux-related variables. These numbers are expected to be qualitatively consistent to what we will find when our data assimilation system is fully functional.

Description of significant results, protocols developed, and research transitions

We conclude 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 cause quite substantial changes to the ocean system is new in the contexts shown above. Even smaller scales are very likely to be important. The limiting space and time scale where changes have little impact because the ocean and atmosphere do not have time to adjust are yet to be determined, but it seems clear that the current observing system is not yet near this boundary. We point out that high temporal observations from research vessels appear to provide a practical approach to furthering such an investigation without modifying the observing system.

A further implication is that small spatial scales are very important to the coupling of the ocean and atmosphere systems. Since SST changes are associated with Ekman upwelling as well as the horizontal transport due to these wind changes, there will be considerable two way coupling that is currently missed in weather and climate models.

Through alternative funding we will examine how these small scale changes in SSTs and winds modify ocean carbon uptake. The Carbon uptake is a function of wind (or surface stress) and temperature, therefore we expect that the systematic patterns of winds and SST changes will also cause systematic changes in Carbon uptake.

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

1) Ability to realistically model and observe small scale variability,

2) The need for a constellation of observing systems and the consequent need to for very carefully intercalibrated data to avoid spurious small scale variability,

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

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

We have made great strides with (1) as can be seen in the referenced work by two graduate students, which will soon be submitted for peer review. Intercalibration was still an issue during this reporting period, but the intercalibration of winds is currently being greatly improved through the RapidSCAT mission. Validation of SST gradients is an ongoing concern that the SST community is beginning to appreciate. We continue to improve our data assimilation technique, but models that work well in mid-latitudes have failed in the tropics. Weather forecasting centers

(e.g., NCEP and ECMWF) have similar problems as can be seen in impact statistics for data assimilation.

Website:

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

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 to push surface fluxes forward as nominees for status as Essential Climate Variables. I have also been closely involved in developing metrics for assessing if the observing system is 'fit to purpose' and key identifying purposes.

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, John Steffen (MS, 2014) and Paul Hughes (Ph.D 2014) on projects that are tied to the ocean observing system and closely related to our longer-term goals for improving the use of this observing system. I have support several local middle school teachers with climate related information and been interviewed by middle school and high school students.

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

Related NOAA Enterprise Objectives: Science and Technology, Engagement

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

Project Lead (PI): Stephan Howden, University of Southern Mississippi, stephan.howden@usm.edu

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

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: 5/31/14-6/1/15

At the beginning of the reporting period buoy USM3m01 was deployed and USM3m02 was undergoing refurbishment.

In early October the MAPCO2 system stopped working. On October 18, 2014 a Guice Offshore, LLC vessel was chartered to bring a USM crew to the buoy to see if there was any obvious reason why the MAPCO2 system stopped telemetering. The sea state was worse than forecasted and a decision was made to not board the buoy. A visual inspection made by circling the buoy at close quarters did not reveal any obvious problem.

On December 11, 2014 the R/V Wilson, from Dauphin Island Sea Lab, was charted to fix the MAPCO2 system. In consultation with PMEL, it was decide that they would ship new system elements to better ensure that the system could be repaired. Upon reaching the buoy it was found that between October 18 and December 11 the buoy had been de-masted (Fig. 17). This was the second time that this has happened to the buoy. Despite this setback, it was determined that the MAPCO2 could still be repaired (Fig. 18) and the Iridium antenna hose clamped to a remaining bit of antenna (Fig. 19). Water samples were taken at surface, mid-depth, and at the seafloor for Total Alkalinity (TAlk) and Dissolved Inorganic Carbon (DIC), and pH using a Niskin bottle, with water samples transferred directly into glass bottles via silicon tubing (Dickson et al., 2007). The bottle samples were preserved using HgCl2 and stored in an ice-filled chest. Samples were then shipped to the University of Delaware (UDel) for analysis, where they were analyzed in Dr. Cai's according to Dickson et al. (2007) and Riebesell et al. (2010).

Figure 17 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 18 Howden (PI) working on the MAPCO2 system.

Two weeks before the scheduled deployment and recovery cruise the main USM buoy technician went on unexpected long-term medical leave. The remaining USM team rallied to make the final preparations and on March 30 buoy USM3m01 was recovered and buoy USM3m02 was deployed by the USCG Cutter Barbara Mabrity (Fig. 20). (At the end of the reporting period that technician resigned from the university and we are presently trying to find a suitable replacement). During deployment one of the anemometer masts of USM3m02 was repeatedly struck on the recovered buoy hull, and its hull was forcefully banged several times against that of the Barbara Mabrity. This may have been the reason why the SAMI did not work after deployment (though on a later trip out to the buoy that problem was rectified; see below).

The Dauphin Island Research Laboratory's R/V Wilson met the Barbary Mabrity to bring the USM crew back to shore. Although the R/V Wilson was supposed to bring a CTD package, the crew forgot to put it on board. Fortunately the USM crew bought a Niskin bottle so surface and bottom samples were taken for TAlk, DIC and pH. The water samples were taken in samples bottles shipped to USM by Wei-Jun Cai's lab at the UDel, and treated as described for the December 11 cruise.

Figure 19 Buoy USM3m01 with operational MAPCO2 system. The Iridium antenna is the cone shaped antenna on the smaller mast stub to the right side.

Figure 20 Buoy recovery and deployment from the USCG Barbara Mabrity on March 30, 2015. Buoy USM3m01 is in the water prior to recovery and USM3m02 is on deck for deployment.

After the buoy deployment, it was found that the SMAI pH sensor was not taking to the MAPCO2 system. On April 18, 2015 a USM technician was able to get a ride on the R/V Pt Sur and get onto the buoy. He was able to reset the SAMI and get it communicating with the MAPCO2 system.

The preliminary data MAPCO2 system data for the reporting period is shown in Figure 21. Data from the SAMI sensor is also available for the same period. The spike in seawater xCO2 in July 2014 is being investigated.

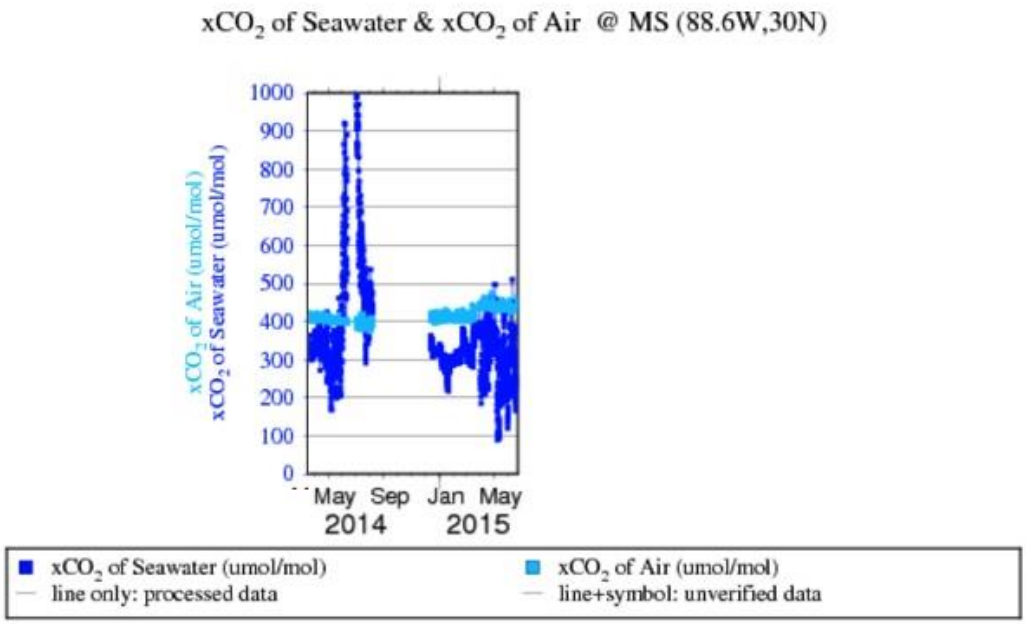


Figure 21 Preliminary MAPCO2 Data during the reporting period. System stopped working early October and was replaced on December 11, 2015.

References:

Dickson, A.G., Sabine, C.L. and Christian, J.R. (Eds.) 2007. *Guide to best practices for ocean CO2 measurements*. PICES Special Publication 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.

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?
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: Not applicable

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 #14-NGI2-82: 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:

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

Project objectives and goals
In order to achieving quality weather forecasts accurately and to extracting climate signals and climate change from satellite data, which remains to be an extremely challenging task, this project focuses on works related to an in-orbit monitoring of satellite-measured radiances, such as characterization of ATMS SDR data quality, cross-calibration of MSU, AMSU-A and ATMS SDR, and satellite-derived global and regional climate trends in physical space. This is a key component to the success of satellite mission. It requires a series of comparison 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
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
Development and test of ATMS de-striping optimal filters for both brightness temperatures and ATMS calibration counts
Impacts of model top on satellite data assimilation and forecast results using HWRF system
Impact of NOAA-15 AMSU-A data on quantitative precipitation forecasts and its implications for three-orbit constellation
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 from 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 the Hurricane Weather Research and Forecasting (HWRF) model top altitude on satellite radiance assimilation and on tropical cyclone (TC) forecasts of. 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 Organisation 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 be assimilated into HWRF. Extending the model top to a higher level allowed a more accurate 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 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.

Since 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 that 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 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) 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? Amount of support? No
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:
Type (speaker, workshop, training): Speaker
Name of event: 1) EUMESTSTAT Meteorological Satellite Conference, 2) 2014 The Joint International Geoscience and Remote Sensing Symposium (IGARSS), 3) The Fifth Asian/Oceania Meteorological Satellite Users' Conference
Date: 1) September 22-26, 2014, 2) July 13-18, 2014, 3) November 19-21, 2014
Location: 1) Geneva, Switzerland 2) Quebec, Canada, 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" 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 #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

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

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

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

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

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

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

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

Progress: 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.

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

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

Milestones: Goal 1 accomplished in a previous reporting year. For the current reporting year (01 Jul 2014 – 30 Jun 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 on-going.

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 geotif using bathymetric (multibeam) and CTD data products collected from OKEX missions (accomplished using ArcMap to create a .png product). It is a cumulative product, where the geotif being overlaid is updated manually every day during a cruise and added to the map (i.e. Okeanos Atlas). Standard protocols also include working with the chief programmer to write a Standard Operating Procedure (SOP) for thinning raw SCS ship track navigation data. This procedure produces a thinned ship track using Keyhole Markup Language (.kml) for visualization in Google Earth™., as well as shapefiles (.shp) for visualization on ESRI®-supported *Digital Atlas*.

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

CTD Data Processing

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 & 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 processing 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 #14-NGI2-84: 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; Richard Jenkins, Saildrone, richard.jenkins@mac.com

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

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. They 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;
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*
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: 7/1/2014 – 6/30/15

During the reporting period preparations have been made for the field-work that begins in early August of 2015. The first phase is deployment of the two PMEL moorings in early August of 2015. These will be deployed on the 500 m isobath (Figure 22) and recovered in

early December. The second phase, begging in late September or early October) is deployment of an NRL Slocum glider that will go back and forth between the two PMEL moorings, a USM Slocum glider that will go from the 500 m isobath mooring line to the CenGOOS buoy, and deployment of two Saildrones to follow the same two paths.

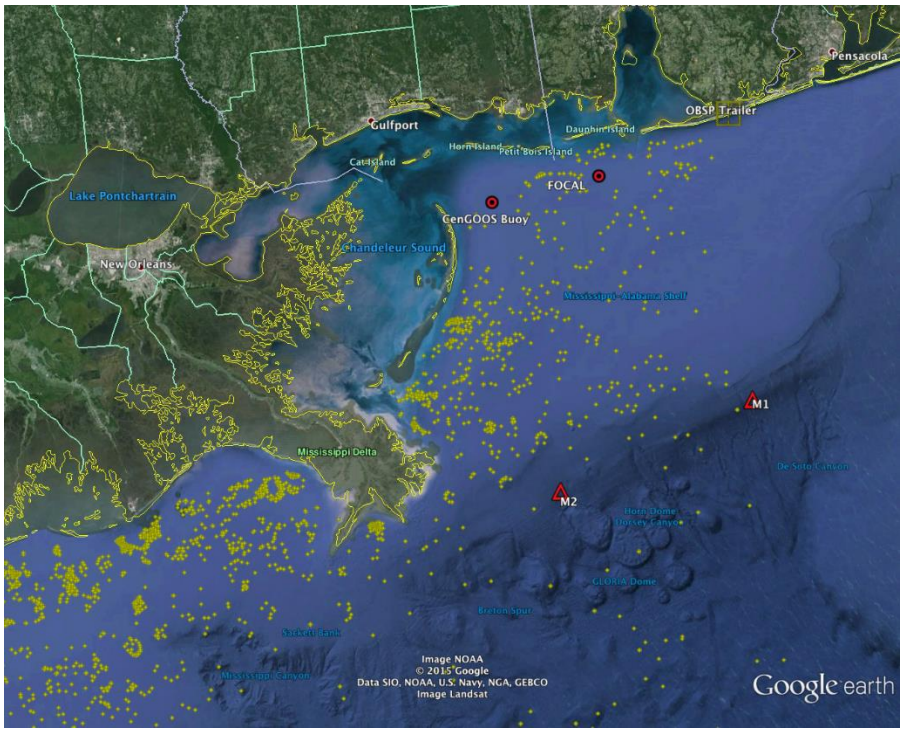


Figure 22 Study region. M1 and M2 are the PMEL mooring locations on the 500 m isobath. The USM CenGOOS buoy is on the 20 m isobath. The yellow marks are oil and gas platforms from a shapefile downloaded from the Bureau of Ocean Energy Management.

Mooring Planning/Preparation

The two PMEL moorings are scheduled to be deployed August 4-5 off of the USM R/V Pt Sur. During the reporting period the final mooring design plans were developed by PMEL with input from USM and NRL. USM will provide a CTD for the CRAWLER mooring to obtain temperature and salinity near the seafloor. NRL will provide two CTDs for the DIC mooring. Chris Meinig visited with Howden and Book at the Stennis Space Center in March to go over plans.

USM submitted forms to the USCG for Notice to Mariners for the two moorings. One will be deployed at 29° 01.312'N 088° 30.776'W and the other at 29° 15.337'N 087° 42.918'W (Figure 22).

Shipping and receiving of the PMEL moorings was arranged between PMEL, the Port of Gulfport, and the Louisiana Universities Marine Consortium (LUMCON; the operators of the R/V Point Sur).

Remote Sensing Planning/Preparation

Howden traveled to UMass-D in April 2015 to meet with Drs. Steven Lohrenz and Sumit Chakroboraty to finalize plans for the remote sensing products, derived from optical remote sensing, they will be providing for the project.

Saildrone Planning/Preparation

In January 2015 testing of a CTD and a suite of meteorological instruments on a Saildrone was performed in San Francisco Bay (Figures 23 and 24). The results from this initial field test were positive.

Howden met with Richard Jenkins in Gulfport, MS to review Saildrone plans for the upcoming field work. A Saildrone was launched in the northern Gulf for a GoMRI consortium and Howden met the Saildrone team after launch to review how things were going. Useful information that has been obtained includes:

- Gulfport is a marginal launch site for the Saildrones due to vessel traffic, a constrained shipping channel in a shallow estuary, and light summertime winds.
- As has been found for Wave Gliders, the weak winds in the summer in the northern Gulf, coupled with a vigorous offshore eddy field, make navigating the Saildrone difficult during that season
- The level of vessel traffic in the northern Gulf is much greater than in the Pacific Northwest and Alaska which makes navigation of autonomous vehicles very challenging. In addition to commercial and recreational fishing, there is a huge amount of vessel traffic servicing the oil and gas platforms in the region.
- The large number of oil and gas rigs in the region also pose a serious challenge to Saildrone operations since pilots have to ensure that navigational ability to keep clear is maintained in the face of changing conditions such as drops in wind speed, very high wind speeds associated with storms, and ocean eddies.

To help mitigate some of these navigational issues, a decision has been made to shift the Saildrone deployments from September to early October when, climatologically, winds are stronger.

Slocum Glider Planning/Preparation

USM's 200 m Slocum Glider was shipped to Teledyne/Webb for refurbishment and is scheduled to be shipped back to USM shortly after the reporting period. USM and NRL have been investigating strategies for dealing with the rigs and vessel traffic in the region during the deployment period.

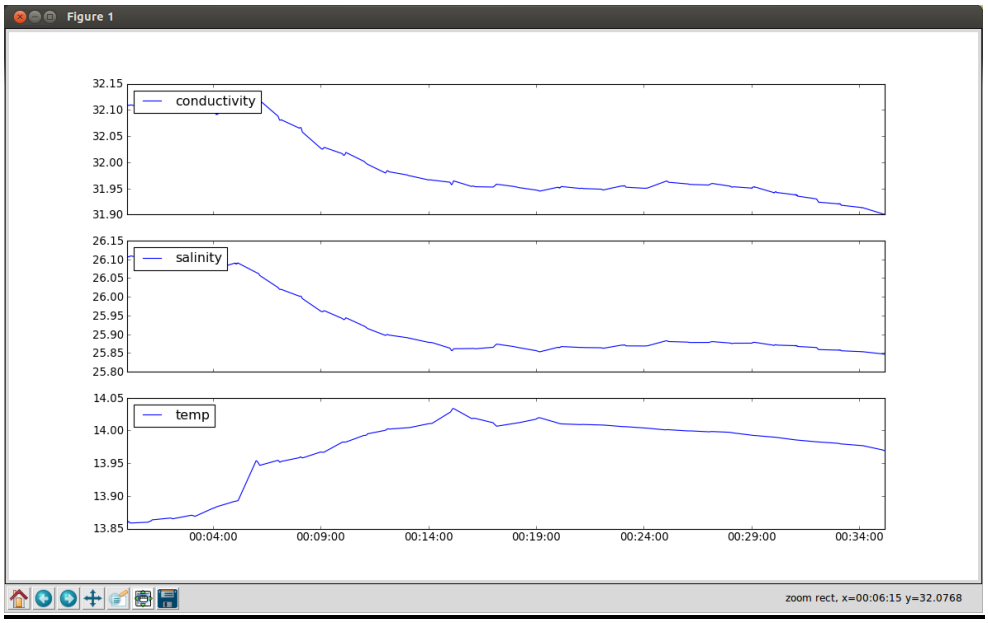


Figure 23 Data from CTD on a Saildrone during testing in San Francisco Bay in January of 2015.

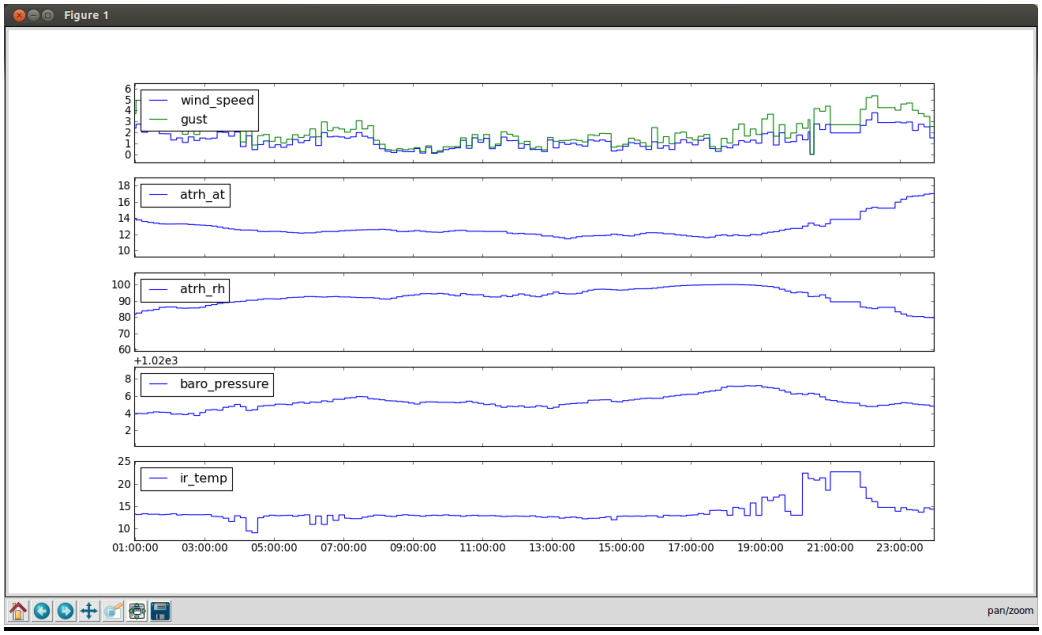


Figure 24 Data from meteorological instrument package on a Saildrone during testing in San Francisco Bay in January of 2015.

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

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?

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, Weather-Ready Nation

Related NOAA Enterprise Objectives: Science and Technology

NGI File #14-NGI2-85: 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: Russ Beard, NESDIS/NCEI

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 prepared for operation and/or operated for support of five live ocean exploration activities:

- August-October 2014: Okeanos Explorer / Atlantic Canyons and Seamounts
- February-March 2015: Okeanos Explorer / Caribbean Trenches and Seamounts (Leg 1)
- March 2015: Okeanos Explorer / Caribbean Trenches and Seamounts (Leg 2)
- April 2015: Okeanos Explorer / Caribbean Trenches and Seamounts (Leg 3)
- May-June 2015: Okeanos Explorer / Tropical Exploration (Western Caribbean, Panama Canal, and Eastern Pacific)

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 for 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: A student was identified, recruited, and accepted to Mississippi State University (MSU) to fill the master's level graduate assistantship position specified in the project narrative. The student, Caitlin Ruby, completed her B.S. in Geographic Information Technology at the University of Southern Mississippi in May of 2015. She has relevant previous career experience with the Naval Oceanographic Office, NASA, and NOAA involving processing and analysis of quantitative oceanographic data. Caitlin interviewed for the assistantship position on January 30, 2015, a formal offer of admission to the MS program at MSU was extended on April 1, 2015, and she accepted on April 9, 2015. She will matriculate on August 17, 2015.

Note: this milestone is delayed by one semester because a specific student identified to fill the assistantship position in January of 2015, chose to accept an employment offer elsewhere and rescinded her acceptance in the fall of 2014.

A research planning meeting focused on goal 2 was held to at the MSU exploration Command Center at Stennis Space Center on May 29, 2015 with the key NOAA personnel responsible for management on NOAA OER data including Sharon Mesick, Susan Gottfried, Denise Giovanni, and Brendan Reser. The meeting focused on structuring Caitlin's graduate research in order to best utilize and complement the existing data management and accessibility work being conducted by the NCDDC group at Stennis.

In consultation with Brendan Reser, the desktop computer, data storage, and software requirements most appropriate to support Caitlin's work and complete project goal two were identified. Procurement of these materials and supplies (in budget narrative under "Commodities and Equipment under $5K ") is anticipated for August 2015.

Research efforts pertaining to project goal 2:

Ruby has thoroughly reviewed International Organization for Standardization (ISO) metadata standards and documentation of the Coastal and Marine Ecological Classification Standard (CMECS). She has also conducted a literature review of previous research that incorporated CMECS.

Ruby has applied CMECS classification fields to 30 video images collected with the NOAA ROV *Deep Discoverer* on 3 different research cruises and integrated those result with associated scientific sensor and navigational data. Based upon this effort Ruby has begun to design a processing workflow for application of CMECS to *Deep Discoverer* data.

Skarke has developed Matlab and ESRI ARC GIS workflows for the purpose of geospatially referencing and visualizing *Deep Discoverer* data.

Research Conducted/Milestones for Goal 3: Previous grants related to the support of the publicly accessible data repository funded the procurement of equipment to support this activity. During this reporting period, that infrastructure has been utilized for the storage of over 2 Terabytes of web-accessible data that is referred to from the NCEI catalog. Early in the

reporting period, an incompatibility between operating systems on hardware within the infrastructure was discovered that prevent consistent uncorrupted upload of data into the system. After extensive testing and evaluation with the NOAA NCEI team, we were able to identify and correct the problem. Since then, the system has worked as expected for both upload and download of data sets. Currently, data sets for 58 missions are housed in the system.

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 #14-NGI2-86: Enhancing the Mississippi Digital Earth Model

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

Co-PI(s) name, affiliation, email address: Robert Moorhead, 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 (70%) of the funding for this project is used in support of the development of new LIDAR data for the Mississippi Coastal Counties (Hancock, Harrison, Jackson, Pearl River, Stone and George). The new LIDAR database will update the previously compiled LIDAR database from 2005. The new LIDAR database has a relatively higher density of mass points and greater vertical accuracy than that of the 2005 database. The new LIDAR database will be used to define a detailed, surface hydrology dataset for assessing run-off impact on coastal communities as well as simulate the effect of sea level rise of coastal assets and emergency response.

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 of 2015, 21 workshops were delivered to 216 participants representing municipalities, counties and state agencies across Mississippi. Technical assistance in the implementation and use of geospatial technologies was provided to many of the workshop participants who established GIS and associated technologies in their respective workplaces.

Two new courses are in the process of development and were made available to the public in the fall of 2014. The courses are designed around the needs identified by workshop participants over the past several years. The 2-day workshops focus on both commercial and open source GIS applications.

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 3,573 square miles of LIDAR data for 6 counties in southern Mississippi. The completed databases are made available to the public through the Mississippi Department of Environmental Quality (MDEQ).

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 4 courses in GIS applications and geospatial database management. Twenty-one 2 and 3 day workshops with 216 participants were held at 4 locations across the state. A detailed listing of the workshops is presented on the following page.

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

Related NOAA Enterprise Objectives: Engagement

Course Name	Date	Location	Number of Participants
Introduction to ArcGIS Online	May 5, 2015	NASA Stennis Space Center	12
Introduction to QGIS	April 28, 2015	NASA Stennis Space Center	9
Introduction to QGIS	April 7, 2015	NASA Stennis Space Center	12
Introduction to QGIS	March 24, 2015	Holmes Community College	11
Introduction to ArcGIS Online	March 18, 2015	NASA Stennis Space Center	12
Introduction to QGIS	March 3, 2015	Holmes Community College	8
Introduction to ArcGIS Online	February 18, 2015	Holmes Community College	9
Introduction to ArcGIS Online	February 10, 2015	NASA Stennis Space Center	5
Introduction to ArcGIS Online	December 8, 2014	Mississippi Emergency Management Agency	10
ArcGIS II: Essential Workflows	November 18, 2014	NASA Stennis Space Center	11
Introduction to QGIS	November 18, 2014	Holmes Community College	9
Introduction to QGIS	November 12, 2014	Holmes Community College	11
ArcGIS II: Essential Workflows	November 4, 2014	Grand Bay NERR - Coastal Resources Center	12
ArcGIS II: Essential Workflows	October 28, 2014	Holmes Community College	9
ArcGIS I: Introduction to GIS	October 22, 2014	NASA Stennis Space Center	12
ArcGIS I: Introduction to GIS	October 2, 2014	Mississippi State University	11
ArcGIS I: Introduction to GIS	September 30, 2014	Holmes Community College	11
ArcGIS I: Introduction to GIS	September 10, 2014	Mississippi Emergency Management Agency	10
ArcGIS I: Introduction to GIS	September 3, 2014	Grand Bay NERR - Coastal Resources Center	13
ArcGIS II: Essential Workflows	August 28, 2014	Mississippi State University	8
ArcGIS I: Introduction to GIS	August 5, 2014	Grand Bay NERR - Coastal Resources Center	11

NGI File #14-NGI2-87: U.S. Research Vessel Surface Meteorology Data Assembly Center Home of the SAMOS Initiative

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

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

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

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 FY2014, 1 New Zealand-, 1 Australia-, and 28 United States-operated research vessels routinely transmitted daily emails containing one-minute averaged meteorology and surface oceanographic data to the DAC. Broadband satellite communication facilitates this daily transfer at ~0000 UTC. A preliminary version of the data is available in near-real time (within five minutes of email receipt) via the SAMOS web pages (http://www.coaps.fsu.edu/RVSMDC/html/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 at the U.S. National Oceanographic Data Center (NODC) on a monthly basis.

Starting in October 2014, the DAC will develop a new ship-to-shore-to-archive pathway for full-resolution (sampling on the order of once per second) data collected by NOAA's Scientific Computing System (SCS) software and will 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 will ensure that a complete record of the full-resolution (as sampled by the individual sensors) SCS data are received by NODC 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 at NODC ensures these data are preserved for future generations of scientists, policy makers, and the public.

The DAC activities focus primarily on NOAA Climate Mission and Technology and Mission Support goals by providing high-quality weather and near-surface ocean data to validate complementary satellite observations; global analyses of the ocean-atmosphere exchange of heat, moisture, and momentum; and computer model-derived analyses of climate, weather, and

ocean parameters. The data distributed by the DAC address the Office of Climate Observation program deliverables related to sea surface temperature, surface currents (via the wind), and air-sea exchanges of heat, momentum, and fresh water.

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

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

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

Description of research conducted during the reporting period and milestones accomplished and/or completed
In FY14, the project focused on deliverables that include the following:

Continue daily monitoring and automated quality control of data received by all vessels contributing to the SAMOS DAC.

Continue routine research-quality evaluation of meteorological data for all NOAA vessels contributing to the SAMOS DAC.

Distribute all quality-controlled SAMOS observations via web, ftp, and THREDDS services and ensure routine archival at NODC.

Develop and test new automated quality control methods.

Engage OMAO to augment instrumental metadata for all recruited NOAA vessels.

Engage new user communities.

Continue liaison activities with U.S. and international (limited) government agencies, archives, climate programs, and throughout the marine community

Additionally in FY14, we began planning for a new aspect of the RV DAC, specifically a new role to evaluate the completeness, documentation, etc. for post-cruise, full-temporal resolution data packages collected by NOAA vessels using the Scientific Computer System (SCS) software and the timeliness of delivery for these packages to NODC.

These deliverables center collectively support an ongoing effort 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 (SAMOS) initiative and the post-cruise underway data collected by SCS on NOAA vessels are primarily used in marine climate 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. Recently, 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.

Description of significant results, protocols developed, and research transitions
FY2014 Achievements

A quick note on FY2014 budget: FSU receives its funding via the Northern Gulf of Mexico Cooperative Institute at Mississippi State University. Through this arrangement, there is a one-year delay between when funds are allocated by NOAA and the time they are received for spending by FSU. This means that our FY14 allocation by NOAA COD and OMAO was not available for use by FSU until 1 October 2014, the start of FY15. For that reason, we will report herein on the plans for the SCS data stewardship activities that were funded by OMAO in FY14, but for which the bulk of the work plan will not be executed until FY2015 by FSU.

The primary achievement in FY 2014 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. Collection statistics for FY14 (compared to FY13) are included in Table 5 and a map of the spatial sampling for FY14 is shown in Figure 25. 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. The only new recruit was NOAA's *Ferdinand Hassler* and the *Aurora Australis* stopped transmitting as a result of technical challenges in Australia. These data span the global ocean, extending into poorly sampled regions of the South Atlantic, South Pacific, and Southern oceans (Fig. 25). For the first time in several years, we received significant data from the eastern Indian Ocean (rarely visited by U.S. RVs). 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 1]. 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.

Over the past year, Kristen Briggs completed visual QC for all recruited NOAA vessels (deliverable 2 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.

We again produced an annual report (Briggs et al. 2014) that summarizes the data quality for all vessels contributing data for the calendar year 2013. The report has been distributed to all operators of SAMOS vessels and posted to the SAMOS web site.

Table 5 Ships transmitting observations to SAMOS DAC during FY 2013 and FY 2014. Seven vessels recruited with funds from NSF's Ocean Instrumentation and Technical Services program and one recruited via a contract with the Schmidt Ocean Institute are shown for completeness. Operators include NOAA, the Bermuda Institution of Ocean Sciences (BIOS), the Woods Hole Oceanographic Institution (WHOI), Australia and New Zealand via the Integrated Marine Observing System (IMOS), the U.S. Coast Guard (USCG), the U. S. Antarctic Program (USAP), the Scripps Institution of Oceanography (SIO), the Schmidt Ocean Institute (SOI), the University of Hawaii (UH), the University of Rhode Island (URI), the University of Washington (UW), and Oregon State University (OSU).

		Number of ship days with data	
Vessel	Operator	1/10/2012–30/9/2013	1/10/2013–30/9/2014
Atlantic Explorer[1,3]	BIOS	156	122
Atlantis[2]	WHOI	169	339
Bell M. Shimada	NOAA	177	105
Fairweather	NOAA	11	75
Falkor[4]	SOI	20	90
Ferdinand Hassler[5]	NOAA	--	88
Gordon Gunter	NOAA	157	167
Healy[2]	USCG	83	30
Henry B. Bigelow	NOAA	155	125
Hi'ialakai	NOAA	77	133
Kilo Moana[1,3]	UH	78	246
Knorr[2]	WHOI	247	231
Lawrence M. Gould[2]	NSF/USAP	259	347
Melville[1,3]	SIO	275	196
Nancy Foster	NOAA	143	120
Nathaniel Palmer[2]	NSF/USAP	345	360
New Horizon[1,3]	SIO	318	309
Okeanos Explorer	NOAA	126	134
Oregon II	NOAA	185	146
Oscar Dyson	NOAA	224	211
Oscar Elton Sette	NOAA	127	131
Pisces	NOAA	207	110
Rainier	NOAA	117	83
Roger Revelle[1,3]	SIO	308	254
Ronald Brown	NOAA	134	157
R. G. Sproul[1,3]	SIO	108	200
Southern Surveyor[1]	IMOS/Australia	157	13
Tangaroa[1]	IMOS/New Zealand	195	156
Thomas Jefferson	NOAA	166	95
T. G. Thompson[1,3]	UW	--	297
		4890	5070

[1]No research-quality visual QC completed.
[2]Visual QC discontinued at the end of 2012 as a result of NOAA budget reductions.
[3]NSF funding supported recruitment (part of UNOLS Rolling Deck to Repository program).
[4]*Falkor* recruited to SAMOS via contract with the Schmidt Ocean Institute. Leveraging COD-funded SAMOS infrastructure at FSU.
[5]Recruited to SAMOS in FY14.

The DAC also developed a prototype air-sea flux product derived using the quality controlled SAMOS observations. This new flux product provides estimates of latent and sensible heat exchange between the ocean and atmosphere and the wind stress at the ocean surface 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). We engaged the air-sea flux community [Deliverable 6], presenting preliminary results and receiving user feedback, at the European Geophysical Union (April 2014) and CLIMAR (June 2014) meetings and a manuscript is in preparation.

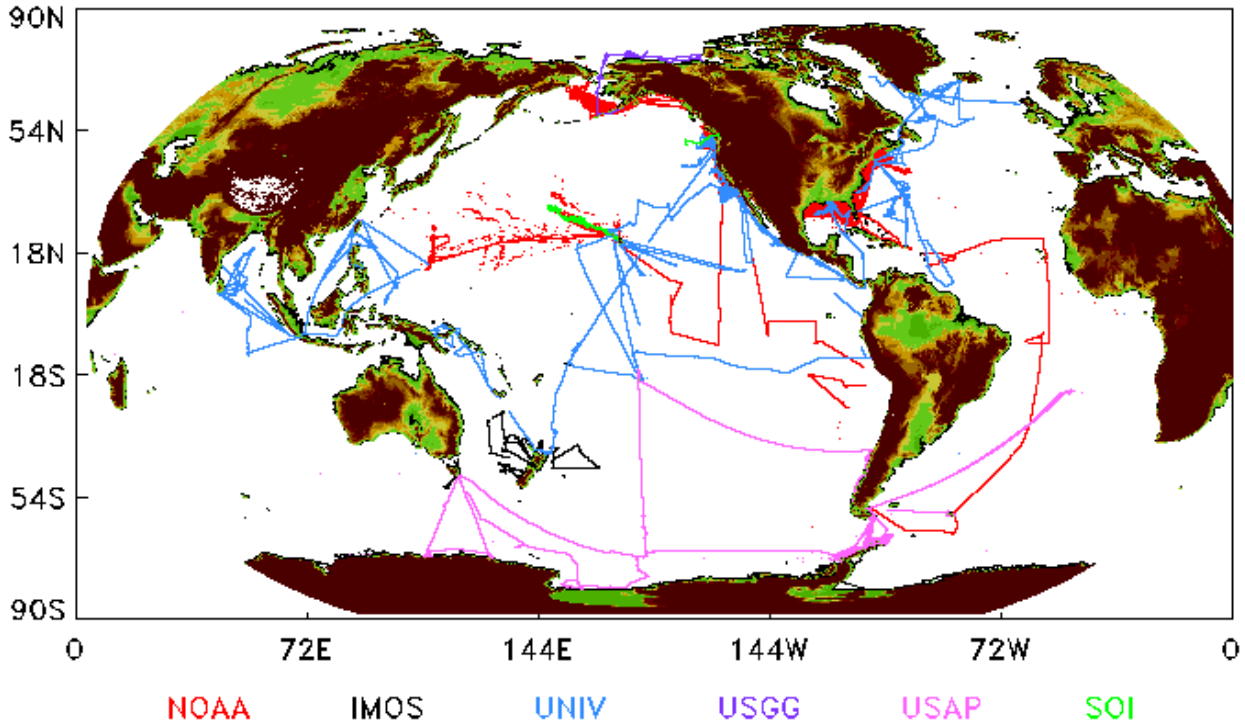


Figure 25 Cruise tracks showing data provided to the SAMOS DAC for FY2014. Data are color coded by the primary data providers. All university-operated vessels are shown in blue.

DAC personnel also achieved a number of technical enhancements to the SAMOS data processing, distribution, and archival systems. Our software team, led by Jocelyn Elya, began streamlining and upgrading our automated data quality processing and web services in preparation to migrate our data management system to four new virtual machines. This will separate operational from developmental code for both data processing and web services, which will support effective testing of new quality control methods [deliverable 4] and provide mirroring of the operational data and metadata on the developmental machines. Processing and web codes have been streamlined for simplified maintenance, portability, and efficient operation. Additional documentation and error logging has been developed. All of these upgrades will become operational when the server migration is completed in early 2015. Another technical enhancement is the preliminary use of Google analytics to determine who is using the SAMOS observations. In FY14, we started tracking visitors to the SAMOS data download pages (29 countries) and are exploring how to track actual data downloads.

Our final achievement of FY2014 was initiating planning for the SCS data package evaluation and SCS issue tracking system. A face-to-face meeting occurred between FSU, OMAO, and NODC personnel on 14-15 July 2014 (Silver Spring, MD). The team reviewed ongoing activities by OMAO and NODC to support direct submission of post-cruise SCS data packages to NODC.

The meeting resulted in several action items for FSU (downloading and examining sample SCS packages from NODC), OMAO (selecting first candidate vessels, providing candidates for issue tracking focus group), and NODC (usage of issue tracking in the past). The discussions laid the groundwork for FSU to move forward once FY14 funds were received on 1 October 2014.

Facilitating Science

The nature of our project is providing high-quality, continuous, instrumental observations to a diverse user community. Distributing data without restrictions and via multiple electronic access protocols makes it difficult to identify specific instances of scientific advancement achieved using the data we provide. We generally rely on users to voluntarily acknowledge the application of SAMOS observations from FSU. In FY14, the DAC had direct interactions with William Landing (FSU, personal communication, 2013) who is using SAMOS pressure and temperature data to calculate aerosol sampling flow rates on select cruises and Byron Blomquist (NOAA, personal communication, 2014) who compared SAMOS data to those from the WHOTS mooring and the independent NOAA ESRL portable flux standard during a research cruise in July 2014. We also have replied to inquiries for using SAMOS observations in a new version of iQuam (a NOAA in situ SST quality monitoring project to support satellite cal/val). Our new along-track SAMOS flux product has also been requested by Lei Shi (NOAA, personal communication, 2014) for their development of near-surface air temperature and humidity retrievals from satellites.

A search of Google Scholar also revealed five new publications that directly use SAMOS observations or examine some aspect of the SAMOS data processing system. Two of the manuscripts (Hauri et al. 2013, Jackson and Wick 2014) addressed problems related to ocean carbon cycles while Reul et al. (2014) focused on salinity variations along the meandering Gulf Stream. Jackson and Wick (2014) and Reul et al. (2014) used SAMOS data to evaluate measurements made by satellites. Hauri et al. (2013) used SAMOS winds to calculate localized carbon fluxes as part of their efforts to constrain the carbon flux budget in the Chukchi Sea, a region thought to be an important atmospheric carbon sink in the ocean. Two additional manuscripts (AbdulAzeem 2014a, 2014b) examined aspects of the SAMOS data processing system as it applies to the field of computer informatics, specifically the distribution and uncertainty in designing database applications.

We also actively participate in national and international meetings and general email exchanges to collect information from potential users of SAMOS data to plan future improvements to our data distribution practices [Deliverables 6 & 7]. In FY14, we had an extensive email exchange with G. Reverdin and N. Martin from the Pierre-and-Marie-Curie University in France who are examining sea-surface salinity variability. These users noted a need for additional geospatial search tools and access to SAMOS observations in ASCII formats. Development of geospatial search tools is being funded by complementary NSF funding and we are planning a submission of SAMOS data into Release 3.0 of the International Comprehensive Ocean-Atmosphere Data Set in early 2015 (which requires adoption of a standard ASCII data format). The latter will provide the SAMOS data to a wider user community, including those working on the next generation of atmospheric and ocean reanalyses, which typically use ICOADS as their primary source of in-situ marine climate data.

Impediments

Visual quality control is manpower intensive and flat budgets from NOAA resulted in the loss of this capability for all non-NOAA vessels at the end of CY2012. When comparing data for the Knorr in CY2012 vs. CY2013, we noted a reduction of nearly 11% in the number of quality flags added to the data in CY2013 because the Knorr only received automated (not visual) QC in CY2013 (see Briggs et al. 2014). This means that the CY2013 datasets likely include suspect data that are reaching the user without application of QC flags. The loss of visual QC for 5 vessels (Table 5) affected 1307 ship days of data, including data from the L. M. Gould, the Nathaniel Palmer, and the Healy, which primarily operate in the Southern and Arctic oceans. The reduction in the quality assessment of these high-value observations may adversely affect climate and ocean circulation studies in these extreme environments.

Data and Information Dissemination and Archival

The core mission of the DAC is data stewardship. This includes ensuring all data, reports, and documentation are readily available and data and metadata are submitted to a national archive for long-term preservation [Deliverable 3].

All near real-time (preliminary, 5-min delay from receipt) and delayed-mode (intermediate or research, 10-day delay from receipt) data are available via web (http://samos.coaps.fsu.edu/, under "Data Access"), ftp (samos.coaps.fsu.edu, 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. Most recent data vary depending on which ships are transmitting data on a given day, but are typically available within a few minutes of 0000 UTC. We routinely test our web services and respond rapidly to failures of the system. In addition to data access, the SAMOS web site includes our mission statement, data policy, and acknowledgements under the "About" tab on the SAMOS home page. The web site also provides access to recruitment materials for vessels, a subscription service for operators to access monthly data reports, desired SAMOS parameters and accuracy requirements, best practice guides, and training materials. SAMOS publications and technical reports supported by COD are available at http://samos.coaps.fsu.edu/html/publications.php and acknowledgements are included in each document.

SAMOS data are not distributed via the Global Telecommunication System. The DAC has an ongoing collaboration with the managers of the U.S. Voluntary Observing Ship scheme at the National Data Buoy Center (NDBC) to assess the quality of data records transmitted via the GTS from the same vessels that contribute to SAMOS. The majority of the U.S. research vessels contributing to SAMOS provide irregular 1-, 3-, or 6-hourly reports to the GTS via other National Weather Service- (NWS) supported programs (e.g., AMVER SEAS). Preliminary results reveal that the SAMOS data can be used to trouble-shoot the GTS data feeds from the NWS programs. The collaboration with NDBC personnel (J. Rolph, FSU, visited the U.S. VOS coordinator in Pascagoula, MS in April 2014) has also allowed SAMOS to receive updated instrumental metadata for several NOAA-operated RVs (deliverable 5). The PI notes that our major user community continues not to require SAMOS data to be delivered via GTS. Our current web, ftp, and THREDDS systems meet their needs.

SAMOS data are archived at the U.S. National Oceanographic Data Center on a monthly schedule 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. NODC makes the archival sets available online via two types of Dissemination Information Packages: the public may download either individual files in the archival set—each file has a unique URL—or the entire archival set in one "tarball" file. Users may find all the SAMOS data by searching for SAMOS under "Contributing projects" on the Open Archive System at http://www.nodc.noaa.gov/cgi-bin/OAS/prd/accession. A check on 14 November 2014 located 1499 monthly SAMOS ship archive sets at NODC. Periodically, the PI downloads SAMOS data from NODC to ensure system integrity.

Back in 2005, the SAMOS acronym was adopted and has been very successful for tracking our data, particularly when searching the NODC archives. The SAMOS initiative has been recognized at international meetings and symposia such as the ESA/SOLAS Earth Observation for Ocean-Atmosphere Interactions Science 2014 and WCRP and EUMETSAT sponsored Climate Symposium 2014. In the SOLAS meeting, SAMOS data were widely used in gas flux calculations and noted in an introductory talk for the session. At the WCRP and EUMETSAT meeting, SAMOS data were noted for their value in validation of satellite retrievals. The SAMOS acronym provides a mechanism to identify use of these data in manuscripts in catalogs like Google Scholar. In FY14, we also initiated a discussion with NODC to assign a "collection level" digital object identifier to the FSU SAMOS data in the archive. Finally, we do acknowledge CPO/COD support for the SAMOS project on the SAMOS web site (http://samos.coaps.fsu.edu/html/ack.php), but need to provide a more prominent "how to cite these data" somewhere near or on the data download pages. We are also exploring Google analytics to better track data downloads from FSU.

Information on collaborators / partners:
Name of collaborating organization: NOAA/OMAO, NOAA/NODC
Date collaborating established: Not reported
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: 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 and Mathew Biddle at NODC to ensure timely archival of all SAMOS datasets. In FY14, NODC 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. Neely Fawaz and Jocelyn Elya are both undergraduate students studying computer science. Through COD funds they have been exposed to the complex and diverse ways that marine climate data are disseminated to the user community. Each has developed or augmented operational data processing and web distribution codes for the SAMOS project. Rachel Weihs, PhD candidate, has been working on one of the outstanding issues in using SAMOS data to estimate air/sea fluxes. Ship-based SST observations may lead to errors in the fluxes in cases where (a) the upper ocean exhibits strong diurnal heating from solar radiation or (b) the depth of the

measurement is subsurface (SAMOS SST typically from 1 to 5 m depth). For flux calculations the surface skin temperature is desired. Ms. Weihs is developing a parameterization for converting sea temperatures from depth to a skin temperature, that accounts for diurnal variability. If this parameterization proves to be accurate, we will utilize it to improve our SAMOS-based flux estimates.

Hosted speakers, workshops and/or any training:
Type (speaker, workshop, training): Speaker
Name of event: Australian Bureau of Meteorology
Date: August 11, 2014
Location: Melbourne, Australia
Description: A seminar describing a decade of success with SAMOS and ongoing partnership with the Bureau to provide SAMOS data from RVs operating in Australia and New Zealand.
Approximate Number of Participants: Not reported

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

Related NOAA Enterprise Objectives: Science and Technology, Engagement

NGI File #14-NGI2-88: Northern Gulf Institute Diversity Internship Program

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

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

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

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 cohort of interns and mentors have been selected and are currently interning at their locations and with mentors at the locations listed in Table 6.

Table 6 2015 NOAA-NGI Diversity Internship participants, mentors, and intership location

	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

An orientation session was held at the Dauphin Island Sea Lab from May 31 through June 2. Interns received an introduction to NOAA (NOAA project liaison – Russ Beard), the Northern Gulf Institute (NGI Co-Director – Steve Ashby), Dauphin Island Sea Lab (Chair, Education & Outreach – Tina Miller-Way) and enjoyed an introduction to the Gulf of Mexico aboard DISL's research vessel, the Alabama Discovery. Interns also received training in data management and metadata (NCEI personnel – 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: None reported

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

Related NOAA Enterprise Objectives: Science and Technology, Engagement

NGI File #14-NGI2-89: 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: Russ Beard, NESDIS/NCEI

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 a) enhance and support integration of regional ecosystem data management into the EDAC via NOAA's National Centers for Environmental Information (NCEI), b) continue NOAA's affiliation with DISL to meet NOAA data management goals, c) continue creation and publication of place-based metadata and associated summary data sets as DISL's contribution to this assimilative effort with NOAA, d) continue testing and integrating automated end-to-end data management (sensor to archive) techniques (this year we will update our approach to meet NOAA's new standards), and e) support NGI research efforts (graduate & PI level) that are beneficial to both NOAA integrated ecosystem assessment (IEA) and REDM efforts. *Making datasets readily available and accessible and overcoming hurdles to faculty and student participation in metadata creation will facilitate scientific studies, public education, and outreach. The resulting data management systems will enhance the Regional Ecosystem Data Management effort and expand the capability of EDAC to gather ecosystem data.* Notably, this year we updated the public accessibility of a 14-year dataset of physical, chemical, and biological parameters in lagoonal systems of Perdido Bay, Florida maintained in Dr. Just Cebrian's laboratory at DISL.

Description of research conducted during the reporting period and milestones accomplished and/or completed
Development of customized ISO 19115-2 metadata writing tools for the DISL research community.

12 new metadata records published, including 5 in the ISO 19115-2 metadata standard.

17 new metadata records in progress, including 7 in the ISO 19115-2 metadata standard.

4 new datasets submitted to NOAA NCEI Ocean Archive System.

Perdido Lagoon sampling conducted 7 times. Lab processing and analysis of samples in progress.

Training of the data management specialist (Mimi Tzeng) in software sharing via the EarthCube GeoSoft GPF Initiative.

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:

Began active transition 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. This has included extensive training of the data management specialist in the ISO 19115-2 standard, followed by development of customized ISO metadata writing tools for the DISL research community to help transition from our use of the MERMAid FGDC metadata writing tool. DISL's tools are available at http://dim.disl.org/ISO/ISO_index.html.

Participation by the data management specialist in NSF's EarthCube Test Governance project, in particular the Science Standing Committee, 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.

Information on collaborators / partners:

Name of collaborating organization: EarthCube GeoSoft Geoscience Papers of the Future Initiative http://www.geosoft-earthcube.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 has undergone this training with a GPF in progress, and will begin learning how to train others to write GPFs, with the intention of eventually bringing these concepts to the DISL research community.

Information on any outreach activities:

Annual Metadata Training Workshop at DISL on March 19, 2015 with Kathy Martinolich, Jacqueline Mize, and Katharine Woodard of NCEI. This was the first year that we focused on the ISO 19115-2 metadata standard. There were 4 attendees, all research staff.

DISL Data Management Newsletter distributed quarterly by email.

Mimi Tzeng attended the EarthCube Test Governance Check and Adjust Meeting on January 27-28, 2015 in Tucson, Arizona. Its purpose was to assess the progress of Test Governance at the midpoint of the project and make any necessary adjustments. Approximately 40 attendees.

Mimi Tzeng attended the EarthCube GeoSoft Early-Career Advisory Committee Face-to-Face Meeting on March 11-13, 2015 in Marina del Rey, California. Its purpose was to allow members of the committee of mostly scientists to inform the GeoSoft project PIs how we use software in our research and what our software challenges are, to allow the GeoSoft project PIs to educate the committee members on software solutions in progress, and to discuss the GPF initiative. Approximately 20 attendees.

Mimi Tzeng attended the EarthCube Scope and Vision Workshop on March 25-26 in Berkeley, California. Its purpose was to present the draft of the Science Strategic Plan (initially drafted in January 2015) to a representative group of geoscientists, then revise and expand it from the science perspective, before the updated draft would be presented to technologists at a followup meeting in April. 36 attendees.

Mimi Tzeng attended the EarthCube All Hands Meeting on May 27-29, 2015 in Washington, DC. All Hands is EarthCube's primary annual meeting. Approximately 150 attendees.

Mimi Tzeng also participated in an NSF EarthCube panel in 2015.

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

Related NOAA Enterprise Objectives: Science and Technology, Engagement, Organization and Administration

NGI File #14-NGI2-90: Determination of Habitat Use and Movement Patterns for Adult Smalltooth Sawfish

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

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

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

Project objectives and goals

The primary goal of this project is to investigate movements and migration of subadult and adult smalltooth sawfish (*Pristis pectinata*), particularly those captured in areas of elevated interaction with fisheries, using satellite telemetry in order to develop life-history information on the species that will help to identify localized areas of aggregation, potential mating sites, and areas with high likelihood of shrimp trawl interaction. We sought to conduct up to 24 days of fishery-independent sampling to capture and tag adult smalltooth sawfish. However, actual days at sea may be limited by permitted captures of endangered sawfish and availability of satellite transmitters.

Sampling locations are based on known records of interactions with commercial shrimp and longline fisheries, recreational fisheries, or research surveys. The shelf edge at water depths of 40-55 meters from offshore of Key West the Marquesas Keys is a known area of sawfish interactions with commercial longline and shrimp 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 all adult and large juvenile sawfish capture, we wither deploy one of the following: MK-10 or MK-10PATF tags manufactured by Wildlife Computers® or X-tag manufactured by Microwave Telemetry Inc. These tags record pressure (depth), temperature, light, and light-based location estimates at intervals predetermined by the. PAT tags will be programmed to release after 2 to 5 months. Light-based geolocation data are notoriously noisy; therefore, a form of the Kalman filter (Sibert et al. 2003) incorporating sea-surface temperature (Nielson et al. 2006) will be applied to the location data. The MK-10PATF tags have an added advantage of logging real-time location data using an onboard GPS during intervals when sawfish are near the surface (e.g., in shallow water). Comparisons of the real-time location data to the raw and filtered light-based geolocation data will provide a measure of the variability and reliability of the light-based data. We are currently analyzing the data using Kernal analyses on location data to define areas of concentrated use,

potential adult aggregation sites, and activity space as a function of temporal cycles (e.g., diel, lunar, seasonal). Site fidelity and indices of reuse will be applied as appropriate. We will examine temperature and depth data for patterns and preferences and will compare the data as functions of diel and seasonal patterns as well as sex and size of sawfish.

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

During the reporting period, three research trips (16 total days, 10 days at sea) were completed and 41 total fishery independent longline sets were made, all aboard an FSU research vessel (a 26' Calcutta). Eleven (11) adult or large juvenile sawfish were captured and tagged (Figure 1). The first trip was completed in September 2014.

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 a trip in September 2014 to test theses limits and also search for sawfish in other areas, including the on the edge of the continental shelf offshore of the Middle Keys. During this trip, we caught three sawfish, an adult male and a large juvenile female still within the Florida Bay aggregation sites and one adult female at 50 meters depth on the edge of the continental shelf. The adult male was a recapture, originally tagged in Florida Bay in March 2012 (2.5 years at liberty). Of interest, this sawfish was missing approximately 60% of its rostrum, but was otherwise, completely healthy. The rostrum was also missing when originally tagged. 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 is the first documented pregnancy of a smalltooth sawfish. All three sawfish were tagged with archiving satellite tags and passive acoustic transmitters and blood was collected for reproductive hormone analyses.

One trip was scheduled for November 2014 but was canceled due to inclement weather; therefore, the next trip was conducted in January 2015. Following receipt of reports from divers of multiple sawfish on a deep wreck (70 m), we intended to conduct five field sampling days divided between Florida Bay and the offshore wreck. During two consecutive longline sets on day two, we captured seven adult sawfish (2 males, 5 females) at a depth of 70 meters. This marked the most females captured during one trip and also only the second time adult males and females have been captured together. No females appeared pregnant, suggesting they may have been in their resting year and possibly preparing for mating. Blood samples were collected from all females and one male for hormone analyses. We deployed our last archiving satellite tags on two females and one male sawfish. Due to concerns over permitted take limits and the lack of satellite tags, we discontinued sampling for this trip.

We conducted a third trip to the Florida Keys in May 2015. Due to weather, only two full days of sampling were completed. Based on reports of multiple adult sawfish in the Broad River in the northern part of Everglades National Park, we used one day to sample this area, ~200 km roundtrip by boat from Islamorada, but no sawfish were captured. We did capture, tag and sample one adult male sawfish in Florida Bay (East Cape Canal) during this trip however.

Description of significant results, protocols developed, and research transitions

During the reporting period we captured 11 and tagged 10 large individuals of the endangered smalltooth sawfish. Using NGI funds and previous funds from the NOAA Section 6 Program, we have completed 242 demersal longline sets during the last four 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 26). We captured 40 adult or large juvenile smalltooth sawfish on longlines and an additional 9 sawfish on rod and reel. Of the 40 captured on longline, 19 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 27). 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 (Figure 28). Adult sawfish spent the great majority of their time in waters less than 10 meters deep.

We also collect blood samples from captured sawfish. These samples have been analyzed by collaborators at the University of North Florida to examine cycling of reproductive hormones in an effort to determine timing and periodicity of vitellogensis, sperm production, mating and parturition. Preliminary data suggest spermatogenesis takes place in fall and winter in preparation for mating in spring. 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. Two peer-reviewed papers resulting from this project were published this year:

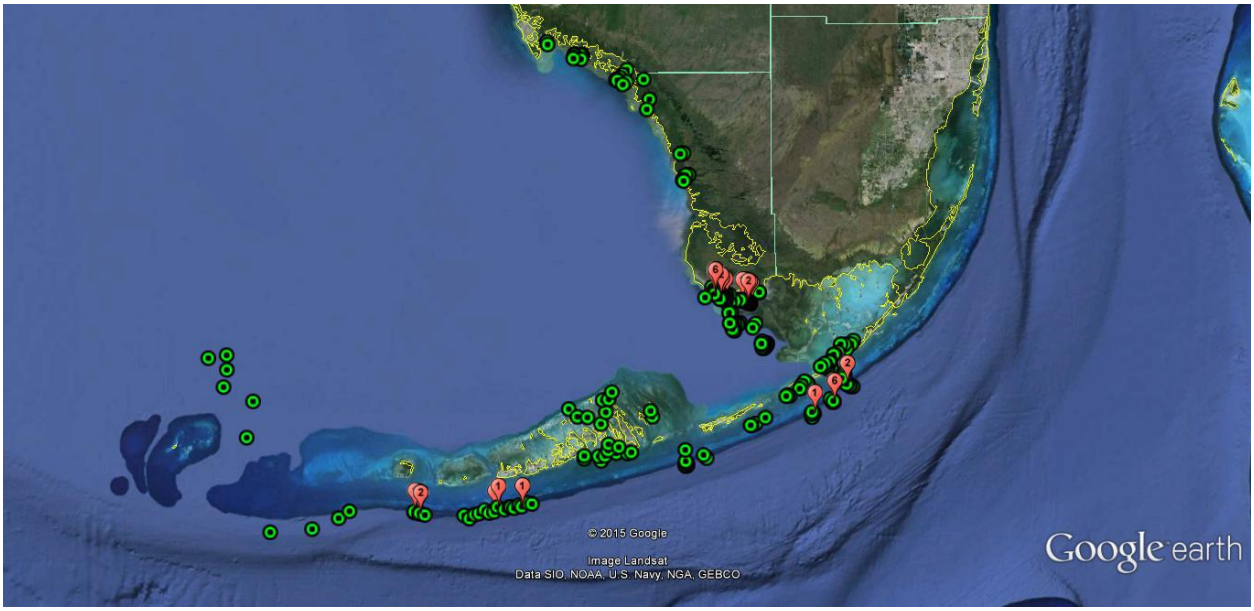


Figure 26 Distribution of fishery-independent longline stations (N=242) sampled between 2011 and 2015 to capture and tag endangered smalltooth sawfish. Red flags = sawfish capture locations, numbers indicate number of sawfish captured on a single set.

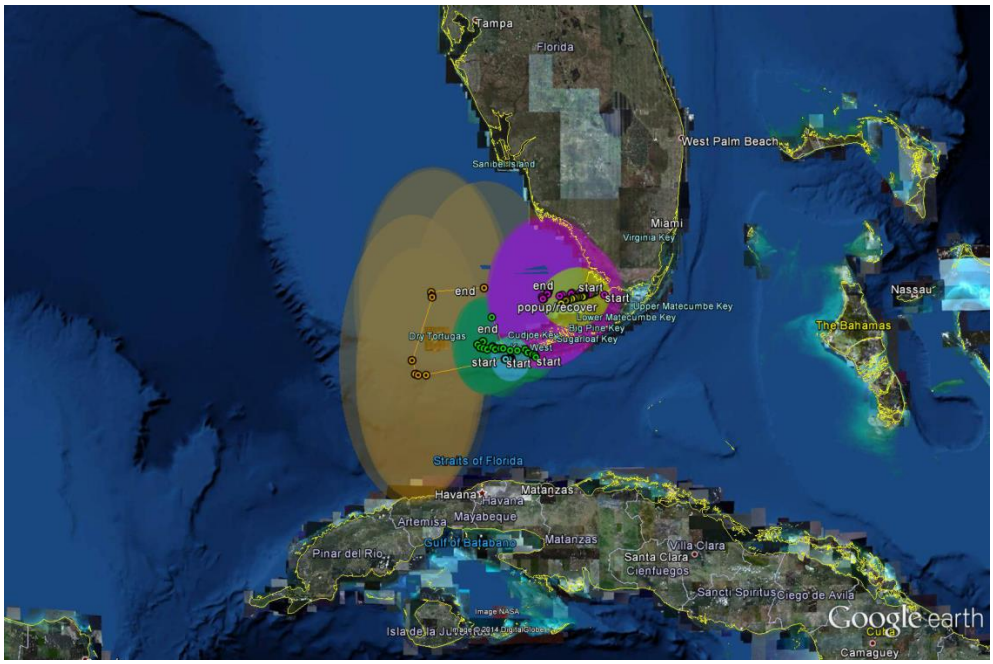


Figure 27 Most likely tracks of five satellite tagged sawfish tagged in Florida Bay and the Florida Keys following application of raw data to a Kalmin Filter. Ellipses represent 95% confidence around tracks.

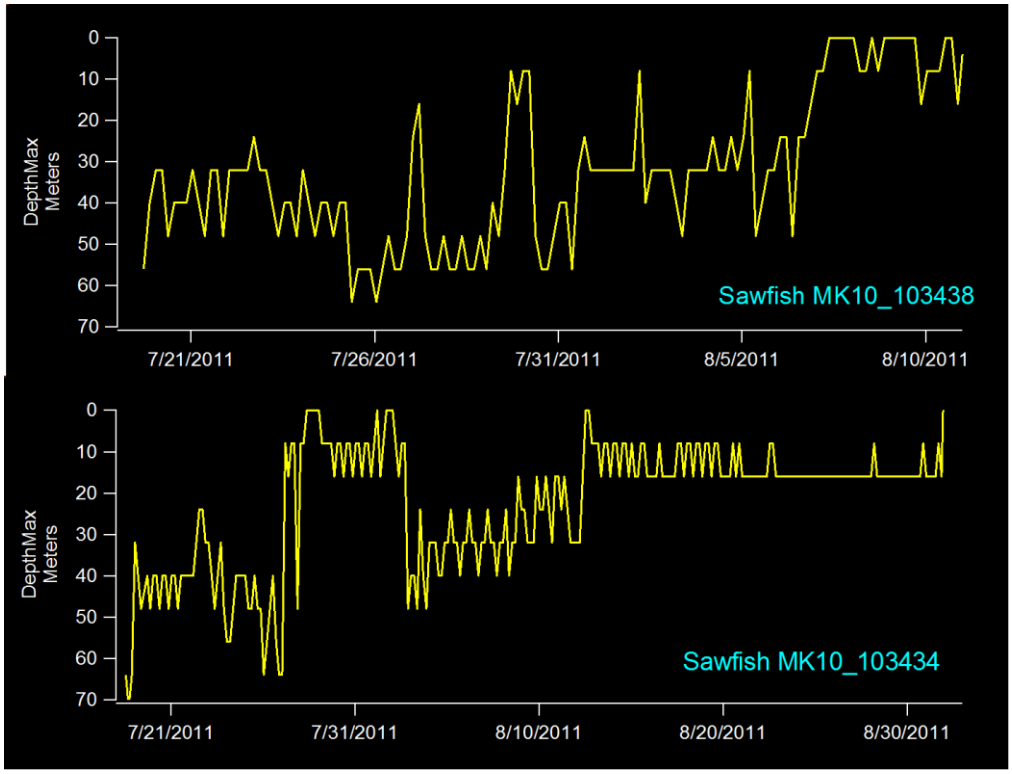


Figure 28Depth data obtained from two sawfish tagged on the edge of the continental shelf indicating ephemeral use of this habitat.

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. We also download receivers belonging to our FMNH colleagues and deploy acoustic transmitters supplied by them.

Information on any outreach activities:
Our NGI supported research was highlighted in two national documentaries produced in 2014:
WPBT – "Changing Seas" Series – "Saving Sawfish"
Discovery Channel: Shark Week, "Alien Sharks: Return to the Abyss"

I gave a numerous invited presentations to public schools, the general public, and university groups that highlighted NGI supported research on smalltooth sawfish:
College of Charleston – Keynote Speaker, Graduate Research Colloquium. Endangered sawfish and deep-sea sixgill sharks: Using modern telemetry to study very large elasmobranch fishes. 19 September 2014
Florida State University Coastal and Marine Lab - Coastal and Marine Conservation Lecture Series. The Ecology of Smalltooth Sawfish in Florida and the Bahamas, Research to Support Recovery of a Critically Endangered Species. 14 August 2014
Altha Public School, Altha, FL. Research on coastal and deepsea sharks and rays of the Gulf of Mexico. 20 March 2015. Lecture to 60 6th and 10th grade students.

Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology

NGI File #14-NGI2-91: Evaluation of VIIRS AOP/IOP Products

Project Lead (PI) name, affiliation, email address: Haibo Yao, 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

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 insitu 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 (see Fig. 29), and another source is climatology data obtained from MODIS Aqua for gyre waters (see Fig. 32).

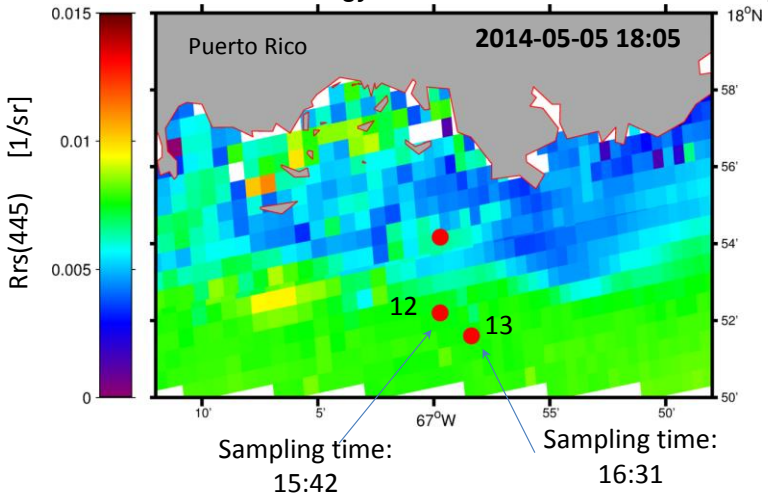


Figure 29 Matchup stations between VIIRS and in situ measurements.

For the Puerto Rico offshore water (see Fig. 29), there are two stations (#12 and #13) with matching VIIRS data, and Fig. 2 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 (see Fig. 31).

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.

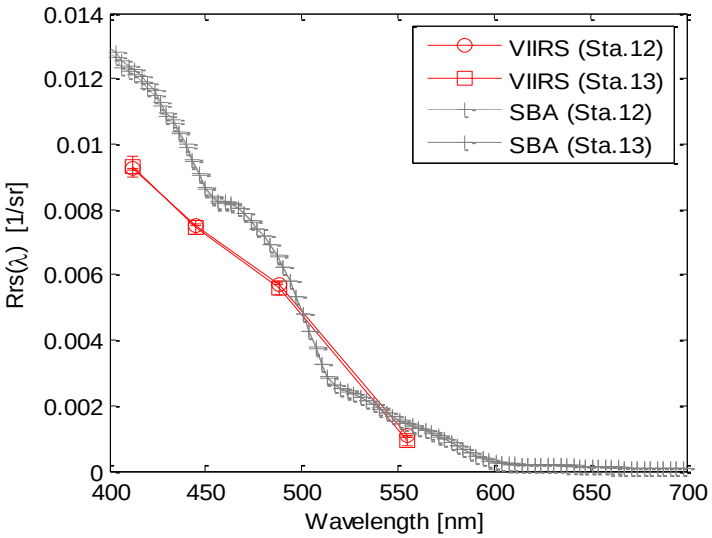


Figure 30 Comparison between VIIRS Rrs and in situ Rrs.

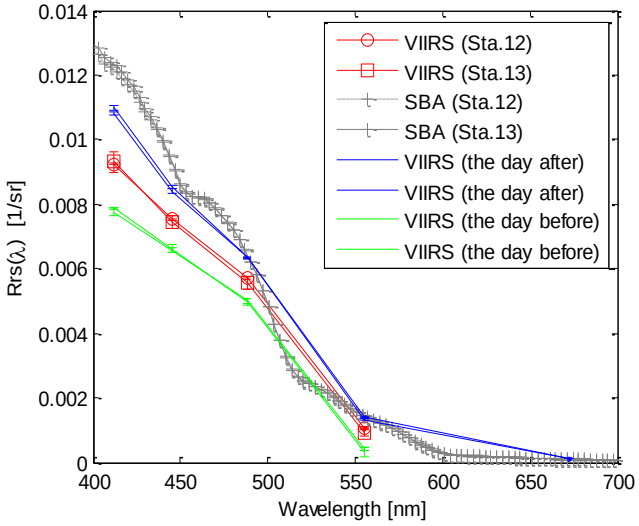


Figure 31 Day-to-day change of VIIRS Rrs.

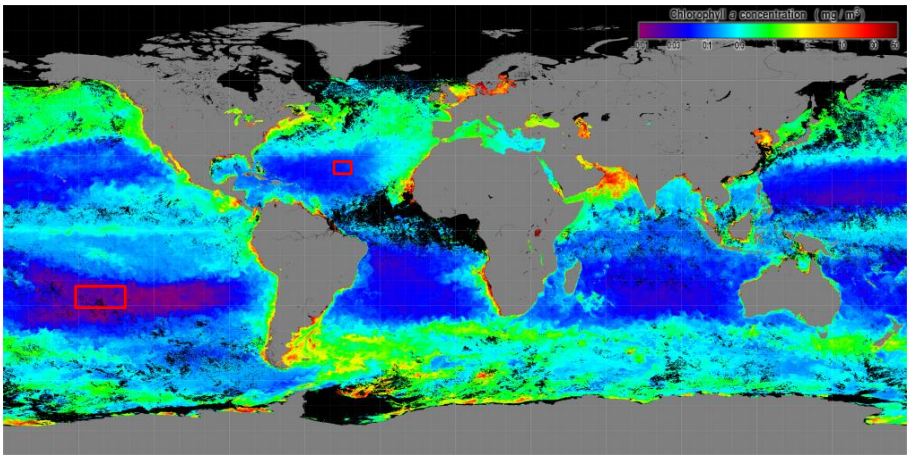
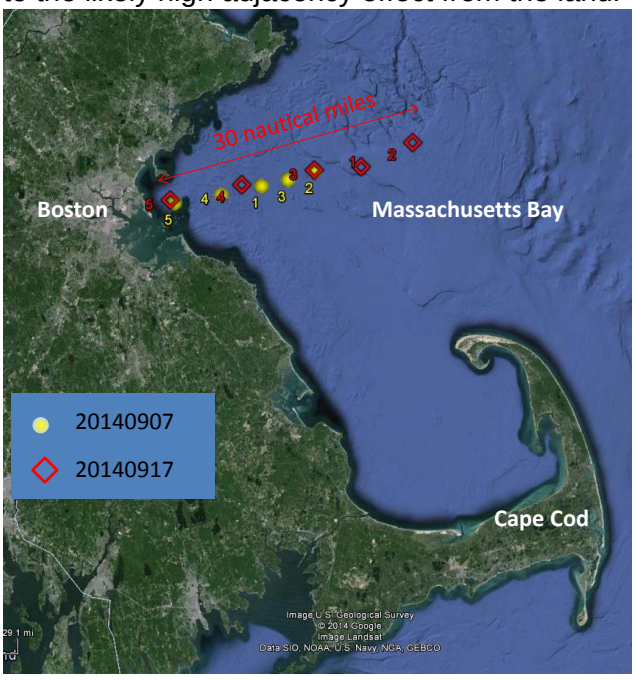


Figure 32 Gyre locations used for comparison between VIIRS EDR with MODIS climatology.

Evaluating VIIRS-derived ocean products over green waters

Field measurements to matchup VIIRS were carried out on Sept. 7 and Sept. 17, 2014, with Fig. 33 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.



Experiment I
20140907
Sky: clear
Wind: 4-8 m/s
Waves: 1-3 feet

Experiment II
20140917
Sky: clear
Wind: 0.5-5 m/s
Waves: 0.5-1.5 feet

2

Figure 33 Matchup stations between VIIRS and in situ measurements.

Figure 34 compares satellite (both VIIRS and MODIS) Rrs with insitu Rrs for measurements on Sept 7, 2014. Apparently satellite Rrs (both VIIRS and MODIS) values are substantially (~30-40%) lower than insitu Rrs for all the bands. This discrepancy is likely a result 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.

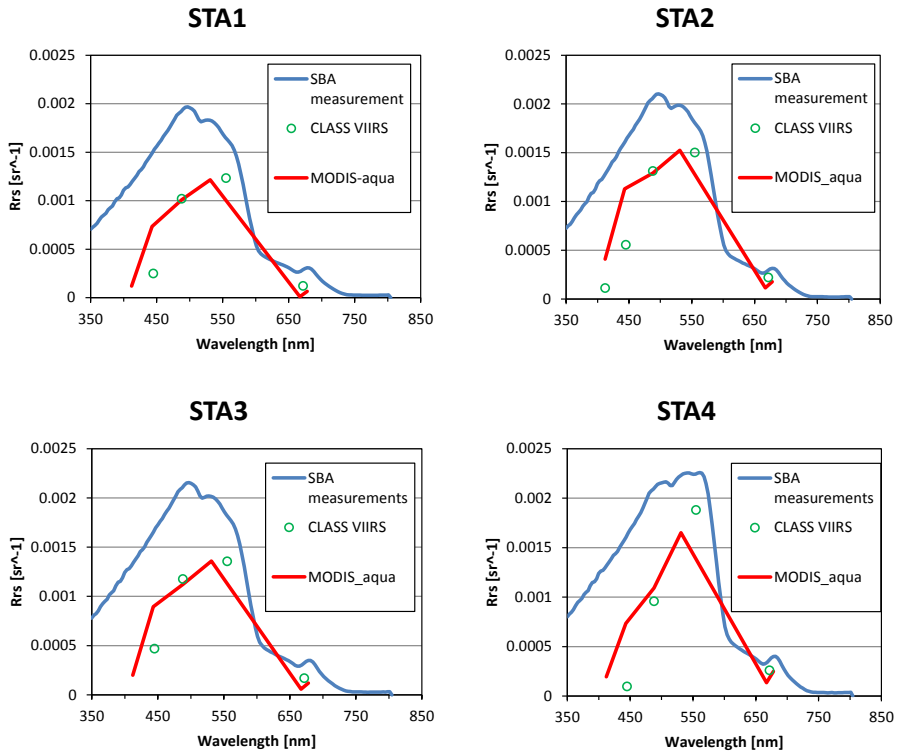


Figure 34 Comparison of Rrs between satellite product and insitu measurements for Sept. 7, 2014.

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

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

Another field measurements was carried out in the North Atlantic Ocean in Nov. 2014 organized by NOAA to validate VIIRS products, with our unique SBA system deployed to measure Rrs of both coastal and offshore waters (see Fig. 34, 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 Fig. 35.

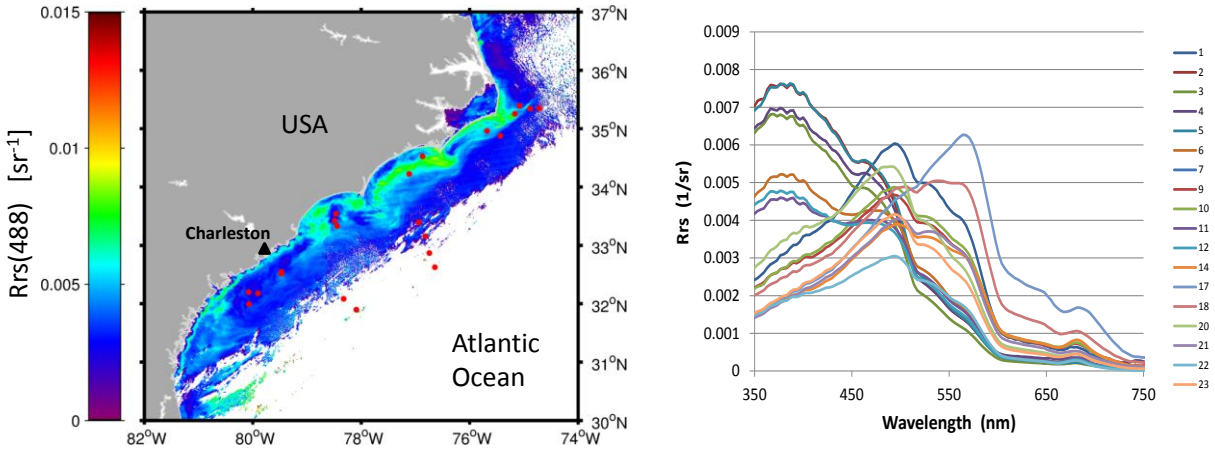


Figure 35 Locations of the stations during the Nov. 2014 cruise (left) and Rrs spectra of these waters (right).

As an example, Figure 36 shows a comparison between VIIRS Rrs (acquired from CLASS) and insitu measurements, where VIIRS in the blue is significantly smaller than insitu Rrs, even for a time difference of 20 min (Sta. 21). This is consistent with the general pattern that VIIRS in the shorter wavelengths are lower than that from field measurements.

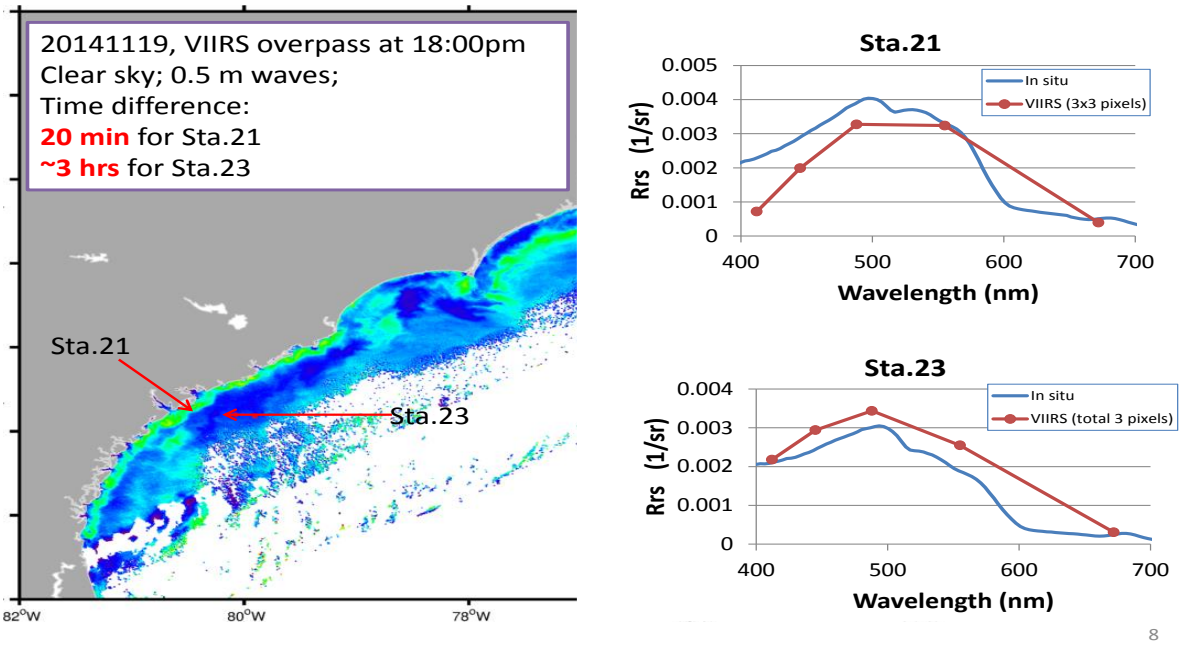


Figure 36 An example of matchup comparison of Rrs between VIIRS (from CLASS) and insitu measurements.

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 insitu 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: Healthy Oceans

Related NOAA Enterprise Objecives: Science and Technology

NGI FILE #14-NGI2-92: Hypoxia National Office Support Activities

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

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

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

Project objectives and goals
Advance the science underpinning management of the large annual hypoxic zone ("dead zone") in the northern Gulf of Mexico.

Provide a forum for strengthening communication between physical, biological, and socioeconomic modelers of the Gulf of Mexico hypoxia and the Mississippi River diversions, and the users and stakeholders.

Validate and refine key fisheries management and habitat conservation needs associated with ecosystem effects of hypoxia and large-scale river diversions in the Gulf of Mexico;

Assess adaptive management needs for advancing ecosystem modeling of hypoxia and diversion effects on habitats and living resources in the northern Gulf of Mexico.

Description of research conducted during the reporting period and milestones accomplished and/or completed
Conducted the 5th Annual Hypoxia Research Coordination Workshop to update scientific understanding of hypoxic zone causes and impacts, coordinate Gulf hypoxic zone research, monitoring and modeling activities, and facilitate information exchange between the research and management communities. The workshop focused on an issue critical to assessing the ecological and socioeconomic value of hypoxia mitigation – the tools and models used to examine the impacts of hypoxia on Gulf fisheries and their habitats in an ecosystem context, including humans. Additionally, the workshop provided a forum to integrate ecosystem modeling focused on assessing Mississippi River diversion impacts. Ecological and socio-economic impacts of diversions are critical aspects of planned restoration activities that require detailed investigations and stakeholder interactions. The workshop was attended by over 100 researchers from many universities and representatives from state and Federal agencies. A proceedings paper entitled **"Advancing Ecosystem Modeling of Hypoxia and Diversion Effects on Fisheries in the Northern Gulf of Mexico"** was prepared (Ashby et al. 2015).

Description of significant research results, protocols developed, and research transitions
The workshop was designed to advance fisheries ecosystem management in the northern Gulf to inform efforts to assess and predict the potential ecological and socioeconomic effects of diversions and hypoxia. Emphasis was on assessing ecological impacts of diversions on aquatic habitats and potential impacts on the development of the northern Gulf hypoxic zone. This is in support of NOAA's Ecological Forecasting Roadmap Initiative:

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

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

It is envisioned that this proceedings paper will serve as an important building block for integration of stakeholder recommendations for balancing ecological, economic, and social benefits related to diversions, hypoxia and fisheries.

Drs. Ashby and Lewitus participated as members of the 5th Annual Hypoxia Research Coordination Workshop Steering Committee, helping to set the agenda and chose participants for writing teams, and participated on the writing team. Workshop summaries will be presented at the Fall Hypoxia Task Force Meeting. Drs. Ashby and Lewitus also attended the Mississippi River/Gulf Hypoxia Landscape Conservation Design Meeting in Memphis, TN on 11 to 14 August 2014, a multi-Landscape Conservation Cooperative effort whose aim is to reduce nutrient pollution in the Mississippi River watershed in order to mitigate Gulf hypoxia and improve local habitats.

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 Kidwell, NOAA NCCOS), Dave Scheurer (NOAA NCCOS), Chris Kelble (NOAA OAR), Howard Townsend (NOAA OHC), LaToya Miles (NOAA ARL), Marie Bundy (NOAA NOS), Steve Giordano (NOAA OHC), Rich Fulford (EPA Gulf Breeze Laboratory), and Lael Butler (EPA Gulf of Mexico Program)

Date collaborating established: July 2009

Does partner provide monetary support to project? Amount of support? None Reported

Does partner provide non-monetary (in-kind) support? Yes

Short description of collaboration/partnership relationship: Workshop co-sponsor

Information on any outreach activities

General Description: Workshop to coordinate Gulf of Mexico hypoxic zone research

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

Date: July 14-16, 2014

Location: Stennis Space Center, MS

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

Approximate Number of Participants: 95

Workshop Output: Ashby, S., M. Bundy, V. Fay, R. Fulford, S.D. Giordano, C. Kelble, L, Myles, J.W. Pahl, R. Raynie, and R. Swafford. 2015. Advancing ecosystem modeling of hypoxia and diversion effects on fisheries in the Northern Gulf of Mexico. Edited by A.J. Lewitus, D.M. Kidwell, and D. Scheurer. Proceedings Paper from the 5th Annual NOAA/NGI Hypoxia Research Coordination Workshop, 14-16 July 2014 at the Mississippi State University Science and Technology Center at NASA's Stennis Space Center in Mississippi, 46 pages.

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

Related NOAA Enterprise Objectives: Science and Technology

NGI File #14-NGI2-93: 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

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

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

Project objectives and goals

Task 1

a. Bimonthly weeklong overflights of the Pearl River coastal watershed using a small UAS designed for mapping operations with two major objectives

    1. collecting quality data to advance the science
    2. developing CONOPS

b. Obtain land-cover, land-use (LULC) information from the bimonthly overflights

c. Obtain land-water masks from each mission data

d. Organize and execute a workshop in the October-November timeframe to update the NWS/RFC personnel on UAS capabilities and to update the UAS manufacturers, integrators, and operators on RFC requirements, as well as to develop a longer term roadmap for the RFCs in collaboration with a representative set of RFCs

Task 2

a. Develop an image cache data portal for the data we collect

b. Develop a data management plan for LASE data

c. Develop a data dissemination portal for LASE data collected under NOAA UAS Program funding

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

Task 1

a. A one-day workshop was held September 15, 2014 in Anchorage, AK in association with the annual Alaska UAS Interest Group meeting. At this workshop, the RFCs presented their UAS-related results and needs and updated their requirements. A summary of the workshop and a copy of the presentations is available at http://www.ngi.msstate.edu/noaa_uas_workshop_2014/presentations.html.

b. Six weeklong UAS-based data collection missions were conducted in the Pearl River coastal watershed in July 2014, August 2014, September 2014, December 2014, March 2015, and May 2015.

c. Several issues with the new version of the Altavian Nova were encountered during the first two missions. Wires came loose and removablr cards lost connection. These engineering and manufacturing issues were resolved by the September mission. We had minimal issues landing in the water. No seepage through the fuselage, for example. An extensive amount of quality scientific data was collected on the last four missions.

d. We determined that landing on the brackish water and then rinsing the exposed electronics in fresh water remained the best recovery approach, as opposed to trying to land in marsh grass or on narrow shorelines.

e. LULC data was extracted from the last 4 flights. Land-water masks were developed from the last 4 flights. Analysis of the September and December 2014 data was presented at the Lower Pearl Total Water Level Science Meeting in February 2015 and at the AAG Conference in April 2015.

f. Assisted with the execution of a set of UAS tests at Avon Park, FL in January 2015. Assisted with analysis of the results.

    1. The tests showed that eBee UAS was an appropriate tool to collect data over smaller areas. It was relatively inexpensive, easy to setup and fly, sufficiently rugged, and provided very good data

    2. The tests showed that the new flight control software for the Altavian Nova still had some bugs. An incident report was provided to NOAA's AOC soon after the incident and to the NOAA UAS Program Office on 27 June 2014. The data that was collected was deemed high quality.

    3. The tests exhibited the ability of the AeroVironment (AV) Puma to fly for 2.75 hours in one flight. On that long flight LiDAR data was collected. AV analysis showed that the quality was very good. AV also collected data with a 6-band MSI payload and a 24 Mpixel mapping payload on 2 subsequent flights

g. 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.

h. We initiated work with the National Estuarine Research Reserves (NERR). After several planning telecoms, in March 2015 we collected 1.5-inch resolution imagery over a large portion of the Grand Bay NERR (GBNERR). In May 2015 we collected half-inch resolution imagery data over the GBNERR Sentinel Sites. In June 2015, we collected video of a simulated chemical spill in a section of the GBNERR downstream from a phosphorus plant. The May 2015 data is being used to determine the response of two types of sea grasses to sea level rise. The June 2015 video documents how a spill might evolve to assist in emergency response.

i. We presented an AGU talk, 2 AAG presentations, and submitted two conference abstracts on the water quality work.

Task 2

a. Developed an image cache data portal for the data we collect. 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.

b. Initiated development of a data management plan for NOAA's LASE UAS data

c. Created a beta-version of 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

a. The 2nd UAS RFC Workshop: the meeting and attendees, as well as the presentations and extensive workshop summary

b. We have shown that it is possible to collect information about harmful algal blooms (HABs), suspended sediments, and colored dissolved organic matter (CDOM) from remotely sensed data. Harmful Algal Blooms (HABs) are caused by species of microscopic plants, phytoplankton. 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, the dinoflagellates of the genus Karenia with its associated toxin brevetoxin are of particular concern. 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) and 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 archival literature.

Task 2

a. Provided over a TB of image data via the image cache

b. Developed a preliminary version of a data portal for the LASE data being collected under NOAA UAS Program office funding and shared the site with the NOAA UAS Program Office

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.
Short description of collaboration/partnership relationship: They assist in providing requirements, collecting data, and evaluating the applicability of the results. 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.
Short description of collaboration/partnership relationship: They assist in providing requirements and evaluating the applicability of the results. 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.
Short description of collaboration/partnership relationship: They assist in providing requirements and evaluating the applicability of the results. 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.

Information on any outreach activities

General Description: The two data portals. One is an image-cache and allows users to see the imagery we are collecting and the mosaics we have produced. The other is to allow discover and dissemination of any data collected with LASE UAS in programs funded by the NOAA UAS Program.
Hosted speakers, workshops and/or any training:
Type (speaker, workshop, training): Workshop
Name of event: 2nd UAS Arctic and River Forecasting Workshop
Date: September 15, 2014

Location: Anchorage Hilton, Anchorage, AK
Description: RFCs presented their UAS-related work, the UAS RFC requirements were updated, and various NOAA Arctic programs were briefed.
Approximate Number of Participants: 100

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

Related NOAA Enterprise Objectives: Science and Technology

NGI FILE #14-NGI2-94 Analysis of Fisheries Acoustic Data

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

Co-PI: Valerie Samedy, Mississippi State University, 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

The National Marine Fisheries Service (NMFS) has conducted numerous acoustic surveys in the Gulf of Mexico for several years. The surveys are designed to monitor the abundance and distribution of organisms occurring within the study area. The cruises take place in spring or summer for the ichthyoplankton or in fall for the small pelagic or demersal organism onboard different NOAA Ship (*Pisces* or *Gordon Gunter*).

The cruises collected data at each level of the trophic chain. Sample sites were randomly selected with proportional allocation according the surface area. 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.

In the field of fisheries research, acoustic methods convert physical measurements into relevant ecological units describing the fish population. The frequencies most commonly used range from 12 to 430 kHz. Acoustic approaches are generally based on data collected with multiple frequencies because many scientific studies show that the frequency response differs between organisms based on the variability of the acoustic response. This is also the case for the surveys in the Gulf of Mexico. Four echosounders with one frequency for each split-beam echosounder (18, 38, 120 and 200 kHz) provided real time information on the spatial patterns and abundance of organisms ranging from plankton to fish. The EK60 was continually recording data from the start of the cruise to the end of the cruise.

Data from six surveys conducted between 2010 to 2015 were evaluated (Figure 37).

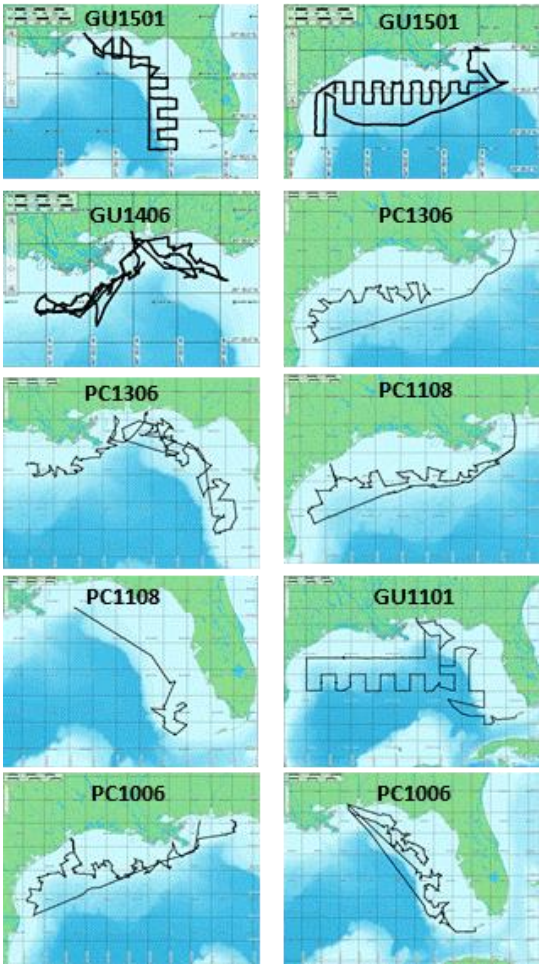


Figure 37 Cruise tracks in the Gulf of Mexico (2010 – 2015).

Description of significant research results, protocols developed, and research transitions
Acoustic data, recorded in an international format (.raw), required an important post-processing work before to be analyzed (to display the preliminary data, to convert and filter echograms, to

remove the noise or the bad data). In this study, acoustic data were analyzed using Myraix Echoview software.

The first step was to update data in the software and make them exploitable. 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. Multiple custom views can be designed to display your choice of objects and their relationships in order to give a workflow more manageable (Figure 38).

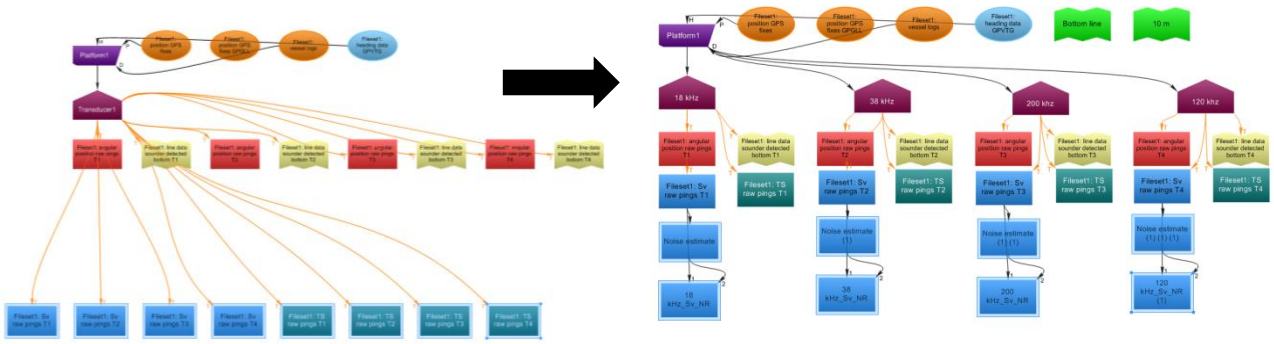


Figure 38 Manage the data flow after to upload the data.

The second step was to replay and scrutinize all acoustic data to generate volume backscattering strengths (mean Sv). An algorithm was developed to estimate the noise for each ping and then subtract it. Echograms were scrutinized again to remove *bad data* (empty water, reverberation or other sources of unwanted echo are characterized and accounted for) from the analysis.

Echo-integration, which integrates the return-echo strength (backscattering) from the echosounder's sampled volume, is a very robust method and is a mean to estimate the number of fish in the detection beam. If more than one target is located in the acoustic beam at the same depth, it is usually not possible to resolve them separately. Echo integration assumes that the total acoustic energy scattered by a group of targets is the sum of the energy scattered by each individual target. This assumption holds well in most cases. The total acoustic energy backscattered by the school or aggregation is integrated together, and this total is divided by the backscattering coefficient of a single animal, giving an estimate of the total number of individuals.

To extract the data, *variable properties* help to define a grid in order to obtain one value per cell. Initial efforts were to analyze every 10 pings by every 10 depth meters. For the each frequency, the grid is from the surface layer to the bottom layer when possible. In acoustics, there are two areas where the target cannot be detected: near the surface and near the bottom. A blind zone exists near the surface and depends on the position of the transducer and the size of the near field. However, on the bottom, the blind zone begins at the depth from which the echo of a target coincides with that of the background. It therefore depends on the morphology of the bottom, the pulse duration and the depth, determining the beam diameter. In this case, exclusion zone was defined between:

- above the *Exclude above line* at fixed depth (10 m) and,

- below the *Exclude below line* at the bottom line or another fixed depth (for the 120 kHz and the 200 kHz) (Figure 39).

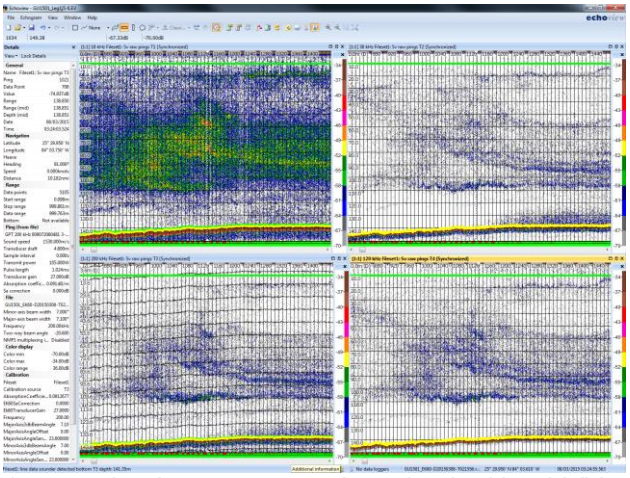


Figure 39 Echograms at 4 frequencies (18, 38, 120 and 200 kHz) with grid (black grid), surface line exclusion (yellow line) and bottom line exclusion (green line).

Resulting values of mean Sv or Nautical area backscattering coefficients (NASC) could be extracted in subsequent by echo-integration. Different categories could to be export (Figure 4) and we decided to select: Process_ID, Interval Layer, Sv_mean, NASC, Height mean, Depth mean, Layer depth_min, Layer depth_max, Ping_S, Ping_E, Dist_M, Date_M, Time_M, Lat_M, Lon_M, Noise Sv 1m, Minimum Sv threshold applied, Maximum Sv threshold applied, Standard deviation, Thickness mean, Range mean, Exclude below line range mean, Exclude above line range mean. The backscattered energy from a volume of water is termed "volume backscattering", S_v (in dB), and integration of S_v over a depth range give the layer strength, S_L (in dB).

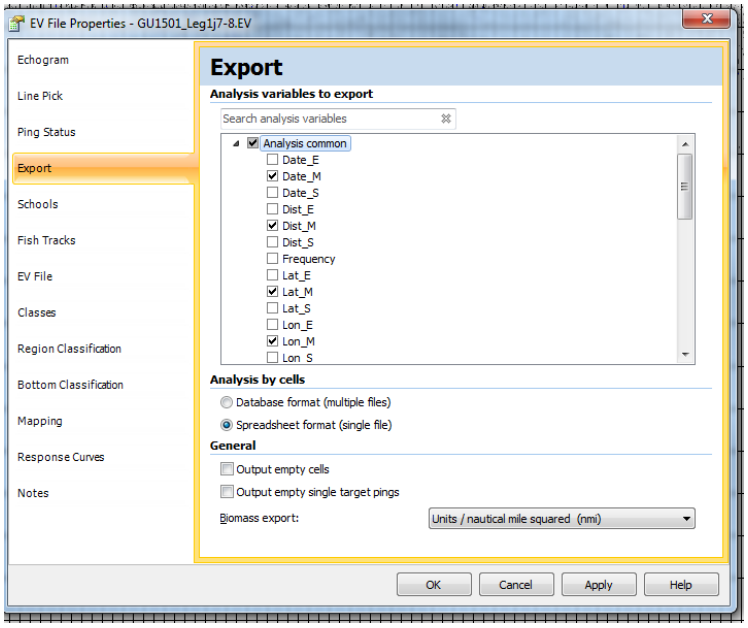


Figure 40 EV Files Properties window with the different options to export data.

Several ways of exploring the data exist in hydroacoustics (Fig. 40). For this study, the data were extracted and recorded in .csv. The data are being integrated in MatLab software in order to create an acoustic assessment "biomass" maps and to analyze the acoustic data set. Due to the fact the bottom trawl surveys generally miss most of the open ocean pelagic fauna quantitative estimates of density were not possible, even in a complex multispecies mixture.

Work continues using *in situ* data to compare with the Atlantis model runs to calculate the theoretical backscattering strengths. Even if the S_L 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, separated by day and night, and determined as averages for large ocean areas.

As the acoustic 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. All echograms can be synchronized. Individual echograms can also be released from the synchronizing. This allows the operator to study and compare different echograms at the same time and different events at different times. 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.

Dr. Samedy attended Echoview training in Nantes, France from May 20 to 22, 2015. During the course, electronic and hard-copy instructional materials, an Echoview hardware dongle (USB license key) and Echoview software installs were provided.
The goal of this training was:

- to have perspective by learning a workflow for processing acoustic data,
- to control by learning ways to explore your data and build dataflows in Echoview

Information on collaborators/partners Not applicable

Information on any outreach activities
Dr. Samedy participated and contributed to the International Council for the Exploration of the Sea (ICES) Symposium on the "Marine Ecosystem Acoustics (Some Acoustics)- observing the ocean interior in support of integrated management" which was held in Nantes, France from May 25 to 28, 2015. The primary aim of this symposium was to bring together scientists and ideas from various fields to facilitate and catalyze interdisciplinary interactions with acoustics as the central tool to further the development of marine ecosystem acoustics. The Symposium reviewed and discussed recent developments in acoustic methods and technologies used to characterize and manage marine and freshwater ecosystems. Particular emphasis had been placed on technologies used to measure diverse aspects of the aquatic environment, techniques for data analysis, and the integration of multiple data sets to elucidate functional ecological relationships and processes. Contemporary challenges and future directions of these objectives had been identified.

Dr. Samedy's presentation was entitled "Comparing hydroacoustic measurements in large estuaries at two frequencies (70 and 120 kHz)", Valérie Samedy, Mario Lepage, Philippe Boët, Jan Breine and Jean Guillard.

Dr. Samedy also made similar presentations at the NMFS Pascagoula Laboratory, MS and the Mississippi State University Science and Technology Center at the Stennis Space Center, MS.

Related NOAA Strategic Goals: Healthy Oceans

Related NOAA Enterprise Objectives: Science and Technology

NGI FILE #14-NGI2-96: 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, Mississippi State University, sashby@ngi.msstate.edu

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

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

Project objectives and goals

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

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

Equipment and supplies were organized for the Untrawlable Habitat Strategic Initiative (UHSI) research cruise. The Module Optical Underwater Sampling System (MOUSS) cameras were deployed and retrieved. Metadata was recorded and updated for the cruise and video files from the ROV were downloaded. Raw video data is being converted into abundance estimates before, during and after transit of the ROV and AUV vehicles in front of the MOUSS cameras. Five other biologists to perform 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

None reported

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: None reported

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

Related NOAA Enterprise Objectives: Science and Technology

NGI File #14-NGI2-102: 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, Jean-Francois Cavula, Vencore Inc, Jean-Francois.Cayula@Vencore.com

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

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 design will be used aboard follow-on satellite missions, therefore it is critical to characterize the sensor and optimal processing techniques for future missions (J1 is to be launched in 2018). The project is coordinating with NOAA, NASA, University, and Navy scientists and has demonstrated the capability for VIIRS ocean products to reach Beta maturity in the JPSS program.

The project goal is to improve and evaluate ocean products by performing calibration and validation of the ocean products of ocean color products and sea surface temperature. Ocean color products include the water leaving radiance, 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 and will also establish a long term climate trend of the ocean properties. NOAA's environmental satellites fulfill a critical national requirement for monitoring ocean properties.

NOAA Center for Satellite Applications and Research (STAR) has developed algorithms and processing VIIRS ocean products which include MS12 for ocean color products and ACSPO for SST. The project goals for ocean color are to collect accurate insitu 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. The goals of SST are to evaluate the accuracy of the Advanced Clear-Sky Processor for Oceans (ACSPO) Sea Surface Temperature (SST) products from the VIIRS satellite..

The project goal is to support the NOAA – STAR and JPSS programs in identifying issues regarding the stability of the 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 processing used to derive ocean products.

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

Ocean Color Calibration and Validation of S_NPP - VIIRS – Research: The NGI ocean color cal val team at Stennis participated in bi-monthly – NOAA- JPSS – cal val team telecons which are hosted by NOAA -STAR. Every 2 weeks, we collaboratively reviewed and discussed collective results of work with other team members. The NOAA JPSS STAR calibration and validation ocean color team represent approximately 28 scientists from 10 universities,

agencies and organization throughout the nation and are major leaders in satellite ocean color. Every 2 months, the NGI- (Stennis team) presented our accomplishments and specific status and results to the cal val team. Six presentations 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.

Gulf Steam Cruise: A major milestone this year was the participation of a dedicated SNPP calibration validation cruise on the NOAA Nancy Foster research vessel for ocean color product validation in the Gulf Stream waters. We developed a science objective for the cruise which left Charleston NC in NOV 10 for a 10 day cruise. The cruise was organized to gather national and international participants in the collection of precision ocean optical propertied which are required for calibration and validation of the VIIRS –NPP ocean color satellite. Participates represented approximate 10 organizations of the most experienced scientists for ocean color cal val all with standard protocols and instrumentation for collection and processing of optical properties. This includes NASA, NOAA, NAVY, University, and European personnel. This cruise represents one of the premiere ocean color cal val cruises ever performed. The objectives of the cruise were to: 1) examine the protocols and uncertainty in collection and processing of optical properties used for ocean color calibration. This includes defining uncertainty between similar and different instruments. 2) validate the VIIRS water leaving radiance (ocean color) and bio-optical products 3) characterize the optical properties across different water types in the Gulf Stream and the validation of the satellite bio-optical products to define these processes.

Because of past experience with the Gulf Stream, the USM team, headed the stations collection locations in different frontal locations across various water mass of the Gulf Stream (Fig. 45). Our participation included measurements of : 1) ship flowthrough bio-optical ac9 (filtered and non-filters) defining the spectral scattering and absorption 2) two above water Analytical Spectral Devices (ASD) for water leaving radiance 3) inwater floating Hyperpro for water leaving radiance 4) Aersol optical depths. There were similar instruments from other cruise participants and we examine the differences between the protocols and processing in data collection. The results of the cruise were documented in a NOAA cruise report that is final stages of publication. There were a total of 23 stations collected in different water masses for calibration and validation of ocean color.

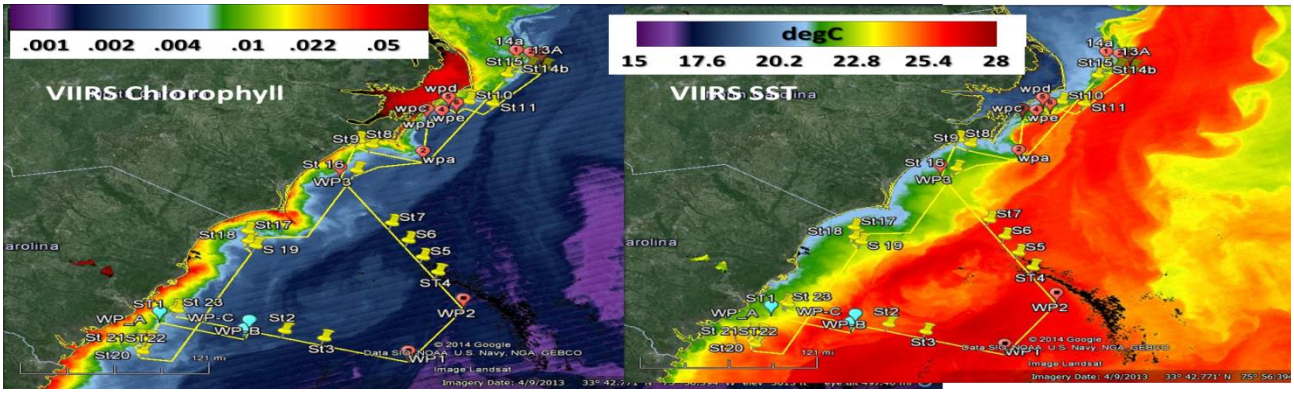


Figure 41 The cruise track of the Nancy Foster on VIIRS chlorophyll and SS crossing the Gulf Stream. The 23 Stations were collected in different water types.

Another milestone accomplished is we examined differences in the cal val protocols for different instruments used for calibration and validation of ocean color. The cruise included an extensive data sets which include vertical profiles: CTD, HPLC - pigments, spectral scattering and absorption, particle fluorescence, Flow Cam, CDOM, and hyperspectral radiometers, and spectral inherent optical properties. The evaluation of the protocols for ocean optical data collection from different at sea instruments is a major contribution for ocean color research. These protocols are required for accuracy assessing the ocean's bio-optical properties and for satellite calibration and validation. The accuracy of these ocean color measurements is used for calibration and validate the VIIRS ocean color radiances (Fig. 46). The accuracy in retrieving the water leaving radiance (nLw) will enable significant improvements in satellite products such as chlorophyll, CDOM, euphotic depth, disuse attenuation depth etc. for NOAA ecosystems applications. The procedures are also critical for the design of new satellites planned by NOAA and NASA in the future. The cruise data also identified how optical properties from satellite can be used to identify ocean processes such as frontal upwelling, cross frontal processes.

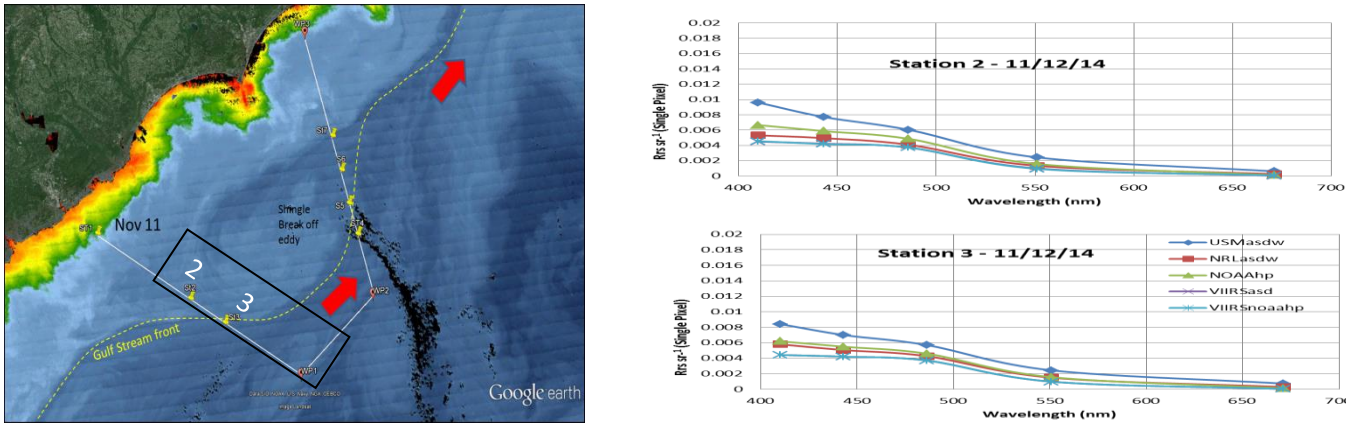


Figure 42 An example of the spectral ocean color matchup of VIIRS and insitu water leaving radiance (nLw) collected at Station 2 and 3 crossing the Gulf Stream. The matchup of the several different instruments including the NOAA Hyperpro and 2 ASD measurements.

The NOAA Navy Foster cruise is setting a national standard for establishing the protocols and procedure for ocean color cal val. A second NOAA cruise is planned for the fall of 2015 for updating cal val procedure in ocean color with the methods, instruments protocols and procedures. We are helping to organizing the cruise with station locations and protocols.

WavCIS – Coastal Calibration Site: The WavCis site off Grand Island Louisiana is equipped with a AERONET SeaPrism instrument and is part of an international network for ocean color cal val site. http://aeronet.gsfc.nasa.gov/new_web/ocean_color.html currently there are 4 sites in the US. The NASA AERONET network provides daily real-time SeaPrism data. The WavCis SeaPrism site is reporting daily water leaving radiance (nlw) and aerosol optical depth every 30 minutes during daytime operations. The WavCis site in the Gulf of Mexico Site and 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 WavCIS site compared to the other sites on the east and west coast of US. We are using the WAVCIS to maintain a consistent and reliable data for monitoring the satellite performance in coastal water algorithms.

We visited the site on a cruise in April 19, 2015 to conduct insitu data collection for validation of the WavCIS data. We collected measurements in joint participation with the University of Mass Boston at six stations near WavCis Platform (Fig. 47). Data collected included in water radiance (Hyperpro) and water sample for chlorophyll, CDOM, particle absorption, particulate inorganic and organic matter (PIM and POM) and total suspended sediment. Matchup's with VIIRS are shown below.

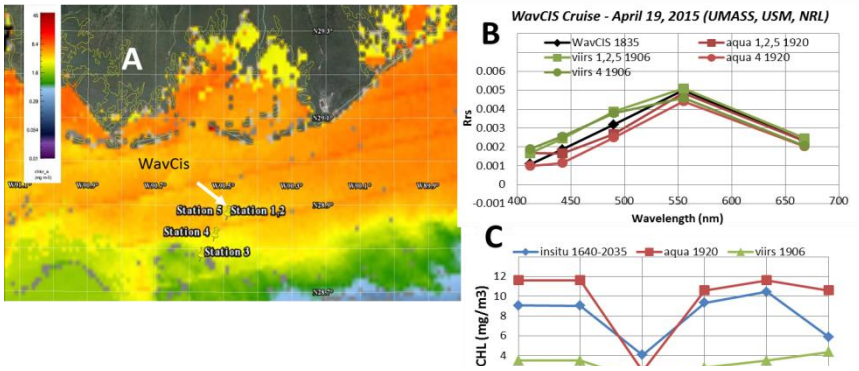


Figure 43 April 19 WavCis Cruise A-The VIIRS Chl with station 1-5 B-Matchup MODIS VIIRS, avCIS, C. Chlorophyll matchup at stations.

Milestone: A data stream from the WavCIS platform was maintained and data provided to NOAA continually throughout the year. The SeaPrism instrument was calibrated and the updates applied and the data stream is used for NOAA VIIRS calibration.

Sea Surface Temperature (SST) –VIIRS – SNPP Research

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

Coastal and diurnal product evaluation: NOAA ACSPO SST product : The uncertainty of the Advanced Clear-Sky Processor for Oceans (ACSPO) Sea Surface Temperature (SST) products from the Visible Infrared Imaging Radiometer Suite (VIIRS) satellite is examined using consecutive orbital overlaps in coastal waters of the Gulf of Mexico. The overlaps SST has a 100minutes between orbits for both the day and night scenes and we evaluated the capability of APSCO to define these diurnal SST changes (heating and cooling) in near coastal and shelf waters We evaluated these changes in SST for a 9 month period May 2014 – Jan 2015. (Arnone et al 2015) in coastal and shelf waters (Figure 48) Milestone completed: Results were presented and published at the SPIE.DSS15 conference "Seasonal trends of ACSPO VIIRS SST product characterized by the differences in orbital overlaps for various waters types" published in the proceedings."

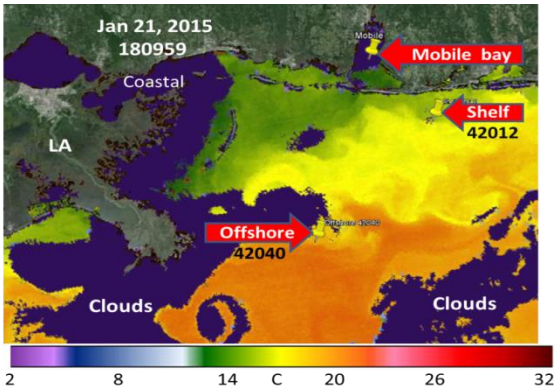


Figure 44 Locations of matchup of ASPCO SST with USGS SST buoy data represent offshore, shelf and Mobile bay waters.

There were small changes in the SST within the 100 minutes (overlap), which indicates that the SST retrievals from APSCO were very good and they compared well with the Buoys SST at these locations. Close examination indicates the changes in SST that occurred within the overlaps period were actually "real" and not the uncertainty in SST values retrieved from VIIRS sensor. This is shown by defining the differences of the SST between the 100 minute orbits (Fig 49).

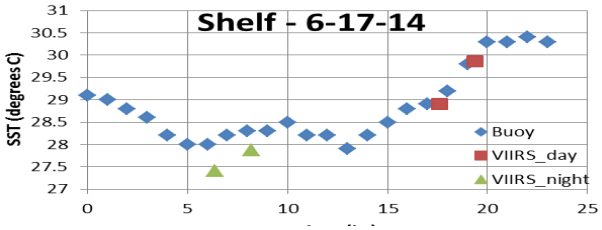


Figure 45 The hourly buoys temperature and he corresponding ASCO SST retrievals for the night and day. The diurnal changes were captured by the VIIRS overlapping SST

Positive SST difference between orbits means the waters were cooling, which occurred in offshore water and negative SST difference occurred in coastal turbid waters.

These diurnal short SST differences were confirmed with the Buoy data (Fig 50).

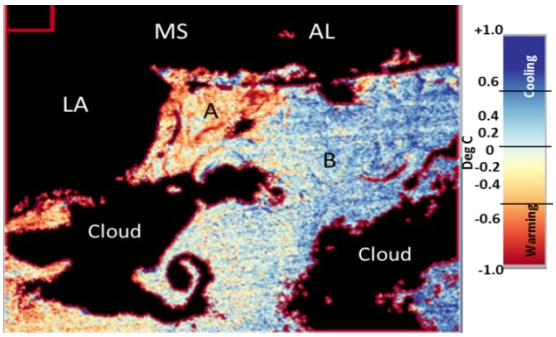


Figure 46 The SST difference in ~ 100 minutes between the overlapping SST.for a day overlap.

A conclusion (Arnone et al 2015) of the coastal research is ACSPO SST retrievals provides an excellent SST retrievals in different water types from open ocean, shelf and coastal waters. The use of the VIIRS overlaps provides unique methods to calibration and validates the sensitivity of SST products. The results show that the ACSPO algorithms are handling the angular effect of atmospheric correction out to ~ 70degrees. This is a major achievement and significantly increases the spatial coverage of VIIRS products. Additionally, the SST retrieved can capture the diurnal changes from heating and cooling of surface waters. These short term SST changes are actually occurring and the differences are not the uncertainty of the SST products. Another major conclusion is that the validation of the SST products used in VIIRS sensor calibration is that the SST matchup of buoys and satellite SST is required within less than 1 hour for define the uncertainty. This time difference changes in differ water types and it the next study. This project participated are the NOAA – JPSS Meeting held at the STAR conference center in June 2014. We presented several SST posters and a talks in results.

Large Scales Open Ocean SST Overlap Evaluation.

The SST evaluation (Cayula et al, 2015) was extended to apply to both daytime and nighttime SST retrievals on four different dates. The spatial coverage area to study the occurrences of orbital overlap was increased to 55S to 55N in latitude, and 120E to 0W in longitude. As SST equations have become similar across products, all using extra satellite zenith angle terms, emphasis was put on evaluating complete products, both SST and contamination detection. The two goals were to evaluate SST products with in situ data and through the orbital overlap method, while at the same time evaluating the orbital overlap method itself. The project evaluated two Sea Surface Temperature (SST) products, one produced by the Naval Oceanographic Office (NAVOCEANO) and the other by the National Oceanic and Atmospheric Administration (NOAA), both derived from data acquired by the VIIRS sensor on-board the Suomi-National Polar-orbiting Partnership (S-NPP) satellite.

NAVOCEANO started producing and distributing VIIRS SST in early 2013. This product which allowed for the quick exploitation of VIIRS data to make SST, was closely based on the processing of Advanced Very High Resolution Radiometer (AVHRR) SST. Since then NAVOCEANO has improved the SST product to better use the VIIRS sensor and in particular the much higher resolution of the data at high satellite zenith angle which allows full swath processing. NOAA STAR) has been producing and distributing the (ACSPO) SST product for over a year. It became publicly available in at the end of May, 2014 on the PO.DAAC repository. This SST product fully uses the capabilities of the VIIRS sensor.

Full swath processing of VIIRS creates significant areas of overlap between consecutive orbits. These overlap regions are found at all latitudes and grow larger away from the equator. The ascending and descending passes were studied separately. For the ascending pass only daytime data were used while for the descending pass only nighttime data were included. By choosing latitudes within 55 degree of the equator, the study avoided multiple orbits overlap and difficulties with nighttime and daytime definitions that develop with higher latitudes. The motivation to use the overlap regions to evaluate VIIRS SST comes from the observation that SST fields stay relatively unchanged within the approximately 100 minutes that separate two consecutive orbits, even in dynamic regions. As such, inconsistencies between SST values from consecutive orbits are likely indications of degraded quality. Conclusions (Cayula et al, 2015) indicate two potential sources of inconsistencies between orbits. One potential source of inconsistencies results from the unequal response of the SST equations when observing a scene from differing view angles.

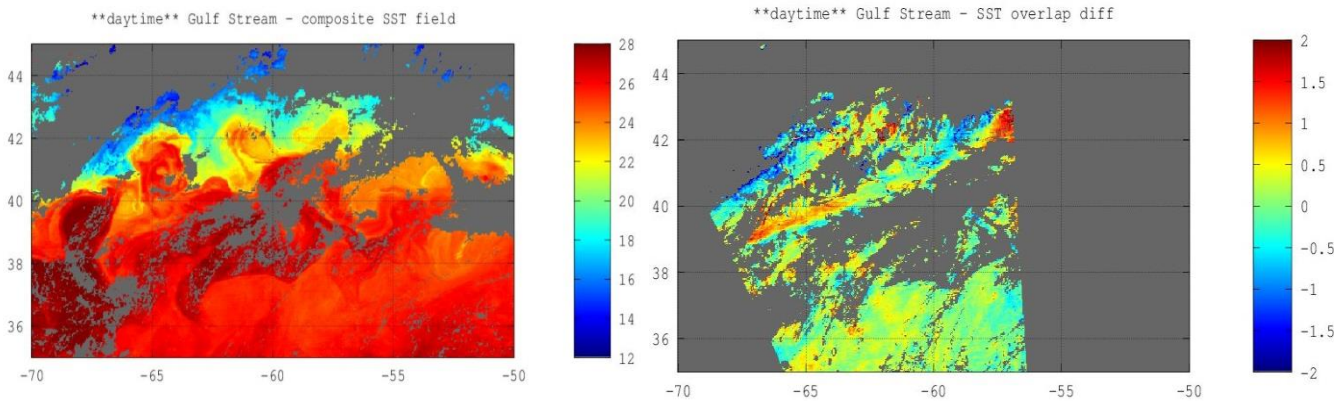


Figure 47 a) ACSPO composite SST field of overlap SST, July 14, 2014; b) ACSPO SST Overlap difference field for July 14, 2014. The large SST discrepancies between consecutive orbits likely indicate significant data contamination.

Another source of inconsistencies addressed in this study is caused by undetected data contamination. For example, clouds that can produce quickly changing localized patterns. It was found that the overlap analysis is particularly effective because the wide coverage of the overlap regions can spotlight areas for which buoy coverage is sparse and where problems can be overlooked. Figures a and b show a case where data contamination is not evident in the SST fields, but appears more clearly in the SST difference fields within the orbital overlap region.

Global nighttime and daytime statistics based on drifting buoys completed the evaluation of the VIIRS SST products and provided a validation of the orbital overlap method.

In summary, the large scale SST overlap study indicates that:

1) The NOAA ACSPO VIIRS SST is a very good and versatile product with excellent coverage, especially when one uses the additional data in lower quality categories. 2) The updated NAVOCEANO VIIRS SST, also performs well and seems well adapted to be used as an input to the Navy Ocean Models. 3) By providing a dense set of comparison points, in regions that are not always well surveyed, the overlap analysis method is useful for detecting problems that are difficult to identify by other data evaluation methods. The standard deviation in the SST difference fields (overlap) and that for VIIRS SST compared to buoys were surprisingly similar.

Milestone accomplished:: Results were presented at the SPIE.DSS15 conference and published in the proceedings - “Evaluation of VIIRS SST fields through the analysis of overlap regions

between consecutive orbits" by Jean-François P. Cayula ; Douglas A. May ; Robert A. Arnone ; Ryan A. Vandermeulen Proc. SPIE 9459, Ocean Sensing and Monitoring VII, 94590S (May 19, 2015); doi:10.1117/12.2179606

Description of significant results, protocols developed, and research transitions

Ocean color- The calibration and validation of measurements used for VIIRS ocean color products were collected for several cruises, including a major NOAA cruise. The cruises provide an international collaboration for establishing protocols for instruments and methods for collection and processing of ocean color radiance measurements for satellite ocean color. The NOAA cal val cruise is setting the standard for the ocean color community for emerging satellites. The WavCIS platform was maintained with a continuous data stream for NASA, NOAA and the oceancolor community. WavCIS SeaPrism data provided excellent continuous data sets in the Gulf of Mexico for coastal validation of ocean color products from the NOAA VIIRS sensor. We developed an enhanced spatial resolution VIIRS ocean products using the I bands. The new products has a resolution of 375 m compared to the standard 750m resolution. This higher resolution SNPP ocean color products was shown to be accurate for coastal waters. (Vandermeulen et al 2015.)

SST- The NOAA ACSPO SST product was evaluated and found to provide excellent results in coastal and offshore waters. We conducted an independent evaluation of the ACSPO VIIRS SST product. There was an evaluation of the updated NAVOVEANO SST product. The VIIRS SST product was evaluated using an orbital overlap method.

Information on collaborators / partners: None reported

Information on any outreach activities: None reported

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

Related NOAA Enterprise Objectives: Science and Technology

APPENDIX A. PUBLICATION DOCUMENTATION

All items listed are under award number NA11OAR4320199.

Publications completed during the reporting period:

Amend Number	Forum	Date	Vol	Pages	Citation
33	**Increasing our understanding of the interaction between physical and ecological processes in the Gulf of Mexico and Caribbean**				
	Journal of Marine Research	2014	72	445-475	ISSN 0022-2402 Online ISSN: 1543-9542
	Geophysical Research Letter	April 2015	42	2926–2933	10.1002/2015GL063304
53	**Pilot Genomic Observatories to Characterize Gulf of Mexico Microbial Populations**				
	GigaScience	June 2015	4	27	10.1186/s13742-015-0066-5
57	**Lagrangian Based Habitat Assessment for Bluefin Tuna (*Thunnus thynnus)*Spawning in the Gulf of Mexico**				
	NOAA SEFSC, Fisheries and the Environment Annual Conference	2015			
59	**Toward Operational Uses of Geostationary Imagery & FY-3 Polar Orbiting Microwave Radiance Data in the GSI Analysis System**				
	Advances in Meteorological Science and Technology	Aug. 2014	4	52-61	10.1002/2014JD021455
60	**Development of Detailed Habitat Maps along the Continental Shelf of the Gulf of Mexico using Previously Collected Multibeam Sonar Data**				
	Proceedings of the US Hydrographic Conference	2015			
69	**Bias Characterization and Hurricane Initialization using ATMS, SSMIS, and AMSR-2**				
	Journal of Oceanic and Atmospheric Technology	Dec. 2014	31	2759-2776	10.1175/JTECH-D-14-00086.1
	Journal of Geophysical Research	Accepted			
	Advances in Meteorological Science and Technology	Accepted			
71	**Diagnosing Atlantic Base Tropical Cyclone Rapid Intensification with Artificial Intelligence and Composite Techniques**				
	95th Annual American Meteorological Society Annual Meeting	Jan. 2015			
	Advances in Meteorology	April 2015			10.1155/2015/814043
	95th Annual American Meteorological Society Annual Meeting	Jan. 2015			
72	**Expanding the Integrated Ecosystem Assessment for the Northern Gulf of Mexico Estuaries**				
	Bays and Bayous Conference	Dec. 2014			
76	**Improving Coastal Precipitation Forecast Through Direct Assimilation of GOES-R ABI Radiance in GSI-NAM/HWRF**				
	Monthly Weather Review	Accepted			
77	**Climate Variability in Ocean Surface Turbulent Fluxes**				
	Marine Technology Society Journal	July 2014	48	15-26	
	Bulletin of the American Meteorological Society	July 2014	95	377-386	10.1175/BAMS-D-12-00162.1
	Journal of Geophysical Research	July 2014	119	4101-4123	10.1175/JCLI-D-13-00369.1
	Journal of Climate	July 2014	27	1928-1944	10.1175/JCLI-D-13-00369.1

82	**Improving ATMS SDR Data Quality for Weather and Climate Studies**				
	Monthly Weather Review	Accepted			
	Journal of Geophysical Research	Accepted			
	Journal of Meteorological Research	Accepted			
89	**Data Management in Support of NOAA's Integrated Ecosystem Assessment for the Gulf of Mexico through the NGI**				
	EarthCube Working Paper	2015	ECWP-2015-1	19	10.7269/P3MG7MDZ
90	**Determination of Habitat Use and Movement Patterns for Adult Smalltooth Sawfish**				
	Global Ecology and Conservation	Jan. 2015	3	764-775	10.1016/j.gecco.2015.03.003
	Aquatic Conservation: Marine and Freshwater Ecosystems	Feb. 2015			10.1002/aqc.2556
91	**Evaluation of VIIRS AOP/IOP Products**				
	Applied Optics	2015	54	546-558	10.1364/AO.54.000347
	Optics Express	Nov. 2014	22	29223-29233	10.1364/OE.22.029223
93	**Sensing Hazards with Operation Unmanned Technology for the River Forecasting Centers (SHOUT4Rivers)**				
	Association of American Geographers Annual Meeting	April 2015			
	Association of American Geographers Annual Meeting	April 2015			
	American Geophysical Union	Dec. 2014			
	Lower Pearl Total Water Level Science Meeting	Feb. 2015			
	Hancock-Harrison County Forestry and Wildlife Association Quarterly Meeting	Feb. 2015			
	Mississippi Department of Marine Resources Seminar	Feb. 2015			
	Southern Group of State Foresters, GIS Committee Meeting	Feb. 2015			
	MSU Dept of Agricultural Economics Seminar	Jan. 2015			
	2015 U.S. Sweet Potato Council Convention	Jan. 2015			
	U.S. Army's Unmanned Aircraft Systems Program, Other Government Agency monthly seminar	Nov. 2014			
	MSU College of Agriculture and Life Sciences Advisory Board	Nov. 2014			
	2014 Alaska Unmanned Aircraft Systems Interest Group Annual Meeting	Sept. 2014			
	NOAA Unmanned Aircraft Systems (UAS) Program 2nd UAS Arctic and River Forecast Workshop	Sept. 2014			
	AgTech Conference	July 2014			
	NOAA Unmanned Aircraft System (UAS) Program 2nd UAS Arctic and River Forecast Workshop	Sept. 2014			

94	**Analysis of Fisheries Acoustic Data**				
	International Council for the Exploration of the Sea (ICES) Symposium on the "Marine Ecosystem Acoustics	May 2015			
	Mississippi State University Science and Technology Center, Stennis, MS	Mar. 2015			
	National Marine Fisheries Service, Pascagoula Laboratory, Pascagoula, MS	Mar. 2015			
102	**Calibration of Validation of NPP VIIRS-Color and SST Ocean Products for Monitoring Oceans**				
	2015 SPIE Proc. SPIE Ocean Sensing and Monitoring , Baltimore Ocean Sensing and Monitoring VII Proc of SPIE	June 2015	9459	1–7	10.1117/12.2053435
	Remote Sensing of Environment	March 2015	158	1–14	10.1016/j.rse.2014.11.010
	Remote Sensing of Environment	Accepted			
	International Ocean Color Coordinating Groups	June 2015			
	2015 SPIE *Proc. SPIE* Ocean Sensing and Monitoring VII, Baltimore Ocean Sensing and Monitoring VII Proc of SPIE	June 2015	9459	1 – 11	10.1117/12.2053435

Summary of publications reported above:

	Institute Lead Author	**NOAA Lead Author**	**Other Lead Author**
Peer-Reviewed	12	1	13
Non Peer-Reviewed	22	1	0

APPENDIX B. EMPLOYEE SUPPORT

Northern Gulf Institute Employee Support July 1, 2014 - June 30, 2015 Personnel (DISL, FSU, LSU, MSU, USM combined)				
Category	**Number**	**B.S.**	**M.S.**	**Ph.D.**
>= 50% Support				
Research Scientist	4	0	1	3
Visiting Scientist	0	0	0	0
Postdoctoral Fellow	2	0	0	2
Research Support Staff	11	4	5	2
Administrative	0	0	0	0
Total (>= 50% support)	**17**	**4**	**6**	**7**
Category	**Number**	**B.S.**	**M.S.**	**Ph.D.**
Employees w/ <50% support	37	8	12	17
Category	**Number**	**B.S.**	**M.S.**	**Ph.D.**
Undergraduate Students	22	22	0	0
Graduate Students	30	2	8	20
Category	**Number**	**B.S.**	**M.S.**	**Ph.D.**
Employees/students that receive 100% of their funding from an OAR lab	0	0	0	0
Obtained NOAA employment within the last year	1	0	0	1

APPENDIX C. OTHER AGENCY AWARDS

Person Name	Prime Sponsor Name	Title	Funding Amount
Ritchie, Jarryl B	BP America	GOMA BP Gulf of Mexico Research Initiative Web Support Project	$37,269.00
Ritchie, Jarryl B	BP America	GOMA BP Gulf of Mexico Research Initiative Web Support Project	$490,764.00
Yao, Haibo	United States Agency for International Development (USAID)	AflaGoggles for Screening Aflatoxin Contamination in Maize	$195,463.00
		Total	**$723,496.00**