NGI Review

Third-Year Science Review Briefing Book

May 11-12, 2020

http://NorthernGulfInstitute.org

Overview of NGI

The Northern Gulf Institute (NGI) was established as a NOAA Cooperative Institute (CI) in October of 2006 as a regional enterprise joining Mississippi State University, the University of Southern Mississippi, Louisiana State University, Florida State University, and the Dauphin Island Sea Laboratory (the State of Alabama's marine sciences institute) to focus on major issues affecting the northern Gulf Coast. Mississippi State University is the lead university. NGI's program office is located at the National Aeronautics and Space Administration's (NASA's) Stennis Space Center (SSC) in a building (pictured to the right) shared with NESDIS's National Centers for Environmental Information (NCEI, formerly NCDDC) SSC operations and personnel in the Office of Coastal Management (OCM, formerly GCSC). The building is adjacent to USM's Marine Sciences complex and on site with the National Data Buoy Center (NDBC). The building is half an hour from the National Weather Service (NWS) offices in Slidell, Louisiana (a Weather Forecasting Office and the Lower Mississippi River Forecast Center) and an hour from the National Marine Fisheries Service (NMFS) facility in Pascagoula, Mississippi.

NGI is a consortium of universities that are geographically distributed. The partner universities bring broad expertise to the NOAA partnership, although the CI focuses on four major scientific and societal issues of importance to NOAA. NGI is not co-located with an Oceanic and Atmospheric Research (OAR) laboratory. To a large extent, NGI focuses on sets of important problems within a region, rather than a specific set of scientific issues. NGI is also partially dependent on congressionally directed funds. The vagary of this source of funds creates a distinct vulnerability for some of NGI's larger projects. NGI addresses problems of significant importance and relevance to NOAA and the nation and the research covers a breadth of topics within the NGI themes.

In the spring of 2016, NOAA announced a Federal Funding Opportunity (FFO) for a competition for a Cooperative Institute in the Gulf of Mexico. The University of Alabama Huntsville was invited to join the original academic units in responding to the FFO. The proposal was to re-form NGI (maintain the name) yet expand the purview to the whole Gulf of Mexico. The themes in the 2016 FFO were only a slight modification of NGI's existing themes. After what was reported to be a very close and competitive competition, we were awarded a cooperative agreement in July with a $35M funding ceiling over 5 years. By the official start of October 1, 2016, we had been awarded $6.65M in awards. Since then, many new projects have been initiated, particularly in collaboration with OAR's Atlantic Oceanographic and Meteorological Laboratory (AOML). To date, considering funding under the CI award, from competitive awards, and from non-competitive awards NGI has been awarded $76M to assist in NOAA's research and service enterprise.

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Agenda

TBD	Pre-meeting: CI review background	Robert Moorhead, NOAA personnel, Review Team

Monday 5/11

8:00-9:00am	NGI: Overview and Summary	Robert Moorhead / Steve Ashby
9:00-9:30am	Review Process and Q/A	Gary Matlock (DAA for Science)
9:30-9:45am	Welcome	Julie Jordan, MSU VP
9:45-10:00am	Western Sound Science Collaborative	Steve Ashby
10:00am-noon	Break and lunch on your own	
noon-1pm	Review Team Executive Session	Review Team only
1pm-3:30pm	Science Talks (7)	15 min presentation; 5 min Q&A
1:00-1:20pm	Shipboard Meteorology	Shawn Smith
1:20-1:40pm	Hurricane Winds / Ocean Climate	Mark Bourassa
1:40-2:00pm	National Water Model Applications	Jamie Dyer
2pm-2:10pm	break	
2:10-2:30pm	Smalltooth Sawfish	Dean Grubbs
2:30-2:50pm	Metagenomics / Bioinformatics	Luke Thompson
2:50-3:10pm	Weather Warning Threats	Kathleen Sherman-Morris
3:10-3:30pm	Social Science Applications	Laura Myers
3:30-3:40pm	break	
3:40-4:00pm	Education and Outreach	Jonathan Harris
4pm-	Review Team Executive Session	Review Team only

Tuesday 5/12

8:30-9:00am	Q&A with NGI Leadership	Moorhead, Ashby, Cebrian, Linhoss
9:00-10:00am	Science Talks (3)	15 min presentation; 5 min Q&A
9:00-9:20am	Hypoxia	Steve Ashby
9:20-9:40am	South Florida WQ Data Analysis	Anna Linhoss
9:40-10:00am	Coastal Data Development (NCEI)	Just Cebrian
10:00-10:15am	break	
10:15-10:45am	Additional Q&A with NGI Leadership	Moorhead, Ashby, Cebrian, Linhoss
10:45-12:30pm	Review Team Executive Session	Review Team only
12:30-1:30pm	lunch on your own	
1:30pm	Debrief NGI Leadership	
TBD	Review Team Executive Session	Review Team only

1. Strategic Plan

a. What is the scientific (not programmatic) vision for the institute?

The scientific vision for the institute is to provide research-driven transformations in regional ecosystem-based management that enables managers and communities to improve the resilience and health of ecosystems that will sustain the economies of people in the Gulf of Mexico. The science must be top quality, credible, reliable, and respected. It should be validated through peer review, yet it should be timely so it can inform policy and decisions in weather, climate, hydrology, and coastal issues.

b. How is it related to the NOAA Strategic Plan?

The last "NOAA's Strategic Plan" was published in 2010 when Dr. Jane Lubchenco was the Undersecretary of Commerce (https://oeab.noaa.gov/sites/oeab/Documents/NOAA-Strategic-Plan.pdf). NGI's scientific vision is derived from that Strategic Plan. NOAA's overarching Vision of the Future was expressed as Resilient Ecosystems, Communities, and Economies. NGI's vision has been focused on ecosystems and communities to sustain and improve economies.

NOAA Long-term Goals were delineated as

- Climate Adaptation and Mitigation
- Weather Ready Nation
- Healthy Oceans
- Resilient Coastal Communities and Economies

As will be discussed in answering Question 1e, the themes that NOAA dictated for the Cooperative Institute in the FFO can be seen to be derived from these long-term goals.

NGI's focus has been on all issues affecting the coastal communities – the effect on the people themselves, the effect on the physical environment, and the effect on the economies. Compared to the other CIs that are focused predominantly on coastal issues, there has probably been relatively less focus on issues farther offshore and more focus on issues closer to shore. NGI's vision has had more focus on Weather Ready Nation than Climate Adaption and Mitigation, recognizing that NOAA "must effectively coordinate and integrate its scientific and technical capabilities to maximize efficiency and minimize redundancy and counter-productive overlap." NGI's seeks "to share expertise within different sectors of NOAA, and all sources of complementary external science capability."

c. What are the goals and objectives?

NGI's goals and objectives include building NOAA's knowledge, capacity, and capability in environmental monitoring and stewardship. We do that by building on and expanding our existing knowledge base and capabilities.

The NGI 2011-2021 Strategic Plan has 5 Long-Term Goals:

Research Goals

- Understand the structure, function, and services of ecosystems across land-sea, ocean-atmosphere, and coastal waters-deep sea interfaces

- Synthesize information across disciplines to reduce uncertainty and to forecast ecosystem responses
- Develop applications that address regional management needs

Engagement Goals

- Develop, facilitate, disseminate, and transition research, knowledge, and applications
- Build internal and external connections for institutional sustainability

d. What criteria are used to measure progress in accomplishing these goals and objectives?

The success of NGI will be the creation of new or improved knowledge and technology and its transition to applications for improved ecosystem-based management in the northern Gulf of Mexico. Two types of measures provide indicators of success for NGI: (1) goals and objectives from research projects and (2) organizational metrics from engagement and education efforts. Research project metrics feed into organizational metrics. Together these provide indicators about the effectiveness and efficiency of NGI, about the value of NGI research to our stakeholders, and about the visibility and branding of NGI. NGI tracks two types of research use: (1) external use by the scientific community, resource managers, and by those involved in engagement and education efforts and (2) internal use by other NGI-funded researchers. Peer-reviewed documentation of NGI-funded research provides an established metric for the quality, rigor, and significance of research. Tracking the allocation of funds provides information for accountability and management of resources and helps inform response to changes in priorities and to events. Documentation of alignment of NGI projects to the outcomes of other agencies provides information about leveraging resources, extending impact, and strengthening our ties with stakeholders. NGI tracks information about students who receive research experience through data about their education and career paths to show NGI's contribution to developing a science workforce. Increasing external knowledge of NGI promotes the visibility, branding, and recognition of the value of the organization and its work. Increasing internal knowledge within NGI is an organizational asset that promotes effective internal operations and coordinated, collective external communication. An NGI Metrics Plan provides periodic updates in the following areas in addition to tracking goals and objectives of research projects:

- External use of NGI research by stakeholders in the scientific and resource management communities and by partners involved in engagement and education efforts
- Formal and informal recognition of NGI research
- Internal use of NGI research to support existing research or advance new opportunities
- Established framework that prepares research for use or improves the usability of research
- Leveraged efforts that extend the impact of NGI
- Acquisition of resources that sustain and grow NGI
- Allocation and alignment of resources with NGI goals
- Implementation plans that align with regional priorities and emphasize multi-institutional collaborations
- Graduate and undergraduate students who receive research experience through NGI

- Collaborations and strong relationships with key stakeholders in the scientific and resource management communities and with partners involved in engagement and education efforts
- Effective internal processes and working relationships

e. What are the major scientific themes?

Climate Change and Climate Variability Effects on Regional Ecosystems (CC)

Research conducted under this theme focuses on the effects of climate change and climate variability on marine ecosystems, adjacent watersheds, and the socioeconomic well-being of the region. It also addresses how the ecosystem affects climate processes.

Coastal Hazards (CH)

Research in this theme encompasses the physical and biological systems, as well as the biological and socio-economic dimensions, associated with coastal hazards. Coastal populations have greatly increased in the past 40 years. Coastal hazards are major concerns to agencies responsible for the public good of coastal regions. The quality of the coastal environment is also a critical element of coastal hazards associated with a sustainable Gulf of Mexico.

Ecosystem Management (EM)

Research in this theme focuses on promoting sustainable coastal development, facilitating community resiliency and enabling an ecosystem-based approach to management, including ecosystem-based fisheries management. These foci are based upon enhanced scientific understanding of the interconnections between the marine ecosystem and the adjacent watershed including their resource stewardship implications.

Effective and Efficient Data Management Systems Supporting a Data-driven Economy (DM)

Research in this theme investigates, develops, and tests innovative data stewardship solutions, enhancing NOAA's data management, visualization, and dissemination capabilities. This research addresses gaps in data management capacity resulting from the development of new environmental data sensors and platforms, larger data volumes, and increased public demand for information.

i. How were they identified?

Pragmatically, the Federal Funding Opportunity (FFO) which resulted in the Cooperative Institute award listed the four research themes: (1) Climate Change and Climate Variability Effects on Regional Ecosystems; (2) Coastal Hazards; (3) Ecosystem Management; and (4) Effective and Efficient Data Management Systems Supporting a Data-driven Economy. They are very similar to the themes for the previous CI award. The themes for it were derived based on an analysis of the science needs to provide environmental intelligence for the northern Gulf of Mexico.

ii. Which themes/sub-themes are near completion?

In general, research theme areas do not reach completion. As an example, as the climate changes, the effects on the ecosystems in the Gulf of Mexico change. The increased frequency and duration of the Bonnet Carre spillway opening due to the increased precipitation in the Mississippi River basin is having a significant effect on the ecosystems in the Mississippi Sound. Specific funded research within the

theme area does start and end with demonstrated results and funding expiration. Themes are long-term and allow NGI to develop the skills and infrastructure necessary to work in these broad areas of science. Should areas become less relevant to NOAA, NGI would consult with and rely on advice from both the Advisory Council as well as the Executive Board for termination or re-focusing of those themes.

The theme that is probably the closest to being completed is Effective and Efficient Data Management Systems Supporting a Data-driven Economy, in that data management is more of a technology issue than a science issue and the science of data management is maturing rapidly. However, the return on investment of storing various datasets will remain an issue for the foreseeable future, as will the value of various discovery and dissemination methods. The realization of what metadata or information about a dataset should have been collected and archived will persist as a constantly reoccurring issue. Likewise, with the increase in remotely sensed data using autonomous vehicles and the increase in data available from expanded video and hydrographic systems, data processing and use of large data sets can be challenging.

iii. What are the emerging thematic areas?

While there is constant evolution in science, we believe that several areas are perhaps due for increased vigor in the near future. NGI is actively exploring the following areas:

- Regional Hazards (more than just coastal). The VORTEX-SE project has identified several scientific facts that lead to more deaths and damage in the southeast than the Great Plains from the same tornado intensity. Flood prediction varies based on topography; in general, the Gulf of Mexico regional is flatter than other regions.
- Socioeconomic issues. How can we get society to believe scientist results? How do we get society to consider ecological issues equally with economic issues? How do we communicate tornado, hurricane, and other severe storm warnings appropriately?
- Autonomous Systems. eDNA verification. The tradeoffs in science quality and knowledge in exploiting autonomous systems. What knowledge can be obtained only with autonomous systems?

f. Scientific partnerships

i. What is your relationship to the OAR Laboratories and other NOAA entities?

AOML: Congress, for the last few years, has added about $2M to the funding for Coasts, Oceans, and Great Lakes research to fund research at NGI and other places. The Deputy Director at AOML has been the steward of those funds. NGI has worked with her to decide what research projects make the most sense. In doing so, NGI has placed several postdoctoral associates, and recently an assistant research professor, at AOML. Since (timewise) that supplemental funding was initiated, NOAA made the Director of AOML the NGI Program Manager (also known as the Lead Technical Program Manager). Thus, AOML is the OAR lab with which NGI works most closely. Specific projects and joint efforts are presented below.

NCEI/SSC: Since 2012, the NGI Program Office, NGI's SSC personnel, and what is now NESDIS/NCEI's Stennis Space Center group have shared a building. In fall of 2016, soon after the existing cooperative institute award had been made, the leadership at NCEI/SSC initiated a discussion to increase our interaction from 1-2 small projects to a broader and deeper relationship. That resulted in 2 awards through the CI award starting 1 Oct 2017 that each exceeded $1M. One award was to support base

funded projects (Coastal Data Development); the other to support their partner projects. The partner projects included:

- Scientific support to the Ocean Exploration and Research (OER) Program for enhanced data, products and services
- Scientific support to the Deep Sea Corals Research and Technology Program (DSCRTP) for enhanced data, products and services
- Scientific support to the Office of Response and Restoration (OR&R) for enhanced data, products and services, particularly OR&R's Environmental Response Management Application (ERMA) and output from the Data Integration, Visualization, Exploration, and Reporting (DIVER) tool
- Scientific support to the Gulf of Mexico Restoration Program for enhanced data, products and services

In the summer of 2018, NGI hit its 5-year funding ceiling and the leadership of NCEI/SSC worked with the Sea Grant program to facilitate a new five-year cooperative agreement to allow NGI to continue that scientific support. This relationship is ***crucial*** to NGI addressing its Data Management theme, as NCEI is NOAA's data management entity. Several NOS/OCM employees, as well as the NOAA RESTORE Science Program Manager, share the space with the NCEI/SSC employees and thus are involved at times in science discussions.

LMRFC: NGI has had a long-standing relationship with the Lower Mississippi River Forecast Center. Initially the work focused on hydrology model advancement and visualization. In 2012, the relationship shifted to exploitation of UAS based on an award from the OAR UAS Program Office. Dr. Suzanne van Cooten, the LMRFC Hydrologist in Charge, has been a co-author and co-presenter on several dissemination opportunities. NGI's support of LMRFC was featured in a NOAA UAS news article (https://uas.noaa.gov/News/ArtMID/6699/ArticleID/812/Another-One-in-the-Books-NOAA-UAS-Science-Team-Completes-Second-Milestone-Operation-to-Aid-Hydrologists-with-Improving-Flood-Forecasts) and a NOAA Postcard from the Field entitled "Live UAS Imagery Maps Historic Flooding."

NDBC: NGI has worked with the National Data Buoy Center on several data processing / management projects. Presently one of our senior research staff members, Yee Lau, is improving NDBC's weather buoy archive process. Previous projects studied the difference in the data collected by an autonomous surface vessel encircling a buoy and the buoy itself and improvements to TAO delayed-mode data processing.

NOS/OCM: NGI has worked with what is now NOS/OCM for over 10 years, focusing primarily on geospatial education and outreach.

NWC: NGI is working with the National Water Center in Tuscaloosa, Alabama to develop new capabilities and research applications for the National Water Model, principally focusing on flooding and agricultural applications.

Programs: NGI has worked with many programs to advance their mission. Some of the larger and more longstanding ones include the OAR Unmanned Aircraft Systems Program, the OAR Ocean Acidification Program, the OAR Climate Program, the OAR OWAQ (now Weather Program) and the NOS/NCCOS Hypoxia Program.

ii. What, if any, formal procedures do you have for cooperative planning?

AOML: The AOML Deputy Director and the NGI Director have historically discussed how NGI can add value to AOML's programs to determine which projects to fund.

NCEI/SSC: NCEI/SSC provides a science needs document and NGI develops a science plan and we iterate to a mutually acceptable plan.

UAS: The most recent program manager has instituted quarterly progress reviews which leads nicely into cooperative planning.

2. Science Review: What are the Institute's most recent scientific highlights and accomplishments?

The NGI Annual Reports submitted in July 2017 and July 2018 provide summaries of the contributions emerging from our research partnerships with NOAA (the July 2019 report was the new Research Performance Progress Report format, which lacked those details), with more detail to be found in the peer reviewed and selected technical publications cited with this report. Highlighted below are some of the most recent scientific highlights and accomplishments. Some of these exemplify the intra- and inter-agency partnerships. More details on each, as well as other one-page project summaries, can be found in Appendix A. Several will be covered as part of the planned science talks.

Anna Linhoss (MSU) and Steve Ashby (MSU) in collaboration with AOML personnel (NGI postdocs and NOAA employees) have analyzed long-term water quality trends in Biscayne Bay and developed a watershed model for a representative portion of Biscayne Bay. The analysis showed that chlorophyll α and phosphate concentrations have increased throughout Biscayne Bay, which is a primary indicator of eutrophication. Higher chlorophyll *a* concentrations were correlated with recent sea-grass die-offs, suggesting an urgent need for management intervention, whereas the state of Florida lists Biscayne Bay as a medium priority impaired body of water.

NGI has been designated by NOAA as the CI for Gulf of Mexico Hypoxia www.northerngulfinstitute.org/gulf-hypoxia. Hindcasting models provided by LSU and Dalhousie are now being used to increase understanding of seasonal hypoxia patterns. Results from these models and the annual cruise to measure the size of the hypoxic area west of the Mississippi River – the "dead zone" – are reported by NOAA to the Hypoxia Task Force to inform management strategies. Interdisciplinary collaboration for GoM hypoxia research is facilitated via workshops and technical working groups. For more details see Ashby's 19-NGI3-80 project report.

Frank Hernandez (USM) – in collaboration with CIMAS personnel sitting in AOML and SEFSC personnel – developed a model that provides an important tool to address questions related to ocean acidification and other processes that may impact the Gulf of Mexico and its natural resources. Model results indicated that: 1) diatom growth is silica-limited in the deep GoM during winter, and near the Mississippi delta during spring; 2) zooplankton grazing plays a key role modulating phytoplankton biomass seasonality; and 3) dominant physical processes influencing the local rate of change of phytoplankton are horizontal advection in the northern shelf and vertical mixing in the deep GoM. Using an expanded model that contained an additional carbon module that simulated dissolved inorganic carbon and total alkalinity, results indicated that seasonal changes in surface pCO2 are strongly controlled by temperature across most of the GoM, except in the vicinity of the Mississippi–Atchafalaya river system delta, where runoff largely controls changes in dissolved inorganic carbon and total alkalinity.

Steve Morey (FSU/FAMU) developed a coupled physical-biogeochemical model of the GoM to simulate the prey concentration for fish larvae of coastal-pelagic and pelagic species including bluefin tuna. The result of this coupled modeling approach is an improved estimate of the larval mortality and thus age-0 abundance. This modeling approach is applied to evaluate the interannual variability in larval mortality, as well to estimate changes in abundance under future climate scenarios.

Luke Thompson (USM) has helped build AOML's omics program by developing computational and data sharing resources. He was initially a postdoc employed by USM, working with Kelly Godwin at the

SWFSC. Having been promoted to an Assistant Research Professor and moved to AOML, he is more recently building on AOML's environmental DNA (eDNA) efforts.

The Stepped-Frequency Microwave Radiometer (SFMR) is the primary tool used for collecting aircraft-based estimates of the surface wind speed in tropical cyclones (TCs). New guidance on the impacts of the aircraft angle with respect to the surface were developed for the SFMR by Mark Bourassa and his team at FSU. The findings have provided forecasters at the National Hurricane Center (NHC) with additional guidance for interpreting the SFMR surface wind speed. In addition, the findings will be incorporated into an upcoming update to the SFMR observation processing, which will further increase the accuracy of the observations. For more details see Bourassa's 17-NGI3-32 / 18-NGI3-53 project report.

FSU is developing a product for air-sea interactions (fluxes of heat, moisture and momentum). Air-sea exchanges (fluxes) are sensitive indicators of changes regional climate and weather patterns, with links to floods and droughts, East Coast storm intensity, and storm tracks. On smaller spatial and temporal scales, they can be related to the storm surge and tropical storm intensity. On longer temporal scales, several well-known natural climate variations have been identified as having direct impact on the U.S. economy and its citizens. For more details see Bourassa's 18-NGI3-42 project report.

Zhankun Wang (MSU), in collaboration with others, has quantified the turbulence on the continental shelf and slope of the Gulf of Mexico, revealing almost a "pancake-like" structure. The results of this project could lead to significant improvements in the parameterizations presently used in modern plume dispersal models.

Andrew Mercer (MSU) has developed a new classification predictor for the rapid intensification (RI) of tropical cyclones that has shown a 20% improvement over the performance of the existing predictors. RI prediction is critical as all major hurricanes undergo RI at least once in their life cycle.

Kevin Knupp (UAH) and his research partners have made significant advancements in understanding thermodynamic profiles ahead of Quasi-Linear Convective Systems (QLCS), the formation of mesovortices (the parent circulation of tornadoes) within QLCSs, and supercell storms in his VORTEX-SE research.

Robert Moorhead (MSU), Jamie Dyer (MSU), Lee Hathcock (MSU), and personnel in the Raspet Flight Research Lab at MSU, collaborating with personnel at the LMRFC and OWP have demonstrated the value and efficacy of using runway launched UAS to assist in flood forecasting and in validating inundation models.

The USM Mapping Center project has performed some of the preliminary unmanned maritime systems research in preparation for standing up the NOAA Unmanned Systems Operations Program at Gulfport, MS. Areas of research were UxS, other GNSSs, and assets to decrease Vdatum uncertainties. The research has been in collaboration with several Navy programs in the area. For more details see Brian Connon's 18-NGI3-58 project report.

An MSU team led by Trey Breckenridge addressed OAR's need for expanded HPC capabilities and capacity, developing a system (Orion) that when installed was the 60th most capable (measured in FLOPS) system in the world.

A parallel version of the WRF-Hydro model with the same configuration and parameterization as the medium-range National Water Model (NWM) operational framework has been compiled and tested on Orion. For more details see Jamie Dyer's "Developing New Capabilities and Research Applications for the National Water Model Over the Southeastern US" project report.

Brian Dzwonkowski (DISL) and Renee Collini (MSU), with just a small amount of funding, improved the accessibility of the data from the longest running time series of coastal hydrographic water column data in the Mississippi Bight and one of the longest in the entire Gulf of Mexico, enabling researchers and agencies to address more easily critically important issues related to ecosystem dynamics (e.g. fisheries populations, hypoxia) and extreme events (marine heatwaves, hurricanes).

In two different projects, Laura Myers (DISL/UA) developed a series of courses to train weather, water, environmental, and emergency management professionals in social science research and applications. In a third project, an analysis of actual warning modes and case studies of warning dissemination knowledge management highlighted variations in location context, weather vulnerabilities, and current communication networks.

In a project focused on improving the communication of tornado warning information for the blind, Kathy Sherman-Morris (MSU) through two rounds of interviews determined that this population would like a greater level of geographic description in the communication of tornado warnings, which is relevant for anyone in a vision limited situation (driving a car). Trajectory information was one of the most desired elements. However, in further research, participants typically rated the lower and higher detail information the same, indicating too much information may be confusing.

3. Education/Outreach

a. What types of educational activities/opportunities (K-12, undergraduate and graduate students) does the institute offer on an ongoing basis?

b. What are the current and planned outreach efforts?

NGI through its associated Education and Outreach offices and personnel have been able to provide significant opportunities to local and regional educators and students alike through design and implementation of science curriculum alongside the various state departments of education as well as through individual teachers and through support of students.

> ***"Thank you so much for providing Starkville High School with the Earth Science Curriculum collection of books, earthquake kits, geode kits, stream table, wave demonstrator spring set, water testing kits, and mineral kits. They all fit perfectly in the MCCRS standards for our students. These kits will enable our students to go above and beyond in the science lab through the application of topics they have learned in class. We will also be able to share some of these with multiple schools within our district. I hope we can continue this collaboration between SOCSD and NGI outreach programs to continue to enhance the education of our students…"***
>
> ***Best regards,***
> ***Brenda Jackson***
> ***Lead District Science Teacher***
> ***Starkville Oktibbeha County School District***

NGI develops "Travelling Trunks" for regional faculty.

These trunks include interactive, experiential science and arts-based curriculum and lessons designed to support the STEM/STEAM requirements for the national college and career readiness standards.

NGI has provided resources for educators, researchers and the public to obtain professional training to stay up to date with, or in some cases learn or gain exposure to, among other things, geospatial technologies. This includes training and education for teachers on both lesson plans and integration of technology. This concept allows for enhancements to workforce development and an understanding of the environment and spatial data. NGI funding also provided analysis results to meteorologists as well as local and regional emergency managers in the field seeking to improve storm warning dissemination to vulnerable populations.

City Planners and Managers learning to use ESRI GIS Software Packages

Additional professional development and outreach opportunities have been undertaken to expose not only professionals but students and the general public to NOAA mission specific science and STEM/STEAM related research and findings of active and often locally relevant projects.

These events include participation by NGI scientists in educational summer camps and engaging K-12 students in ocean and atmospheric coursework. Workforce and professional development mean nothing without interaction with students and future scientists. NGI also takes a great interest in forging community STEM/STEAM engagement events, with active demonstrations, displays and activities for students and members of the public which include: NASA Infinity Center Homeschool Mondays, Stennis "Take your kids to work day," Mississippi Science Teachers Association Annual Meeting, GOMA (Gulf of Mexico Alliance) All Hands Meeting, Gulfport High School Theatre (Theatrical Production on Climate), Harrison County School District (Visiting Faculty lectures, displays and activities), Lynn Meadows Discovery Center (Children's Museum displays and activities), SC18 and SC19 (Super Computing Conference to discuss NOAA use of new HPC systems), Celebrate the Gulf (Marine Science Festival), Mississippi Aquarium - Gulfport, and Starkville Oktibbeha County School District (Visiting Faculty lectures, displays and activities).


Results of the sponsored operations and research have been disseminated through several channels including publication in peer reviewed journals and proceedings as well as through both public and project specific specialized meetings, conferences and workshops. As a result, both the public and other local stakeholders have been given a better understanding of their associated environments. (Please see Appendix A - Publications).

The NGI Education and Outreach 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 and to disseminate 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.

Education and outreach is something NGI has taken seriously since its inception. We are constantly developing coastal, marine and atmospheric science courses, curriculum and fieldwork for regional and even national educators to use as supplemental material for their classroom.

During the course of the past three years NGI E&O has been involved with the many major outreach projects including hosting numerous lesson plans from previous projects (over 500 lesson plans for public use at http://gk12.msstate.edu/lessonplans.html that regional teachers are using to supplement the coursework sent home to students during the pandemic school closures.

NGI has a presence at the Mississippi Science Teachers Association (MSTA) annually where our scientists and members have the opportunity to interact with science teachers from all regional school districts, where we provide guidance and instruction on developing current, high value STEM/STEAM based lesson plans and introductions to the various capabilities and potential assistance that our scientists and curriculum development personnel can provide to their classrooms. Moving forward we will be implementing the same mission for other regional and national science teacher associations, especially those located near our current missions and operations.

NGI provides opportunities for professional development for teachers including continuing education opportunities for teachers and industry professionals in conjunction with the MSU Geosciences Program in the form of continuing education and graduate courses in earth and atmospheric science.

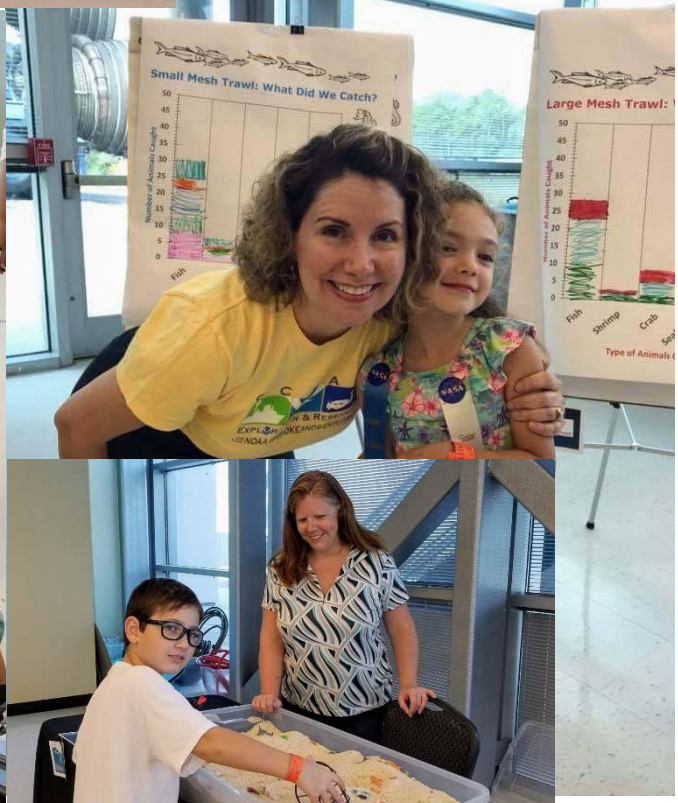
NGI develops "Travelling Trunk Shows." These trunks include Art and Science based curriculum designed to support the national college and career readiness standards. We typically include the "science, literature and arts behind the scenes" that includes targeted classwork and lessons of discovery for, specifically in our case, oceanography, marine and fisheries science, and weather. These trunks provide STEAM focused interaction with large numbers of schoolchildren, their parents, teachers and administrators.

We have also developed a "Scientists Get Involved" program that includes science, engineering and mathematics faculty from departments spanning all NGI partner institutions, giving visiting, timely, guest lectures in classrooms of local schools, children's museums, public events and festivals all along the Gulf Coast and throughout the region.

NGI and NOAA NCEI Staff taking part in outdoor classroom teaching and outreach opportunities in Pass Christian, Mississippi

Public events our scientists and educators are involved with include the “Celebrate the Gulf” marine science festival, NASA Infinity home school and science Saturday and Lynn Meadows Discovery Center Earth Day and Career Day Celebrations. These events provide NGI and NOAA team members the opportunity to reach nontraditional students in the region during events held at the NASA Infinity Scient Center on the Mississippi Gulf Coast. These events have included ROV and robotics demonstrations as

well as hands on sampling and statistical demonstrations for students to experience what it is like to collect and analyze data.

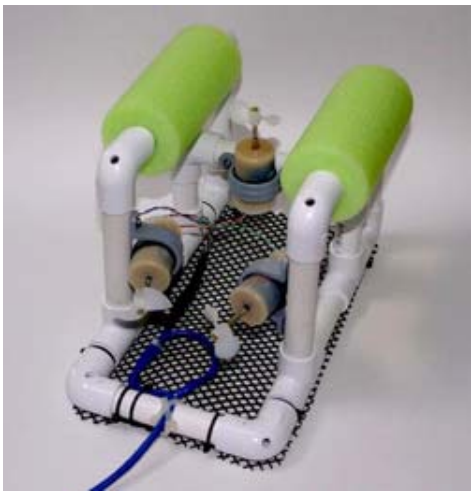


As a local partner with NASA Stennis Space Center, the NGI personnel in conjunction with the local NOAA affiliates have provided support and interactive career and educational activities for the annual Take-Your-Child-To-Work Days. These activities include ROV and Analytical activities to spark interest in the fields of Marine and Earth and Atmospheric Science. The NGI team along with NOAA's National Centers for Environmental Information (NCEI) and the National Marine Fisheries Service (NMFS), the University of Southern Mississippi (USM), and the Gulf regional chapter of the Marine Technology Society (MTS) have collaborated to support this annual event with an attendance of over 200 students between the ages of nine and fourteen.

The most recent event, "Mission Hoopossible," focused on the basics of remotely operated vehicles (ROVs) and their application in the field of marine science. NGI scientist Madalyn Newman spearheaded the activity and introduced the participants to NOAA's Office of Exploration and Research, to the NOAA's Ship Okeanos Explorer, and to the Okeanos' ROV Deep Discoverer. The children watched several Okeanos highlight video clips and discussed different career opportunities.

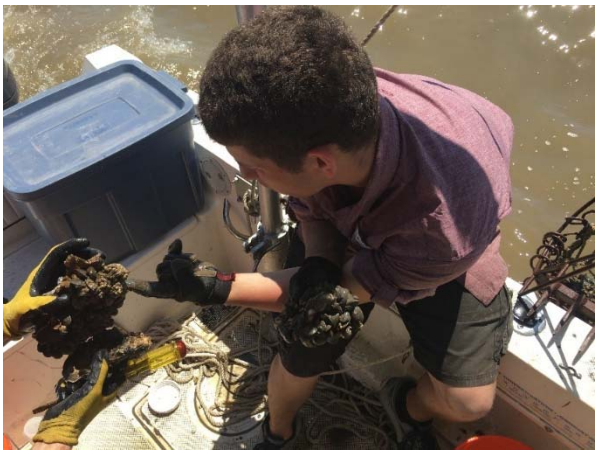
The students also participated in an ROV challenge which consisted of having them break into small teams to operate two SeaPerch ROVs in a swimming pool. Each student took a turn navigating the ROV through two hoops in a 10-minute relay race. One of the groups finished in about 6 minutes! The activity supports STEM/STEAM learning and demonstrates the importance of having different skill sets to

successfully complete a mission and provides insight into some of the challenges that scientists can face in a harsh ocean environment.



One of the more public outreach projects that NGI has undertaken is its partnerships with regional school districts. NGI has worked closely with the science departments in Oktibbeha (MSU area), Desoto (Memphis area), Harrison (coastal) and Hancock (coastal) counties to provide STEM/STEAM based curriculum and materials including the afore mentioned “Travelling Trunks” in support of our mission to educate and influence NOAA scientists of the future.

NGI provides visiting scientists and lesson plans to regional educators and districts. In addition to visiting classrooms, NGI Scientists have also taken the opportunity to include local high school students (seniors and upcoming college freshmen) interested in a career in earth and atmospheric sciences to take part in data collection and fieldwork during summer semesters in no cost, experiential learning opportunities as part of ongoing research along the Gulf Coast. We believe this kind of interaction with students provides valuable insight for the students and helps to develop or enhance career interest in STEM/STEAM fields, especially in the earth and atmospheric sciences which further support the future employment needs for NOAA. So far we have utilized student assistance from Oktibbeha, Harrison and Hancock County School Districts as part of a pilot project with the intention of implementation on a larger scale in the future.



A Starkville High School Senior assists in marine micro-plastics and oyster reef restoration sample collection offshore Pass Christian, MS

We have also created a very successful partnership with the Gulfport High School Theatre and Science Departments, to create an award-winning travelling play to help regional students to understand the potential environmental and socio-economic threats posed by climate change.

The idea required partnership with an internationally recognized children's playwright to take STEM/STEAM concepts as described in the national college and career readiness standards and project them to students in regional schools in such a manner as to make the ideas more understandable and less frightening, while providing the students with scientifically accurate talking points and information from which they, as the future leaders, can move forward with an understandable dialogue. This project involved not only an artistic approach (STEAM) to science but also traditional science (STEM) class lectures on related topics by NOAA/NGI field specialists. This project has won several regional theatre awards including best original work for 2019 and moved up to the State-Level theatre competition (Mississippi Theatre Association). It was also invited to participate in Story-State at Mississippi State University.

This project fostered a high level of interest, both socially and in STEM/STEAM career development, especially from coastal schools and students, on the topics within which environmental and climate science is based.

"*Hello Opportunity*" Theatrical Production Partnership between NGI and Gulfport High School

NGI participated in a workshop that brought together farmers, fisherman, natural resource professionals and agricultural industry leaders from across the Mississippi River Basin to learn from one another and brainstorm ways to reduce Gulf Hypoxia. Mississippi State's Beth Baker, associate extension professor and director of the Research and Education to Advance Conservation and Habitat (REACH) program, and Steve Ashby, NGI Co-Director, presented information about management strategies and water quality in the Mississippi Bight, as well as collaborative partnerships to tackle nutrient losses in the Mississippi River Basin. A public video can be viewed at http://ngi.msstate.edu/news/story.php?d=847. NGI also

participates in working groups of the Hypoxia Task Force to discuss outreach programs such as EPA's Farmer to Fisherman Exchange Program.

NBC News “Learn” has recently produced a segment highlighting research work undertaken by Anna Linhoss, NGI Associate Director, who is conducting work on Biscayne Bay offshore Miami, Florida. She and fellow MSU researchers Pawan Upadhyay, Steve Ashby and NOAA's Atlantic Oceanographic and Meteorological Laboratory's Chris Kelble are helping to prevent nutrient enrichment from producing algal blooms in the bay. "Discovering You: Engineering Your World" is produced by NBC News Learn in partnership with Chevron, the American Society for Engineering Education and the National Science Foundation. A public video can be viewed at https://www.nbclearn.com/engineering/cuecard/120771

In addition to traditional education and outreach activities, NGI has also participated in research and sponsored students to take part in numerous national STEM/STEAM based conferences including Super Computing in support of the NGI-NOAA “Orion” Supercomputer, as well as the American Geophysical Union, Restore Summit, Gulf of Mexico Alliance All Hands Meetings, the Mississippi-Alabama Sea Grant Consortium’s Bays and Bayous Symposium, the IEEE Oceans Conferences, and the Coastal Estuarian Research Federation annual CERF conference program.

The NGI Education and Outreach Program also disseminates content and reports of research accomplishments through a multi-media approach including emails, Twitter, Facebook, and continual updates to the institution’s website via Portal Blog Posts and a quarterly online publication called “The Portal” which includes 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 right sidebar: www.NorthernGulfInstitute.org).

NGI and its NOAA NCEI affiliates are also engaged with activities in support of Girls Engaged in Math and Science (GEMS). The GEMS program provides an annual educational program at the NASA Stennis Space Center that is designed to actively involve girls in STEM/STEAM related activities through interaction with working science professionals in an informal setting. The GEMS Program supports the national need to close the STEM/STEAM gender gap utilizing eight teaching strategies to encourage self-confidence and elevate interest in the areas of math and science with female students. GEMS teacher practices focus on these strategies to strengthen girls’ beliefs regarding their abilities in math and science.

NGI Team members are continually seeking out additional external funding for our STEM/STEAM based outreach. The NGI E&O Director is part of a team that has been awarded $1.63M through the National Science Foundation (Award # 1934194) to directly support our education and outreach mission. The project, entitled ***“Integrating Computational Science Practice, Weather Data Analysis, and 3D Visualization in the Secondary Earth and Environmental Science Curriculum,”*** is funded through 2022. The goal is to teach regional faculty and students to design, develop, and test eight learning modules for middle and high school STEM curriculum that integrate computational practices and thinking, with atmospheric science through use of data analysis, visualization, and modeling of large-scale weather datasets. Each of the modules will engage students in using a free, open-source application for analyzing and visualizing geoscience data. Each module will also emphasize the following computational science concepts and practices: 1) The ability to access and manipulate data, 2) The ability to use computational tools to analyze and interpret data, and 3) The application of computational reasoning and model-based understanding to construct quantitative, scientific explanations and predictions about events and

processes in atmospheric systems. Teachers will be participating in developing and testing new approaches to teaching and learning, as well as development of a framework for supporting ongoing teacher efforts to create new instructional materials that integrate computational thinking science practices.

This project will use a design-based research approach to test the hypothesis that science education empowered by large-scale atmospheric datasets and fused with computational thinking and practices will: 1) promote meaningful science learning as envisioned by the Next Generation Science Standards, and 2) foster literacy in atmospheric and computational sciences among middle and high school students.

The project is intended to directly engage approximately 44 secondary school teachers and 2,000 of their students. The work of the project is guided by five objectives: 1) Develop and test 3D Weather learning modules that integrate computational thinking and practices into atmospheric science learning through data analysis, and 3D visualization and interpretation of large-scale weather data; 2) Develop and conduct teacher professional development that supports integration of computational thinking and practices into secondary science instruction and empowers secondary science learning with large-scale weather data; 3) Investigate how the integration of 3D Weather data modeling and visualization into Earth and environmental science classes support students' and teachers' development of computational thinking and model-based understanding of the complexity of the atmospheric systems; 4) Investigate teachers' experiences and perceptions of integrating computational thinking and practices into atmospheric science instruction in order to learn how to support teachers to engage in these instructional practices, and 5) Develop a research-based framework guiding teachers' future efforts of developing new instructional materials integrating computational thinking and practices into science instruction. Research activities related to each of these objectives will be employed to guide the iterative process of improving educational practices through analysis, design, development, and implementation.

The NGI Education and Outreach Program continues to be positioned to provide high-impact, curriculum-based support to students, educators and the general public throughout our region. We look forward to continuing to provide a better future to our communities through educational opportunities concerning their environment.

Additional NGI related news and accomplishments include the following:

2019

Commercial Drone UAV Features Moorhead's Expertise on Drone Environmental Research, Surveying and Mapping (December 9, 2019)

NBC NEWS Learning Channel Highlights NGI Assistant Director's Research in Collaboration with NOAA's AOML (November 14, 2019)

NGI, HPC2 and NOAA Partner to Protect People and Property with Powerful Supercomputer System (November 12, 2019)

MSU's Northern Gulf Institute Partner with NOAA, USM, MTS, to Teach Students Marine Science (August 29, 2019)

NGI Marine Scientist Helps NOAA Explore Methane Seep Field off The NC Coast (August 20, 2019)

NGI and NOAA's Atlantic Oceanographic and Meteorological Laboratory Study Shows Nutrients Entering Biscayne Bay (August 14, 2019)

NGI Research Partner, Louisiana University's Marine Consortium, State that Oxygen Levels are Just Slightly Lower than Forecasted, but still 8th Largest Gulf 'Dead Zone' in History (August 1, 2019)

Heartland to Gulf: Farmers, Agricultural Leaders and Natural Resource Professionals Work to Reduce Gulf Hypoxia (July 31, 2019)

Mississippi State Researchers are Examining the Economic Impact of the Bonnet Carré Spillway's Opening on the Gulf Coast Seafood Industry (July 26, 2019)

NGI's Co-Director, Steve Ashby, Serves on Advisory Panel that Supports NCCOS Workshop on Hypoxia's Effects on Marine Life (July 24, 2019)

New Supercomputer at MSU's HPC2 Ranks 4th Fastest in U.S. Academia: Supercomputer to Power NGI and NOAA Research (June 19, 2019)

A June 2019 Forecast Shows Largest Ever Deadzone in Report Published by NGI Partner LSU Marine Consortium's Nancy Rabalais (June 11, 2019)

Fox News Shares NGI's Anna Linhoss' Expertise about how Fresh Water Diverted into the Gulf Coast Affects Marine Life and the Fishing Industry (June 7, 2019)

MSU Marine Scientist's Work Published in 'Nature Ecology & Evolution' (April 11, 2019)

HPC2 Administrator, GRI, NGI, and CAVS Researchers Earn Recognition for Exceptional Research and Leadership Honors (April 3, 2019)

Northern Gulf Institute Uses Drone's Eyes to Focus on Floodwaters to Help NOAA Improve Forecast Predicitons (March 20, 2019)

2018

Moorhead and Ashby on WRJW's 'Spotlight on 'Stennis' Morning Drive Radio Show (November 27, 2018)

NGI and NOAA Researchers Help Students Learn about Import Factors that Impact Water Quality (November 19, 2018)

University and Government Scientists Release 2018 Summer Cruise for Hypoxia 'Dead Zone' Report (August 2, 2018)

Mississippi State's Northern Gulf Institute Supports NOAA Okeanos Explorer, 'America's Ship for Exploration' (June 29, 2018)

Mississippi State University #UAS Partnerships with DHS, U.S. Coast Guard Big Steps Forward (June 11, 2018)

NGI and Dauphin Island Shark Expert Studies Predators' Underwater Paradise (May 17, 2018)

NGI and GRI's Moorhead and MAFES' Davis and Linhoss Lead New MSU Study to Evaluate Wetland Restoration Efforts (February 8, 2018)

2017

2016 Hypoxia Monitoring Workshop Report Now Available (July 7, 2017)

Mississippi Today Headlines GRI and NGI Researchers' Work: When Invasive Plants Attack, a New Tech Tool Can Nip it in the Bud (June 23, 2017)

Mississippi State's VP of Research Leads Task-force that will Tap ASSURE, Northern Gulf and Geostyems Research Institute's UAS Research to Meet Critical Needs for Economic Development on Gulf Coast (June 2, 2017)

NGI and GRI Coastal Researcher's Work Make NOLA.com Headlines (June 2, 2017)

Mississippi State's ASSUREuas, GRI and NGI will give Governor UAS Demonstrations During Visit to Coast (May 31, 2017)

2016

GRI and NGI Researcher is Awarded with Early Career Research Fellowship (October 31, 2016)

The Northern Gulf Institute Renews Agreement with EPA (August 23, 2016)

Mississippians Are Helping Lead Way on Commercial Use of Drones (July 19, 2016)

Cochran: Northern Gulf Institute Gets Expanded Role as Mississippi Wins New NOAA Award (July 18, 2016)

Northern Gulf Institute Named NOAA's Cooperative Institute for the Gulf of Mexico Region (July 18, 2016)

ASSURE Partner, Mississippi State NGI and NOAA Transform Science with UAS (July 15, 2016)

Dannreuther and Reynolds Earn University Research Awards (April 29, 2016)

NGI and Multi-team Partnership Recognized Nationally for Scientific Excellence (April 13, 2016)

Mississippi State Researchers Helping Officials Monitor, Manage Forest Restoration After Wildfire (March 29, 2016)

After the Burn: Using UAS to Monitor and Manage Forest Restoration (March 18, 2016)

NGI and NOAA Offer Paid Internship Program: Deadline to Apply is March 18, 2016 (March 1, 2016)

Twenty Agencies Form Monitoring Network to Help Save Avian Wildlife (February 16, 2016)

Gulf Coast Reporters' League Magazine Highlights Northern Gulf Institute (January 11, 2016)

4. Science Management

a. How does the Institute identify new intellectual opportunities?

New Intellectual opportunities are identified in many ways. The most prevalent is probably needs driven (strategic). Others might be considered more curiosity driven.

A NOAA Program Manager once said that NOAA program managers tend to fund via competitive processes when they have a question for which they want the larger community to determine novel ways to address, whereas they are more likely to fund a CI for projects for which NOAA wants to be involved in the research process.

b. What are some recent examples of intellectual opportunities?

One example that addresses our data management theme and is a science question was driven from our UAS work on flood mapping, detection, and analysis. The National Weather Service's River Forecast Centers make their daily flood forecasts early in the morning. Thus, getting them information on the situation then is crucial. As the day progresses, they may refine or adjust the forecast. With present FAA rules and the need to exploit the sun's illumination to image, the earliest we can start collecting data is sunrise. We can get decimated (compressed) overlapping images and estimates of their position from the UAV as it flies. Getting those images in front of the forecasters as quickly as possible is a priority. Once the UAV lands, we can download full resolution images and more accurate geospatial positioning information. By mosaicking the overlapping images, we can smooth out illumination variations, correct slight positioning errors, and create an image covering the complete area of coverage for that flight. The intellectual opportunity comes in what data to transmit in real time, what data to store, and what data to store where. What other information is necessary / beneficial in the common operating picture and for which users? Tradeoffs between completeness and accuracy compete with timeliness. The optimal approach also depends on when and how the data is used.

VORTEX-SE has addressed the question of why tornadoes of the same intensity tend to be more deadly and destructive in the Southeastern US vice the Great Plains.

The appearance of Karenia brevis (Red Tide) along the Mississippi coastline in Dec 2015, much farther north than it normally occurs, promoted questions of why that were addressed by Bob Arnone's satellite imaging group at USM/SSC.

The increasing openings and extended openings of the Bonnet Carre spillway has raised many questions about the resulting impact on the environment. Was the increased dolphin mortality a result of the opening? If so, how much and why? How fresh and for how long can the water be that fresh and oysters survive?

c. What is the strategy for new starts (projects, techniques, campaigns, etc.)?

For NGI, the strategy varies depending on the size and need. Sometimes someone sees an issue that they think needs to be addressed. VORTEX-SE is an example, (more deaths and damage though generally weaker storms). Sometimes the issue is identified by NOAA management – insufficient high-performance computing capability for research. Sometimes it is a realization that new technology can address a knowledge need better – autonomous systems.

Sometimes these strategies are collaborative projects between two or more academic units within NGI and sometimes not. Examples of new starts that have been collaborative are VORTEX-SE, the

advancement of the National Water Model, the Hypoxia Project, and the Western Sound Science Collaborative (WSSC).

New starts that have not been collaborative have been driven by the expertise of the particular academic unit: USM Mapping Center, UAS for Flooding and Adam Skarke's work with NCEI and OAR/OER.

d. How much of the Institute resources are reserved for new opportunities or bright ideas?

This question implies the CI has pure discretionary funds, which NGI does not. Under the CI agreement NGI gets Task 1 funding. The amount is a percent of the Task 2 and Task 3 funding. NGI's percentage has been around 3.6% recently (4.6% for FY16, 4.3% for FY17, 3.6% for FY18, 3.5% for FY19, 3.7% for FY20). 1% (so 22-29% of our recent Task 1 funding) is to be dedicated to "Education and outreach activities including support of post-docs and graduate students within the CI not assigned to specific projects or research; support of undergraduate research interns; development of community outreach, education, and training programs; and support for CI education and outreach staff." This is per a policy memo adopted by the NOAA Research Council in April 2012. The E&O funding is called Task 1B. Per that same memo, the remaining is to be used for "Administrative activities including CI start-up, management, and administration; this may include partial funding/salary support for the CI Director, Administrator, and other support staff; facilities (including non-project based ship or supercomputing resources, or other activities carried out under current cooperative agreements in Task I); travel; visiting researcher support; and other strictly administrative activities." This is called Task 1A.

The NGI Director decided, given the multi-institutional structure of NGI, to dedicate half of all of the Task 1B funding for an E&O Director and programs he led, and to offer half of the Task 1B funding generated by the other institutions (i.e., not MSU) to them. To date, only FSU has used any of that funding.

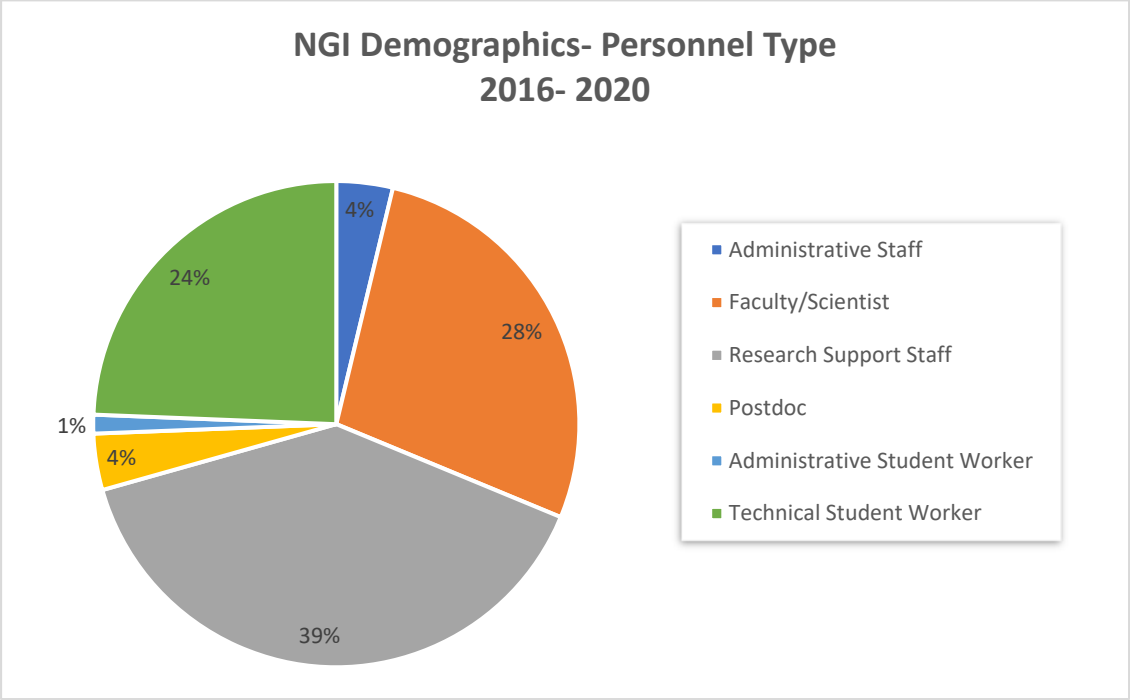
The Task 1A funding has been used to partially support the Director, the Co-Director, and the Program Administrator; to pay for some travel; and to fund a PhD student and two MS students at MSU. The PhD student was a strategic hire and is now being supported by the National Water Model non-competitive award. He is being supervised by Dr. Jamie Dyer. One MS student supported the UAS-based flood analysis work for a semester. The other MS student is being supervised by Dr. Just Cebrian and is supporting a longitudinal study in Perdido Bay and is helping to establish an ecological lab facility on the gulf coast to be used by at least 4 NGI researchers from 2 locations.

e. What is the demographic structure of the Institute employees?

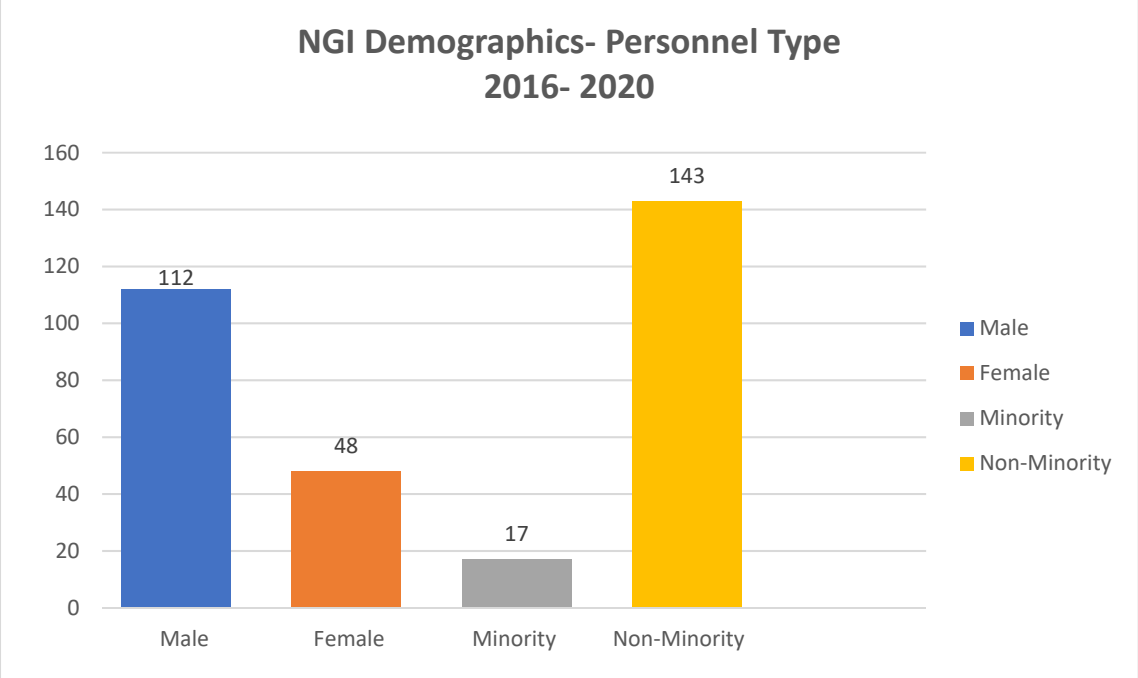
NGI employees span six (6) academic units. Based on various other demographic reports we have been asked to provide to NOAA, we broke the 160 identified employees into 6 groups:

- Administrative Staff (6)
- Faculty/Scientist (44)
- Research Support Staff (63)
- Postdoc (6)
- Administrative Student Worker (2)
- Technical Student Worker (39)

The relative quantity of each is shown in the chart below. All the administrative staff work for MSU. The Faculty/Scientist are highly distributed. Appropriately a quarter of the research support staff supports NCEI/SSC. Technical student workers include graduate and undergraduate students.



Of the 160 employees, we asked supervisors for theirs and their employees gender and minority status. The number of employees in each category is shown below.



f. What is provided for human resources development (recruitment, rewards, training, etc.)?

Recruitment by NGI is usually done as a result of a new project. Each academic unit has its own recruitment approach and support structure.

As an example, MSU NGI employees are eligible for the same awards as any other MSU employee in the same employment category. Recently we instituted a rewards program exclusively for the employees at SSC, where most of our NGI employees are located and where most of the employees are NGI employees. The first round of awards was paused by the recent pandemic.

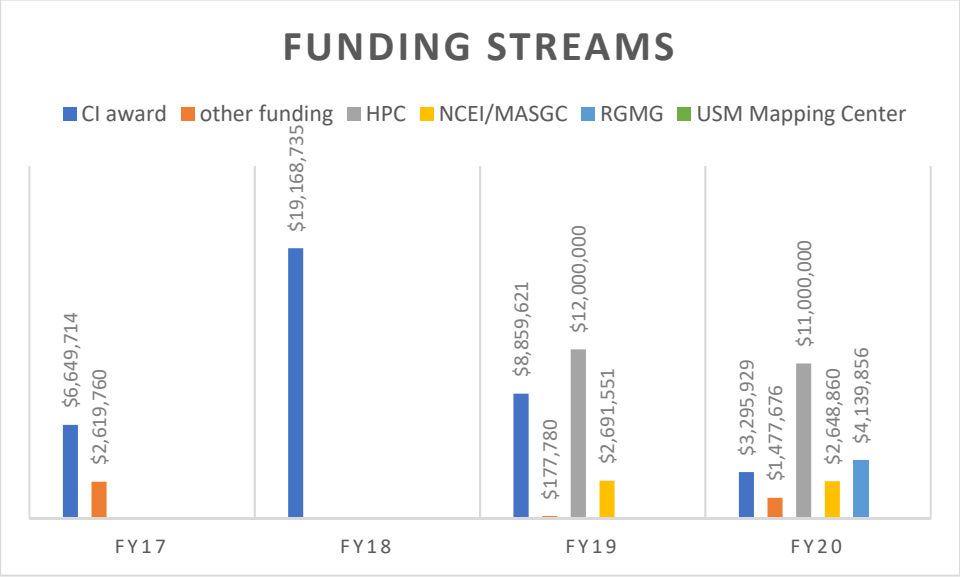
MSU NGI employees receive the standard university training on cybersecurity, harassment, and such, as well as more detailed and stringent cybersecurity training since they are part of the HPC2. The HPC2 has implement the NIST 800.171 training and standards mandated by DoD, NASA, and other federal agencies.

Similar practices are in place in other NGI member universities.

g. What is the state of the financial health of the Institute? (Provide a budget summary and identify imbalances or needed adjustments.)

The first chart below (Funding Streams) shows the funding sources over the last four years. Noteworthy is that the HPC funding and the funding from NCEI were originally awarded through the CI, but for the last 2 years awarded separately. Likewise, for FY20, the RGMG and the USM Mapping Center funding were made as non-competitive awards. Note the USM funding thus went directly to USM.

The second chart (Financial Status) shows all our Task 1 funding, as well as all the subcontracts. Funds awarded directly to MSU PI's are not reflected on this, only the Task 1 amounts.



Financial Status			
	Total Budget	**Expenses**	**Available Balance**
Robert Moorhead	$ 386,267.91	$ 151,024.43	$ 235,243.48
Steve Ashby	$ 286,935.00	$ 158,832.70	$ 128,102.30
Brandy Akers	$ 33,226.16	$ 33,226.16	$ -
Jonathan Harris	$ 60,000.00	$ 139,214.30	$ (79,214.30)
Whitley Alford	$ 35,248.84	$ 12,299.94	$ 22,948.90
Postdocs	$ 150,000.00	$ -	$ 150,000.00
Grad Students	$ 50,000.00	$ 37,670.83	$ 12,329.17
Total Salaries	**$ 1,001,677.91**	**$ 532,268.36**	**$ 469,409.55**
Fringe Benefits	$ 345,580.90	$ 138,164.64	$ 207,416.26
Tuition	$ 21,504.00	$ 20,186.58	$ 1,317.42
Travel	$ 93,339.00	$ 38,856.84	$ 54,482.16
Subcontracts			
DISL	$ 285,743.00	$ 261,980.66	$ 23,762.34
FSU	$ 2,063,157.00	$1,469,408.21	$ 593,748.79
LSU	$ -	$ -	$ -
UAH	$ 2,730,742.00	$1,600,762.18	$ 1,129,979.82
USM	$ 7,249,184.00	$4,991,435.19	$ 2,257,748.81
Contractual	$ 70,086.00	$ 11,421.26	$ 58,664.74
Commodities	$ 58,319.00	$ 5,746.29	$ 52,572.71
Equipment	$ -	$ -	$ -
Total Direct Cost	**$13,919,332.81**	**$9,070,230.21**	**$ 4,849,102.60**
Indirect @ 45.5%	$ 45,736.74	$ 45,500.00	$ 236.74
Total Cost	**$13,965,069.55**	**$9,115,730.21**	**$ 4,849,339.34**

h. How does the Institute intend to work towards accomplishing its financial goals?

NGI is a unique CI in that the prime (MSU) typically retains less than 70% of the annual CI funding. Funds that came as a result of Congressional direction have funded projects at MSU, USM, and UAH.

NGI, as a unit within MSU's High Performance Computing Collaboratory (HPC2), manages its financial activities under an umbrella of fiscal rules and regulations established by the HPC2 Operational Board (OpsBoard) and the university. NGI is the second largest of the 7 centers and institutes in the HPC2.

Our goal is to expend funds in a way that provides the greatest benefit for the research. In addition, NGI maintains the following informal financial goals that are reviewed continuously during proposal submissions, audits, and fiscal year closeouts by the University's Central Administration.

- Proposal budgets are submitted with adequate documentation to allow an outside reviewer to make a judgment on the reasonableness of proposed costs considering the research proposed.
- There is a process for the submission and approval of project expenditures and approvals which adhere to the provisions of Federal Circulars A-21 and A-110.
- At the completion of the research no federal projects will be over-spent.
- Research proposals are submitted on a timely basis to coincide with the funding requirements of the on-going research.
- A mechanism is in place that allows NGI management to effectively monitor university posted project expenditures and encumbrances on a monthly basis.
- Staff are paid in accordance with their appointments and salary rates, and monitored for relative uniformity among employees of similar skill sets, seniority, etc.
- There is a process for the periodic review of personnel staffing to projects during the university fiscal year.
- NGI maintains a current file of all NGI project expenditures and support documentation required for internal and external audit and management review.
- All expenditures are thoroughly reviewed to ensure accuracy and appropriateness.

i. Are there any issues in interacting with NOAA that require attention?

There are several.

A major issue for NGI seems to be there is not one NOAA. The planning process for the FFO that ultimately funded NGI in July 2016 (to start 1 Oct 2016) failed to obtain realistic estimates about how much various Line Offices and Programs might want to fund NGI over the next 5 years. The planners were told to be conservative, apparently with the expectation that NOAA's Grants Management Division (GMD) would continue to allow ceiling increases. NOAA is now addressing the inadequate communication / planning issues by making CI ceilings 2x the expected funding. The strategic planning example in Appendix E shows more issues in the way CIs are funded.

The way the Cooperative Institute Program is executed has changed frequently. NOAA's mission, OAR leadership, and the present funding environment probably all contribute, but it has been hard to plan a research program over the last 3-4 years.

Another significant issue is that NGI is not co-located with an OAR lab. However, we are co-located with NESDIS, NOS, NMFS, and NWS facilities and offices. Given the recent increased emphasis on transition planning by OAR, more cross line-office coordination on funding would be beneficial to NGI.

j. Are there any issues in interacting with the University that require attention?

No.

Appendix A: Project Summaries

This Appendix contains one-page project summaries. For most multi-year and continuing projects, we requested that the PI condense everything into one succinct page of information. We tried to address all 8 overarching themes in the review guidelines in at least one project report:

- Quality, Creativity, Integrity and Credibility – NOAA science must be top quality. In general, NOAA is known for and should continue to strive for science that is acknowledged as being credible, reliable, and respected. Therefore, NOAA science needs to be screened and evaluated through appropriate peer review as being of high quality. Appropriate client groups should also express satisfaction that NOAA science is relevant in terms of informing policy decision-making.

- Timeliness, Scale and Scope – NOAA science should be timely in the sense that it will be conducted and completed in a timeframe that is useful to decision-makers. It must also be at a scale and a scope that is useful.

- Science Connected to the Formulation, Application and Operational Implementation of Policy – NOAA science should be directly linked to the information required for policy-setting and decision-making. NOAA science should be designed and conducted with the understanding it is intended to inform and improve decision-making relative to coastal and ocean stewardship responsibilities, and policy formulation in weather, climate, and hydrology.

- Capacity-Building – NOAA has multiple environmental monitoring and stewardship responsibilities which collectively provide the foundation and constitute the nation's ability to assess and address environmental issues. Among these is to assist its partners (including state and local governments, universities, private firms, non-profits, international affiliates, etc.) to build capacity to address scientific and technical questions related to atmospheric, oceanic, coastal and hydrological prediction and assessment efforts. Reviews should address how NOAA science contributes to meeting these responsibilities.

- Education – Working collaboratively with partners, stakeholders, and citizens to protect and restore our environment for the benefit of current and future generations requires far-reaching public education initiatives, public support and public involvement. NOAA also needs to inform the environmental scientists and practitioners of the future. Therefore, an educational and public outreach component of NOAA science should be encouraged.

- Efficiency – NOAA must effectively coordinate and integrate its scientific and technical capabilities to maximize efficiency and minimize redundancy and counter-productive overlap. Unnecessary programs or program elements must be eliminated. There needs to be greater effort to share expertise within different sectors of NOAA, and all sources of complementary external science capability.

- Social Science Integration – There are important human dimensions to the use of environmental predictions (weather and climate forecasting) and to the management of the Nation's coastal and ocean resources. Understanding complex environmental systems requires the integration of the social and economic sciences with the biological and physical sciences. Successful integration begins in problem formulation and is present through science activities to the end of the research pipeline.

- Diversity – There is a need to expand involvement of people not historically involved or represented in NOAA science programs. NOAA should take explicit and tangible steps to achieve greater diversity in its science programs, projects, and activities. NOAA systems, policies and practices should encourage diversity and support all employees as they work to reach organizational and professional goals.

Some projects have no report due to the PI retiring (e.g., Bob Arnone) or leaving the NGI academic units (e.g. Pat Fitzpatrick, who is presently swamped trying to teach 5 new courses online and finish the semester).

The project summaries are in alphabetical order by project PI. Projects funded under the Cooperative Institute Award have project numbers; others simply a project title.

16-NGI3-04: Development of Trace Element and Strontium Isotope Water Chemistry Baseline Data for the Pearl River Watershed
PI(s): Peter Allen and Brenda Pracheil

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

Objective 1: Collect water samples throughout the Pearl River Watershed and nearby watersheds flowing into Lake Pontchartrain, LA. Results: Water samples were collected in the Pearl River and Bogue Chitto River Basins. Water samples were also collected from drainages along the northern edge of Lake Pontchartrain and Lake Maurepas, LA, including the Tchefuncte, Tangipahoa, Tickfaw and Amite Rivers. Water was collected from the limits of accessibility to sturgeons in the upper reaches to regions near confluence with saline water.

Objective 2: Analyze water samples for trace elements and strontium isotopes (i.e., ^{87}Sr and ^{86}Sr). Results: Water samples were analyzed for trace elements using solution inductively coupled plasma mass spectrometry (ICPMS) and for strontium isotope concentrations using solution multi-collector ICPMS.

Objective 3: Use data to develop a map of water chemistry in the Pearl River Watershed. Results: Water chemistry maps for trace elements (Sr, Ba, Mn, Mg, Zn) and strontium isotopes (Sr^{87}/Sr^{86}) in the Pearl River Watershed were developed using water chemistry data.

This study indicates trace element and strontium isotope patterns within the upper Pearl River and Bogue Chitto Rivers are distinct and would likely allow for retrospective analyses of habitat use of fishes utilizing these areas. The gradual longitudinal gradients in trace elements and strontium isotopes would presumably facilitate within river habitat use. Large differences in trace element and strontium isotopes between freshwater and saline habitats would allow for clear identification of movements between these two habitat types. Distinguishing retrospective habitat use in the drainages flowing into Lake Maurepas and Lake Pontchartrain would be more difficult based on the similarity of trace element and strontium isotope ratios among rivers. Discharge in these rivers is much lower than in the Pearl River Watershed, and habitats in many of the lower rivers were typified by slow flow and hypoxia. These conditions would presumably not be conducive to utilization by Gulf Sturgeon, although there may be seasonal variability facilitating habitat use. A publication describing these results was published:

Gunn, M. A., Z. S. Moran, B. M. Pracheil, and P. J. Allen. 2019. Spatial changes in trace element and strontium isotope water chemistry in a temperate river system with application to sturgeon movement. Journal of Freshwater Ecology 34(1):739-755.

19-NGI3-80: Hypoxia National Office Technical Assistance, Observations, Monitoring, and Coordination
PI(s): Steve Ashby

Project Description: Nutrient pollution from the Mississippi River runoff leads to seasonal formation of hypoxia along the northern Gulf of Mexico continental shelf, impacting valuable living resources and their habitat. Mitigating this ecosystem stressor is one of the greatest water quality restoration challenges in the nation. Congress authorized the Harmful Algal Bloom and Hypoxia Research Control Act in 1998 to address this challenge. The Act also authorized the interagency Mississippi River/Gulf of Mexico Hypoxia Task Force (HTF). As a member of the HTF, NOAA supports hypoxia research, monitoring, modeling, and model development. NGI is continuing to provide support to NOAA and has been designated as the CI for Gulf of Mexico Hypoxia. www.northerngulfinstitute.org/gulf-hypoxia

One of the outcomes of the 6th Annual NOAA/NGI Hypoxia Research and Coordination Workshop was the establishment of the Comprehensive Hypoxia Assessment and Monitoring Program in the Gulf of Mexico. This includes multiple universities, NGOs, state, and Federal representatives. There are eight working groups that meet as needed. These groups focus on monitoring state waters (Texas, Coastal Louisiana, and Mississippi/ Alabama), monitoring with autonomous vehicles, fisheries management monitoring, Hypoxia Task Force Monitoring, Ocean Acidification Monitoring, and collaboration with the Gulf Restoration Monitoring Network. One of the outcomes of these meetings has been to bring researchers from 3 states together to increase the understanding of hypoxia east of the Mississippi River (Figure 1).

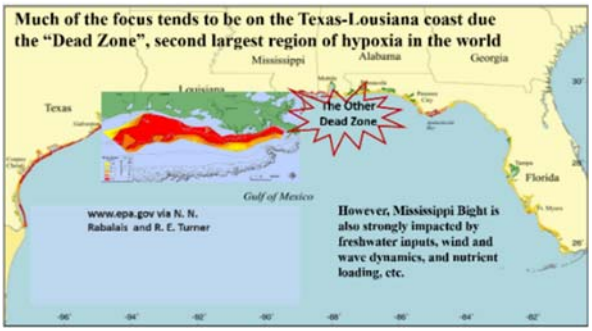


Figure 1. Highlights areas east of Mississippi River

This project now supports the annual hypoxia cruise lead by Dr. Nancy Rabalais in collaboration with LUMCON. Results from this cruise are used to verify early predictions of potential size of the hypoxic zone calculated from the spring loading of nitrogen and phosphorus in the Mississippi River (Figure 2). The HTF uses the annual cruise to mark progress in efforts to reduce the size.

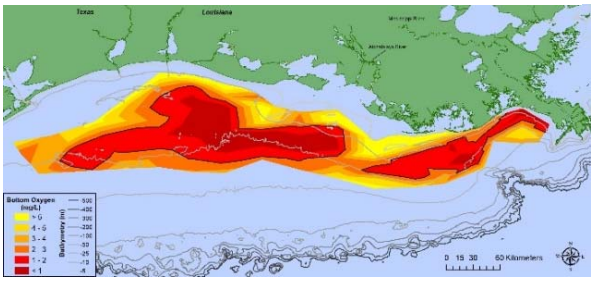


Figure 2. Map of the hypoxic area 2019, Rabalais et al.

Model development has resulted in more robust biogeochemical modeling that now supports modeling of living marine resources funded by another NOAA program. This project is also supporting modeling at LSU and Dalhousie to "hindcast" the dissolved oxygen dynamics and allows 3-D simulations for a better understanding of the temporal and spatial extent of hypoxia. Science support by this research adds credibility to the discussions and decisions within the HTF. This project addresses 3 of NOAA's focal areas, 1) Technical Assistance, 2) Observations and Monitoring, and 3) Coordination. Other partners include NOAA's National Centers for Coastal Ocean Science, Coastal Hypoxia Research Program, Gulf of Mexico Ecosystem and Hypoxia Assessments, Gulf of Mexico Hypoxia Watch, and the GoM Regional Collaboration Team (including Sea Grant). NOAA themes addressed include Quality, Creativity, Integrity and Credibility, Timeliness, Scale and Scope, Capacity-Building, and Education

19-NGI3-85, Bayesian Merging of GLM Data with Ground-Based Networks
PI: Phillip Bitzer

Project Description: The launch of the Geostationary Lightning Mapper (GLM) on GOES-R, and subsequent launch on GOES-S, has enabled continuous measurements of total lightning, i.e., intracloud (IC) and cloud-to-ground (CG) over a wider domain than previously available. With this, there are a wealth of new possible applications using lightning activity. This project focuses on the determination and utility of the cloud flash fraction – the fraction of flashes in a given time that are IC flashes – in severe weather applications, particularly tropical cyclones. This is done with two approaches: 1) a Bayesian methodology in which other lightning data sources are used and 2) a Random Forest methodology in which only satellite data is used.

While the GLM provides a new source of lightning data, other methods of detecting lightning exist, in particular, ground-based networks. Because each instrument/method has intrinsic strengths, merging lightning data sources provide a more robust estimate of total lightning. To do so, we utilize a Bayesian approach [Bitzer et al., 2016] to produce a dataset in which common detections are merged with unique detections from each source.

The Bayesian approach also allows determination of the cloud flash fraction (CFF). For the matched flashes, the classification given by the ground-based network is used to determine flash type. The temporal variation of the CFF has been studied relative to changes of intensification of tropical cyclones. The CFF in the eyewall of Hurricane Harvey (Figure 1) has a higher correlation (0.51) than flash rate alone (0.30, not shown). Other GLM-only attributes in the rainband are positively correlated to windspeed, e.g., maximum group area, flash energy.

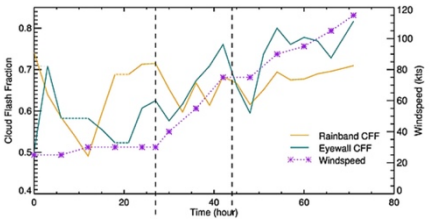


Figure 1. Time series of cloud flash fraction (CFF) and windspeed in Hurricane Harvey.

In addition, significant work has been done to develop a flash-type discrimination using GLM-only data. This addresses a common drawback to satellite lightning data. A random forest method has been used to estimate the CFF over the Western hemisphere. Although data artifacts exist in Figure 2, particularly in the eastern part of the domain, initial results largely show the same patterns previously found in CONUS. Figure 2 shows the first estimate of CFF over South America.

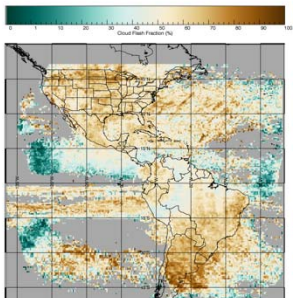


Figure 2. Cloud flash fraction using GLM only for the Western hemisphere.

The CFF product is currently being developed further into the operational environment. Current work includes exploration of suitable time steps in which to display the product to forecasters. This is part of the research-to-operations initiative of this project. A working example in an AWIPS environment is shown in Figure 3.

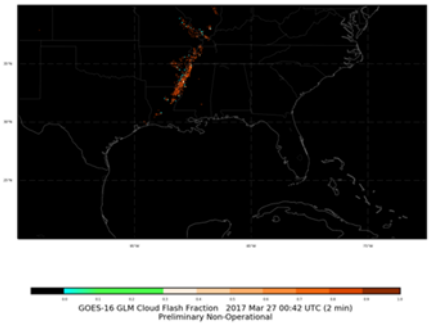


Figure 3. Working implementation of cloud flash fraction product for AWIPS.

This project specifically addresses NOAA research objectives for a Weather-Ready Nation and Climate Adaptation and Mitigation. Further, it contributes to the NOAA AI strategy to use Artificial Intelligence to better leverage available weather data.

17-NGI3-32: Further Refinements to Stepped-Frequency Microwave Radiometer Surface Wind Measurements and **18-NGI3-53**: Hurricane 3-D Wind Structure Analysis Using Stepped-Frequency Microwave Radiometer Surface Wind Measurements
PI(s): Mark Bourassa

Project Description: Tropical cyclones (TCs) are one of the major threats to coastal communities in the United States. One of the key components to ensuring these communities are properly prepared for TCs is providing accurate forecasts and watches/warnings for potential hazards of the storms. The Stepped-Frequency Microwave Radiometer (SFMR) is the primary tool used for collecting aircraft-based estimates of the surface wind speed in TCs. These surface wind speed observations are used as input to numerical models and by forecasters to produce the most accurate forecasts and watches/warnings of the potential TC hazards. While the SFMR has proven to be incredibly reliable over the past 15 years, areas for further improvement to the accuracy of the observations have been identified. These projects address some of these areas for improvement, such as dependence on the angle of the aircraft relative to the surface, impacts from rain on the measurements, and how measurements of surface wind speed from other instruments (dropsondes and aircraft-based radar systems) are compared to the SFMR measurements to check for accuracy and to gain a better understanding of the TC wind field.

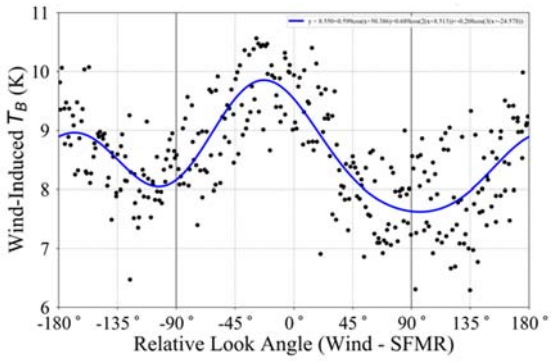


Figure 1: Variation of SFMR measurements relative to the surface wind direction in the same location.

New guidance on the impacts of the aircraft angle with respect to the surface were developed for the SFMR. Figure 1 illustrates how the SFMR measurements for the same conditions change when the aircraft tilts up/down (pitches). These changes can result in a difference of a few m/s in the retrieved wind speed if not accounted for properly. Investigation into the impacts of heavy rainfall on the SFMR measurements identified contributions from rain that were being attributed to wind speed, which were previously unknown. Comparison of the SFMR data to dropsondes and aircraft-based radar systems have illustrated much larger variability in commonly used comparison techniques than has previously been understood. The radars also depicted several features in the TCs that may explain discrepancies between the SFMR and wind speed data collected at the height of the aircraft.

All of the findings from these projects have provided forecasters at the National Hurricane Center with additional guidance for interpreting the SFMR surface wind speed. In addition, the findings will be incorporated into an upcoming update to the SFMR observation processing, which will further increase the accuracy of the observations. As we continue to improve the measurements from the SFMR, our knowledge and forecasting of TCs increases, which allows us to continue increasing our ability to protect life and property, especially in coastal regions.

18-NGI3-42: Climate Variability in Ocean Surface Turbulent Fluxes
PI(s): Mark A. Bourassa and Shawn R. Smith

Project Description: Florida State University (FSU) produces monthly in-situ fields of surface winds (the 'FSU Winds') for the tropical Pacific and Indian Oceans. We are **developing a much higher quality product** for air-sea interaction (fluxes of heat, moisture and momentum) that also uses satellite data. The FSU Wind fields are available for monthly updated El Nino – Southern Oscillation (ENSO) forecasts, **within eight days after the end of the month**. The flux-related variables are useful for forcing ocean models, testing the realism of atmosphere and ocean prediction models that link the ocean and the atmosphere (which is important for longer weather forecasts and seasonal to interannual forecasts for variability like ENSO), and for understanding some aspects of climate related variability.

The FSU activity is motivated by a need to better understand interactions between the ocean and atmosphere on daily to interdecadal time scales, and on spatial scales from ocean basin wide phenomena like ENSO to small scale processes related to sea surface temperature fronts and surface current gradients. Air-sea exchanges (fluxes) are **sensitive indicators of changes regional climate and weather patterns**, with **links to floods and droughts, East Coast storm intensity, and storm tracks**. On smaller spatial and temporal scales they can be **related to the storm surge and tropical storm intensity**. On longer temporal scales, several well-known natural climate variations have been identified as having **direct impact on the U.S. economy and its citizens**. For example, changes in the pattern of winds over the Southeastern United States change the amount of rain that falls in each region, and modifies the strength of the land sea breeze (which accounts for 40% of the precipitation in North Florida). Improved predictions of ENSO phase and associated impact on regional weather patterns could be extremely useful to the agricultural community.

The monthly FSU Winds are available at https://www.coaps.fsu.edu/RVSMDC/html/winds.shtml and https://www.coaps.fsu.edu/woce/html/ndnwinds.htm.

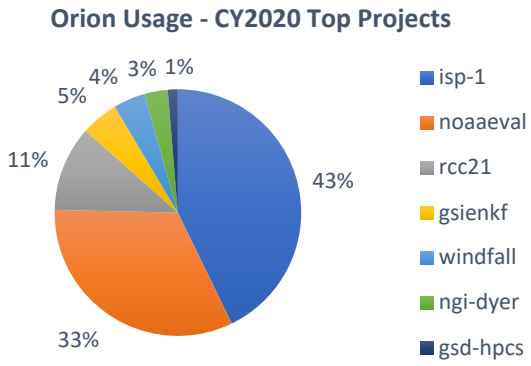
This project **trains graduate students** to understand and make greater use of marine observations, and **leverages research activities** (e.g., NOAA and NASA funded research) to train these students to better understand NOAA data and to make use of NOAA data to address research questions. We also employ undergraduate students to produce our data products, and often work with the same **students on data-related capstone research projects**. Similarly, students are trained in development of the observing system. These students come from very diverse backgrounds, and these efforts **directly broaden the diversity of the future work force**. Science topics that have been investigated in recent years include (1) **intercalibrate extreme winds** measured from satellite, buoy and aircraft winds; (2) how observations from dropsondes launched from NOAA aircraft could contribute to our **understanding of the boundary-layer in tropical cyclones** (Ahern et al. 2019); (3) the sensitivity of modeled fluxes (Shi and Bourassa 2019) to (a) resolution, (b) two-way coupling with the atmosphere and waves, (c) surface currents, boundary-layer parameterization scheme, and (d) the parameterization of sea state dependency; (4) modeling surface stress changes due to sea spray in extreme winds; (5) regional changes in ocean stratification due to tropical cyclones (Steffen and Bourassa 2018), and (6) determining what a proposed satellite will be able to see between regions of rain in hurricanes. We are currently assessing how to use NOAA observations to validate flux models, and plan to use this information in the development of our satellite-based flux product. The understanding developed in most of the above topics can **contribute to better weather and climate forecasts** as well as **improve decision making for ocean stewardship**.

17-NGI3-30: HPC Support for OAR
PI: William B. (Trey) Breckenridge III

Project Description: NOAA depends on high performance computing to meet many aspects of its mission. Environmental modeling is critical to the products and services that the American public depends on NOAA to produce. In his presentation at the Senior Research Council meeting in September 2016, the NOAA OAR AA stated his top 3 issues. The second was high performance computing (HPC). He noted that a review of how much HPC capacity OAR really needed had been completed, and that the present capacity was significantly below the required level. The need is clear for more dedicated research high performance computing capacity to enable NOAA is to fulfill its research mission.

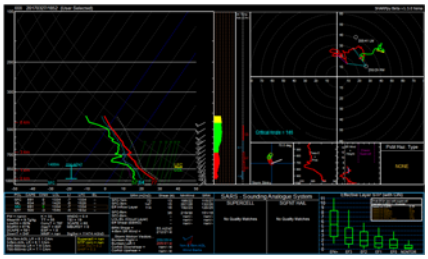
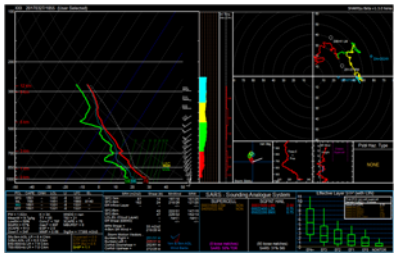
MSU has long been a leader in high performance computing, supporting research and operational needs for numerous federal agencies for several decades. Coupling this HPC expertise with the existing NGI research relationship with NOAA created a natural fit for MSU to build new HPC capacity in support of NOAA research and development activities. Furthermore, the extensive HPC capacity at MSU supports research in all four of the NGI's research themes and more. Larger projects include: 1) Comprehensive numerical modeling of the global system, which is the cornerstone of weather forecasting, weather and climate research, and understanding ecosystems and coastal issues; 2) Simulation of the complex interactions of the atmosphere, ocean, land surface, cryosphere, chemically active atmospheric constituents, biogeochemical cycles on land and in the ocean, and terrestrial and oceanic ecosystems; 3) Coastal ocean predictions and forecasts, including storm and climate scale inundation planning, resilience and response, safe and profitable marine transportation, and predictions to mitigate the impacts of hazards and toxins ranging from oil spills to harmful algal blooms; and 4) Accelerated modeling and simulation activities to provide relevant decisions support information on a timely basis for decision-makers.

The present HPC system at MSU, named Orion, is a Dell C6420 cluster containing 1,800 nodes with a total of 3,600 Intel Xeon Gold 6148 processors (72,000 compute cores in aggregate) and 345 terabytes of RAM, a 10 petabyte high performance data storage system, and a Mellanox HDR InfiniBand interconnect. The system ranked as the 60th fastest system in the world in the TOP500 Supercomputer Sites November 2019 list and has a peak performance of 5.5 PetaFLOPS. Production operations began on January 1, 2020 starting with a small subset of priority users identified by NOAA. Utilization has now grown to a total of 474 users working on 57 unique NOAA projects. During CY2020 a total of 838,118 jobs have been submitted to the system consuming 62,026,152 wallclock-hours of CPU time. As of the end of March 2020, the system is running at near capacity; with this utilization rate the researchers will consume approximately 50,000,000 wallclock-hours of CPU time per month.



Title: Understanding the Variability of Southeastern Severe Storm Environments using Mobile Soundings during VORTEX-SE
PI: Michael Brown

Project Description: In order to assess the robustness and variability of tornadic storm ingredients (e.g., CAPE, vertical wind shear, moisture), the "gold standard" is a concerted campaign of tropospheric soundings at fine temporal and spatial intervals. Full tropospheric soundings are also essential to effective post-field modeling and data assimilation efforts (including other scientists writing different proposals). The strength of mobile systems is in the ability to flexibly adapt the deployment to the forecast, and to provide periods of higher (research quality) temporal and spatial resolution that are not ordinarily possible. The objective of PI-Brown was to Better Understand the role of surface heterogeneity and mesoscale boundaries on the SE severe storm environment.
Rationale: During the 1994-95 VORTEX field campaign, Markowski et al. (1998) found that nearly 70% of the significant tornadoes occurred on or near boundaries not associated with the parent supercell storm. While many of the boundaries they identified were from previous convection, others have noted prevalent mesoscale circulations associated with changes in land-cover (Koch and Ray 1997; Segal and Arritt 1992; Rabin et al. 1990). Recently, Gutter and Brown (2015) identified an increase in sensible temperature of nearly 15^{o} C inside a SE tornado damage swath, with a subsequent increase in convective activity within 15 km of the scar during the following convective season. The vast majority of work linking non-classical meso- and local-scale circulations to surface heterogeneity has emphasized periods where the synoptic environment is quite benign. It is unknown how vigorous such circulations might be in severe storm environments where stronger low-level winds and vertical shear prevail.
Project Findings: While the larger goal of robust atmospheric soundings near severe-local storms did not always allow for local identification of land-surface discontinuities in real-time, during one IOP our teams completed atmospheric profiles across a distinct agriculture / forest boundary. Small improvements in local environmental shear was noted over the agricultural region, likely due to a slightly less turbulent flow in the lower PBL. However, surface instability across this boundary showed distinct changes where the agricultural region showed nearly twice the Convective Available Potential Energy when compared to the forested region. The greater instability was generated through slight increases in low-level atmospheric moisture over the agricultural landscape. While limited in scope, this suggests that updrafts rooted in the PBL may respond to sudden increases or decreases in instability which has been tied to tornado genesis.

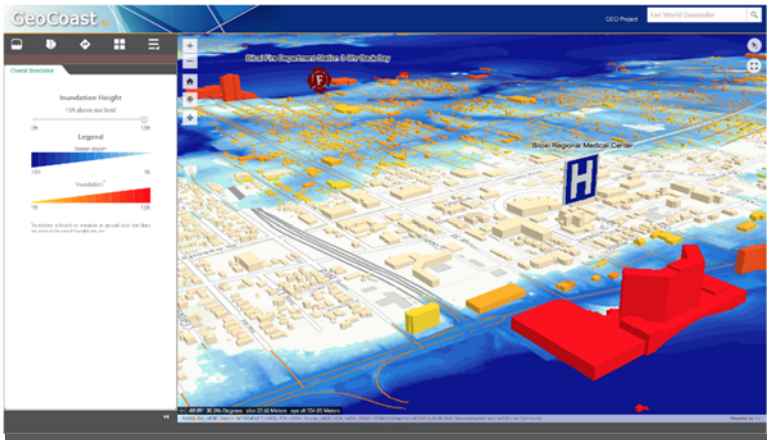
	
Within Forested Landscape	Nearby Agricultural Landscape

19-NGI3-64: Regional Geospatial Modeling
PI(s): John Cartwright and Robert Moorhead

Project Description: The Regional Geospatial Modeling Grant (RGMG) focuses on the promotion of geospatial technology to improve coastal communities. The promotion of this technology includes workforce training in geographic information systems (GIS) for government employees (local, state, and federal) as well as the general public, the development of web-based geospatial tools for public use, and the creation of new geospatial data for public consumption. The Geospatial Education and Outreach (GEO) Project facilitates the use of these data and resources by providing GIS training opportunities and application development for data accessibility by technical and nontechnical users.

GEO Project workshops employ two mobile classrooms at various facilities near participants. Workshops are offered with both commercial and open source software covering topics ranging from introductory GIS to multi-user database systems. Since October 1, 2016 the GEO Project has offered 78 workshops to 751 participants.

Application development includes web-based spatial tools for enhanced visualization and data dissemination. Applications developed include a web-based GIS for the general public. The application is compatible with all computer operating systems and provides tools to create data and text overlays as well as upload spatial datasets from GPS units. The web application can be accessed at: https://geoproject.hpc.msstate.edu/GeoDawg.



GeoCoast 3D: https://geoproject.hpc.msstate.edu/geocoast3d/

Lidar data for coastal Mississippi were used to develop a digital earth model for assessing the impacts of sea level rise on transportation networks in 1-foot increments. The GeoCoast (2D) application was developed to evaluate this impact on traffic patterns and accessibility to critical infrastructure. GeoCoast (3D) is an enhancement with improved visualization and capability for building and roadway inundation levels. Users can visualize impacts based on multiple models and data sources, including basic inundation, NOAA Sea Level Rise, and ADCIRC storm surge. Current application development efforts are focused on augmented reality (AR) development for GeoCoast and multi-criteria decision analysis (MCDA) for coastal watershed erosion.

The majority of funding (70%) is used to support a subcontract to the Mississippi Department of Environmental Quality (MDEQ) for data development. Early data development efforts produced the previously mentioned lidar data and an updated road center line data set. Current subcontract tasks are associated with the development of an enhanced (1:4800) hydrography database for Mississippi watersheds. Updates are planned for 19,182 square miles of Mississippi watersheds and currently 16,006 square miles are complete. In addition to the data development, efforts to optimize the use and effectiveness of the data are ongoing to expand public accessibility.
http://data-somdits.opendata.arcgis.com/

Title: Coastal Science Research, Data Development and Information Services
PI(s): Robert Moorhead, Steve Ashby and Just Cebrian
Project Description: Working with NCEI/SSC, the Northern Gulf Institute (NGI) aims to develop environmental information products and services that serve the needs of scientists, managers and the public in general. These products and services are defined broadly and include, but are not limited to, data bases, interactive maps, decision support tools, and publications. These activities are supported by two main funding categories, i.e. base funding and partner funding. The latter corresponds to funds provided to NCEI by other programs and NOAA line offices, and in turn NCEI utilizes NGI personnel to meet some of those partners' needs. Below we summarize selected programs within the two funding categories.

Base Funding:

HABSOS: It represents the largest data set of *Karenia brevis* (toxic alga) concentrations in the Gulf of Mexico. The tool allows for mapping features to track the distribution and fate of these toxic blooms.

Hypoxia Watch: This multi-agency effort coordinates data assembly into common formats and archives to efficiently track oxygen content in coastal waters, including the Gulf of Mexico, thereby allowing for detection and action towards hypoxic conditions

Coastal and Marine Ecosystem Classification Standard (CMECS): The standard constitutes a common vocabulary that enhances the classification, comparability and understanding of marine habitats.

Microplastics distribution in the Global Ocean: This is a new effort started this year that intends to archive information on microplastics occurrence in the global ocean and create unprecedented maps and models to better understand their distribution and transportation across oceans.

Oxygen dynamics in the Global Ocean: This product shows the temporal (seasonal and interannual) and geographical distributions of oxygen content across the world's oceans and identifies trends that aid in the characterization and understanding of oxygen dynamics in the ocean.

Coastal Ecosystem Data Assembly Center (CEDAC): This is a framework to facilitate data contribution and ingestion from providers, creation of large data sets, and efficient utilization by diverse users. The framework sits on a system network with large storage and processing capacity

Extension and Outreach (E&O): E&O activities are carried out in diverse forums, such as classrooms, open houses and environmental festivals. Coastal environmental sciences are featured in our E&O activities.

Partner Funding:

National Centers for Coastal and Ocean Science (NCOOS): This work includes support for data management and archiving; stewardship for the creation of a concerted, coordinated data archiving plan; migration of data bases to various portals; and metadata generation and maintenance.

Natural Resource Damage Assessment (NRDA): The main duties for this service have been the organization and management of data files, including QA/QC, and ensuring easy and complete access to the data files by users.

National Marine Fisheries Service (NMFS): A tool has been developed to track probable origins of sea turtle carcasses stranded on the shoreline in the Northern Gulf of Mexico. The tool also allows for predictions of probable stranding areas given a specific open-water location of the carcass.

Deep Sea Corals Research and Technology Program (DSCRTP): The support provided to this Program consists of managing the Program's data base and Data Working Group; publishing technical reports describing the Program's data base and maps; and enhancing communication between data providers, stewards and users.

Ocean Exploration and Research (OER) Program: Tasks provided for the Program include ensuring data flow from the Okeanos Explorer into the archives; overseeing and coordinating data management activities; developing new data management and storage tools; and authoring Program's data management documents.

18-NGI3-58: USM Mapping Center
PI: Brian Connon

Project Description: USM's Mapping Center, as an activity of the Hydrographic Science Research Center (HSRC), was funded through NGI from 2016-2019 by the NOAA Office of Coast Survey (OCS). For 2020, NGI was unable to continue to manage USM's funding due to cap space issues and USM used a sole source, 1-year agreement with OCS. USM is now competing for a 5-year Cooperative Agreement designed to fund an Ocean and Coastal Mapping Center.

In the 3 years of the Mapping Center funded through NGI, several key areas of research were addressed, primarily unmanned systems, Global Navigation Satellite Systems (GNSS), and water levels.

The primary goals of the project were to take receipt, and begin using, an unmanned surface vessel (USV), a CWorker 5 from L3 ASV Global; and procure a mulitbeam sonar system for integration and deployment on a Saildrone USV. The CWorker 5, *Sea Eagle*, is a 5m long USV capable of conducting hydrographic and oceanographic survey operations. *Sea Eagle* has conducted numerous research cruises with a variety of hydrographic sensors, primarily for familiarization of USM personnel. *Sea Eagle* was demonstrated during USHYDRO 2019 along with L3 ASV Global and Kongsberg, who provided a sonar system and a marine broadband radio system. *Sea Eagle* was also used to collect a common dataset for GEOHAB 2020 in collaboration with R2Sonic, a multibeam sonar company.

The Saildrone USV, "Surveyor", was outfitted with a Norbit shallow water multibeam system and integrated Inertial Navigation System. Integration was done at Saildrone facilities in Alameda, CA prior to transport to USM's Marine Research Center for testing in summer of 2019. "Surveyor" conducted two 1-week cruises out of Gulfport and collected high resolution bathymetric data, including discovery of an uncharted wreck. "Surveyor" returned to Saildrone facilities for further engineering, testing and the creation of a second Saildrone USV, "Profiler" which was outfitted with a sound velocity profiler on a winch system. Initial results showed great potential for use of this technology in remote areas, such as the Arctic Ocean. Current efforts are to reduce power requirements, develop a concept of operations, and understand/address communication limitations.

An Echoboat USV, manufactured by Seafloor Systems, was gifted to USM in 2019. Mapping Center funds were used to outfit this small USV with a multibeam sonar and batteries to match systems used by NOAA's Navigation Response Teams. USM and the local NRT are working together to use this USV as an experimentation and troubleshooting platform; it can also be used for operational disaster response.

GNSS research has been focused on understanding other (i.e. non-GPS) GNSS and their capabilities and limitations with respect to precise point positioning. Research involves evaluation of mass market (low cost) GNSS receivers as compared to high end, geodetic quality GNSS receivers. Preliminary results show that these mass market GNSS receivers can meet requirements for precise point positioning under certain conditions. Further work, conducted by a PhD candidate, will evaluate these receivers for use in the maritime environment to measure water levels, waves, etc.

Water level research centered around determination of Vdatum uncertainties in the northern Gulf of Mexico. Significant subsidence occurs in this region, making maintenance of Vdatum values difficult. Three USGS water level gages and an AXYS Hydrolevel buoy were utilized in the region to better ascertain the range of uncertainty found within Vdatum. This information provides NOS with important data to further refine Vdatum calculations.

Title: Developing New Capabilities and Research Applications for the National Water Model Over the Southeastern US

PI(s): Jamie Dyer and Andrew Mercer

Project Description:

The primary goals of this project are (1) implementation and development of the National Water Model (NWM) within the Unified Forecast System (UFS), and (2) development of applications of the NWM to water-related issues across the Southeast US.

Regarding the first goal, the NWM will be implemented and tested over sub-domains within the Southeastern US with a focus on data flow and coupling methods, calibration of model parameters, and assessment of output accuracy and precision. The focus on the development efforts is on short-range (hours to days) and medium-range (days to ~two weeks) simulations, which reflects current UFS applications of "Short-Range Weather / Convection Allowing" and "Medium Range Weather" simulations and guidance. The primary benefit of the research is the inclusion of hydrologic simulations at these time scales, which is currently not an element of the UFS. Given the importance of water-related information over the Southeast US in terms of both quality and quantity, incorporation and testing of the NWM in the UFS for the purpose of hydrologic research applications is critical.

The second goal focuses on evaluation and improvements in the NWM over the Southeast US to address extreme hydrologic conditions such as flood and drought, with a focus on drought. The first sub-task component under this research goal is an evaluation of the existing NWM performance for basins within the Southeast region. Particular attention will be given to NWM performance in drought and low flow regimes using the latest version of the NWM consistent with the UFS system. The second sub-task component addresses data needs for the NWM to simulate a variety of hydrologic conditions. One focus will be on groundwater withdrawals for municipal and agricultural uses during drought and low flow conditions, while another focus will be on land use, leaf area index, and soil moisture values and their influence on the precision and accuracy of NWM output.

Progress has been made on three research objectives associated with the overall project goals. First, leveraging the high-performance computing (HPC) capabilities at Mississippi State University (MSU), a parallel version of the WRF-Hydro model with the same configuration and parameterization as the medium-range NWM operational framework has been compiled and tested. The primary domain was limited to cover the Southeast US, while several subdomains covering individual basins were also developed for future research objectives. Second, in preparation for an assessment of the influence of land use, leaf area index (LAI), and soil moisture on the accuracy and precision of WRF-Hydro simulations, the sensitivity of near-surface temperature and moisture patterns over the Southeast US was quantified within the framework of the WRF-Hydro model. Changes in these atmospheric features have a large impact on surface-based heat and moisture fluxes; therefore, it is important to consider the ramifications of land use changes from the meteorological perspective before implementing hydrologic simulations. Third, to accomplish the task of evaluating the National Water Model (NWM) in low flow conditions, work has been done on acquiring historical NWM output and comparing it against observed recorded data during low flow events. The archived historical data output that was generated from a 25-year (1993 - 2017) historical run of the NWM were downloaded from NOAA's data storage. The data files have been clipped to the Southeastern US region, and the hourly data have been converted to daily averages for the channel routing and lake outputs and monthly averages for the land and atmospheric outputs.

18-NGI3-61: Improving historical data access for coastal application
PI(s): Brian Dzwonkowski and Renee Collini

Project Description: Accurate, robust, accessible data describing environmental conditions are critical to understanding changes and dynamics of coastal ecosystems and for productive management, conservation, and restoration of natural resources that are the foundation of local ecologies and economies (Mills et al, 2013; NAS 2016; U.S. COP, 2004). Mooring based measurements in the coastal ocean are a key component of modern ocean observing systems, providing data essential for a range of scientific, commercial, and public interests. The FOCAL WE-CP buoy has been collecting oceanographic measurements (i.e., velocity and hydrographic data) approximately 20 km southwest of Mobile Bay, Alabama for over 13 years (Figure 1). *This mooring operation represents the longest running time series of coastal hydrographic water column data in the Mississippi Bight and one of the longest in the entire Gulf of Mexico.* However, funding for this data collection has typically been derived from process orientated studies, providing support for discrete periods of time. The continuity of the data collection between major projects has been pieced together by various sources of internal money and in-kind contributions from DISL and the University of South Alabama. As a result, multiple principal investigators have been responsible for data collection over the years, which has generated inconsistencies in data processing and organization. *This represents a significant limitation to the dissemination and accessibility of the data to regional stakeholders and the broader scientific community.*

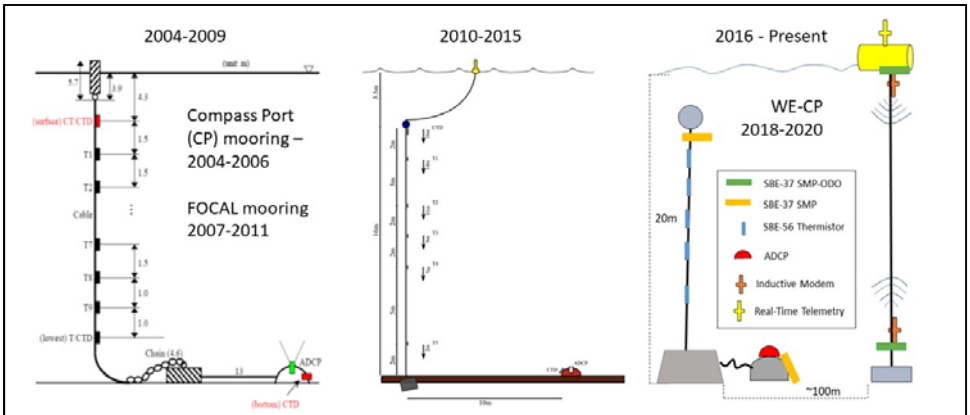


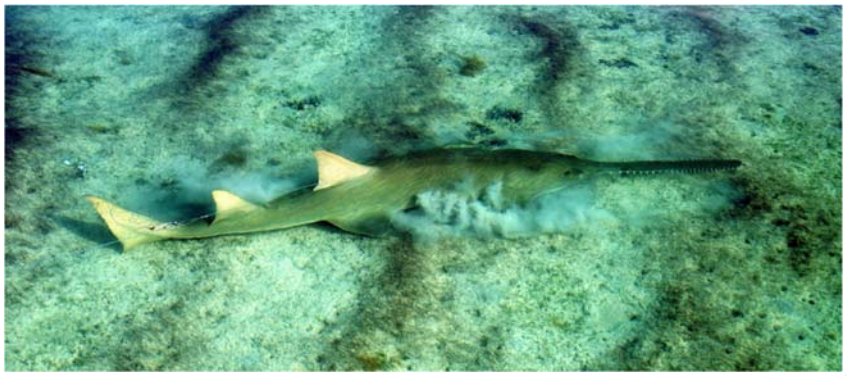
Figure 1. Changes in the long-term mooring site over time

To maximize the benefits of this data set, we conducted a data management project that organized the historic data collections from the mooring system, providing direct access to these historical data in conjunction with the real-time data from the FOCAL WE-CP buoy. The existing historical data set required several data management actions and are now available at NOAA NCEI (https://accession.nodc.noaa.gov/0203749).

Improving accessibility of these data directly addresses human interests and activities through overarching themes of maintaining water quality, understanding coastal hazards such as climate change and hurricanes, and improving resilience of Gulf ecosystems to natural and human disasters. The results of this project are dramatically increasing the applicability of the historical data with new users from research institutions across the U.S. (e.g. Paul Harnik, Franklin and Marshal University; Troy Mason Farmer, Clemson University; Luciano Chiaverano, University of Southern Mississippi) as well as by local and regional agencies (e.g. NOAA Unusual Mortality Event Response Team for Dolphins in the Northeastern Gulf of Mexico, Alabama Department of Conservation and Nature Resources, Mississippi Department of Marine Resources Office of Restoration and Resiliency). These stakeholders are applying these data to critically important issues related to ecosystem dynamics (e.g. fisheries populations, hypoxia) and extreme events (marine heatwaves, hurricanes).

19-NGI3-76: Determination of movement patterns and reproductive status of adult smalltooth sawfish
PI(s): R. Dean Grubbs (FSUCML) and Jim Gelsleichter (UNF)

Project Description: The sawfishes include five living species of large subtropical shark-like rays that possess an elongated toothed rostrum that renders them highly susceptible to entanglement gears and makes them the target of fisheries as curios. All five species of sawfishes are listed worldwide as Endangered or Critically Endangered in the IUCN Red List of Threatened Species. The U.S. population of smalltooth sawfish (*Pristis pectinata*) declined drastically and its range contracted considerably during the last half of the 20th century. As a result, in 2003 the smalltooth sawfish became the first domestic marine fish listed as Endangered under the U.S. Endangered Species Act. Bycatch in commercial fisheries, primarily those employing gillnets and trawls, was the leading cause for the decline and remains the primary hindrance to recovery. As part of the ESA listing, the National Marine Fisheries Service published a Smalltooth Sawfish Recovery Plan in 2009. The top action item listed in the recovery plan (NMFS 2009) is to "prevent or reduce mortality of the species in fisheries to ensure their long-term viability." Our research directly responds to this and 11 other recovery plan Action Items.



Our specific research objectives are to:
A) Determine specific habitats and area of high site fidelity that may meet the criteria for Critical Habitat listing for adult smalltooth sawfish
B) Determine spatial and temporal overlap between adult smalltooth sawfish habitat and commercial trawl, gillnet and longline fisheries that may lead to elevated bycatch mortality.
C) Determine the long-term residency and migration patterns of adult U.S. smalltooth sawfish.
D) Determine the reproductive status and cycle for U.S. smalltooth sawfish and determine if specific mating aggregation sites exist.
E) Monitor whether that smalltooth sawfish population in the U.S. is stable, increasing, or decreasing.

We also maintain a very active outreach and education component of this project to bring conservation awareness to the public. We present our results to public schools, educational camps (e.g. SeaCamp), university clubs and classes, and public seminar seminars. Our work is featured in local to national scale newspaper and magazine articles and has been the focus of multiple nationally televised documentaries.

17-NGI3-28: Predicting the impact of anthropogenic climate change on physical and biogeochemical processes in the Northern Gulf of Mexico and **18-NGI3-43**: High-Resolution Modeling of the Ocean Acidification in the East and Gulf Coasts of the U.S.
PI(s): Frank Hernandez, Sang-Ki Lee (UM/CIMAS), Yanyun Liu (UM/CIMAS), Fabian Gomez

Project Description: To examine seasonal and interannual patterns in plankton biomass across the Gulf of Mexico (GoM) (*Project 17-NGI3-28*), we configured a 13-component biogeochemical model, which included nitrate, ammonium, nanophytoplankton, diatom, chlorophyll from nanophytoplankton and diatom, microzooplankton, mesozooplankton, small and large detritus, dissolved organic nitrogen, opal, and silicate. The model was forced with historical surface fluxes of momentum, heat, and freshwater from the European Center for Medium Range Weather Forecast reanalysis product (ERA-Interim), as well as 54 river sources of freshwater, and nutrients. Model outputs were validated against observations derived from research cruises, coastal buoys, and ship of opportunity. The resulting model was then modified (*Project 18-NGI3-43*) to include an additional carbon module that simulated dissolved inorganic carbon and total alkalinity. Using the original model, we were able to explicitly represent small- and large-size plankton components, and (for the first time in the region) simulate the role of silica as limiting nutrient of diatom growth (Gomez et al. 2018). Model results indicated that: 1) diatom growth is silica-limited in the deep GoM during winter, and near the Mississippi delta during spring; 2) zooplankton grazing plays a key role modulating phytoplankton biomass seasonality; and 3) dominant physical processes influencing the local rate of change of phytoplankton are horizontal advection in the northern shelf and vertical mixing in the deep GoM. This work highlighted the need for an integrated analysis of biologically and physically driven biomass fluxes to better understand phytoplankton biomass phenologies. In a second model experiment, we used the model along with satellite and in situ observations to examine the impact of El Niño-Southern Oscillation (ENSO) on the northern GoM ecosystem (Gomez et al. 2019). We found that ENSO is a main driver of the interannual variability in salinity and plankton biomass during winter and spring. Composite analysis of salinity and plankton biomass anomalies showed a strong asymmetry between El Niño and La Niña impacts, with much larger amplitude and broader areas affected during El Niño conditions. ENSO disturbances in the cross-shore salinity gradient drive the alongshore-current anomaly in the Louisiana-Texas shelf during winter, closely following the thermal wind equation. ENSO-induce wind disturbances reinforce the alongshore-current anomalies during winter. During El Niño springs, the wind influence on alongshore circulation anomalies is more important, and the alongshore-current anomalies deviate from the thermal wind approximation. The coastal circulation disturbances determine to a large degree the distribution of the ENSO-induced plankton biomass anomalies. Overall, ENSO-induced changes in salinity, plankton biomass, and coastal circulation across the northern GoM are closely interlinked and can potentially impact the abundance and distribution of upper trophic levels. Using the expanded model with the carbon module, we described surface inorganic carbon system variables and sea–air CO_2 fluxes in coastal and ocean domains of the GoM (Gomez et al. 2020). Model results indicated that seasonal changes in surface pCO_2 are strongly controlled by temperature across most of the GoM, except in the vicinity of the Mississippi–Atchafalaya river system delta, where runoff largely controls changes in dissolved inorganic carbon and total alkalinity. Further, our model results also show that seasonal patterns of surface aragonite saturation state are driven by seasonal changes in dissolved inorganic carbon and total alkalinity, and reinforced by the seasonal changes in temperature. Simulated sea–air CO_2 fluxes were consistent with previous observation-based estimates that show CO_2 uptake during winter–spring and CO_2 outgassing during summer–fall. This model provides an important tool to address questions related to ocean acidification and other processes that may impact the Gulf of Mexico and its natural resources. This research is being done in collaboration with John Lamkin (NOAA/SEFSC).

19-NGI3-86: Continuation of Secure Archival Storage for NOAA/NMFS Preserved Specimens at USM's Plankton Archival Facilities
PI: Frank Hernandez

Project Description: The National Marine Fisheries Service (NMFS) Pascagoula Labs of the Southeast Marine Fisheries Science Center routinely collects approximately 5,000 plankton and other biological samples per year. These samples are fixed and preserved in chemical solutions that are either flammable (ethanol above 70% v/v) or carcinogenic (formalin in seawater) and, therefore must be stored in suitable enclosures for risk reduction to human health and safety. The John C. Stennis Space Center in Hancock County, MS owns 30 earthen-covered units that were originally built as ammunition storage bunkers for the US Army. These 'bunkers' have been transferred to NASA, who, in turn, leases individual units to tenants with needs where their design is critical. In 2012, the University of Southern Mississippi took possession of two of the bunkers for the purpose of long-term storage of approximately 10,000 zooplankton samples stored in both ethanol and formalin. Additional space in these units was made available to NMFS-Pascagoula, and approximately 20,000 additional samples were located to the unit. The combination of earthen for temperature regulation and explosion-proof electrical fixtures made the bunkers ideal for storage of hazardous preservatives. The bunkers required minimal modification as steel shelving was donated by NASA and USM purchased safety equipment for the initial bunkers. NOAA's NMFS is responsible for collecting, analyzing, archiving and maintaining biological samples for fisheries independent surveys. In particular, samples from the plankton surveys of the Southeast Area Monitoring and Assessment Program (SEAMAP) are used to provide fisheries-independent data for stock assessments (Red Snapper, King Mackerel, Gray Triggerfish, Bluefin Tuna) and provide a long-term archive of samples to examine ecosystem-wide changes in Gulf of Mexico productivity related to human perturbations (e.g., Deepwater Horizon oil spill) and climate change.

19-NGI3-73: Recent Declines in Coastal Migratory Pelagic Species Along the US Gulf and South Atlantic Bight and Potential Impact of Large-scale Ocean
PI(s): Frank Hernandez and Sang-Ki Lee (UM/CIMAS)

Project Description*: According to standardized fishery surveys, many target species in the Gulf of Mexico (GoM) and South Atlantic Bight (SAB) are declining in abundance, suggesting a potential shift in system-wide productivity. In particular, several species within the coastal pelagic suite (e.g., king mackerel, Spanish mackerel and Cobia) show declines in recruitment in the late 2000s. Concurrently, the upper ocean temperatures in the SAB and GoM have increased greatly during the recent years, largely due to the increasing westerly and trade wind system in the North Atlantic and the associated upper ocean heat accumulation in the subtropical North Atlantic. In this study, we will explore a hypothesis is that the anomalous accumulation of the upper ocean heat in the SAB and GoM suppressed the coastal upwelling and biological productivity along the GoM and SAB, and thus caused the scarcity of the food sources for the coastal pelagic species. To test this working hypothesis, we plan to analyze available fisheries data (landings data, survey data and fishery-dependent data), available ocean observations, a high-resolution ocean reanalysis product and a suite of ocean-biogeochemical model outputs available from AOML. This research is being done in collaboration with Mandy Karnauskas (NOAA/SEFSC).

*though funded, this project start has been delayed while recruiting a postdoc

19-NGI3-93: Underwater Glider Operations and Science in the Gulf of Mexico: A Public-Private Partnership
PI: Stephan D. Howden

Project Description: The University of Southern Mississippi (USM) has been developing a center of expertise in Unmanned Marine Systems (UMS) in the northern Gulf of Mexico whose goals include increasing the US capacity in UMS through Certificate programs. USM has delivered its 3rd consecutive springtime 5-week undergraduate UMS Certificate, so-called Tier 1, program, that provides the student a foundational knowledge of UMS platforms & sensors, operations, and maintenance (O&M). This project is developing a next-level UMS Operator Certificate (so-called Tier 2) program focused on underwater gliders, but where appropriate glider topics are generalized to other UMS platforms. This 12-credit undergraduate program will be focused on educating people in all facets of glider operations so that the certificate holder could, for example, run a small glider group for a PI, or be a glider technician in a large glider operational group. The training will include the knowledge and technical skills required to pilot gliders and to maintain and manage glider inventory and supplies, and the environmental awareness needed to plan and ensure that missions can be completed.

The Tier 2 glider Certificate program is being designed as part of 4 academic courses: MAR 435 Operating Instrumentation in Marine Environments II; MAR 436 Unmanned Maritime Systems: Vehicle Planning; MAR 438 Unmanned Maritimes Systems: Vehicle Management; and MAR 440 Unmanned Vehicle Field Project. Like the Tier 1 UMS program, these Tier 2 courses can be offered over a 5-week mini-semester, or over a regular semester. The instructional materials for MAR 435, MAR 436 and MAR 438 are being developed through a public-private partnership with Perspecta, which has developed software and training for glider operations of the Naval Oceanographic Office. MAR 440 is being developed by USM/SOSE faculty and staff involved with the Tier 1 program. Representatives from NOAA IOOS, Naval Meteorology and Oceanography Command, and Naval Oceanographic Office have participated in the bi-weekly USM-Perspecta team curriculum development meetings.

USM owns 2 Slocum G1 gliders that although are ready for operations are two generations behind the latest gliders from Teledyne/Webb and are no longer supported. USM has been able to work with its partners to use newer glider models for Tier 1 training, but the project included funding for a new glider that can help support the program.

Progress to date: Course descriptions for each of the 4 new courses have been developed, submitted and approved through the Curriculum Committee of the USM School of Ocean Science and Engineering (SOSE), the College of Arts and Sciences Curriculum Committee, the University Academic Council Executive Committee and the University Academic Council. The next step is approval by the Provost. We are on track to offer the program in the second half of the Fall of 2020 semester. Detailed outlines and syllabi for each course have been developed, and lecture materials and exercises are being developed to those outlines for all but MAR 440 by Perspecta. As of the time of this report the completion of curricula material is 47% for MAR 435, 34% for MAR 436 and 4% for MAR438.

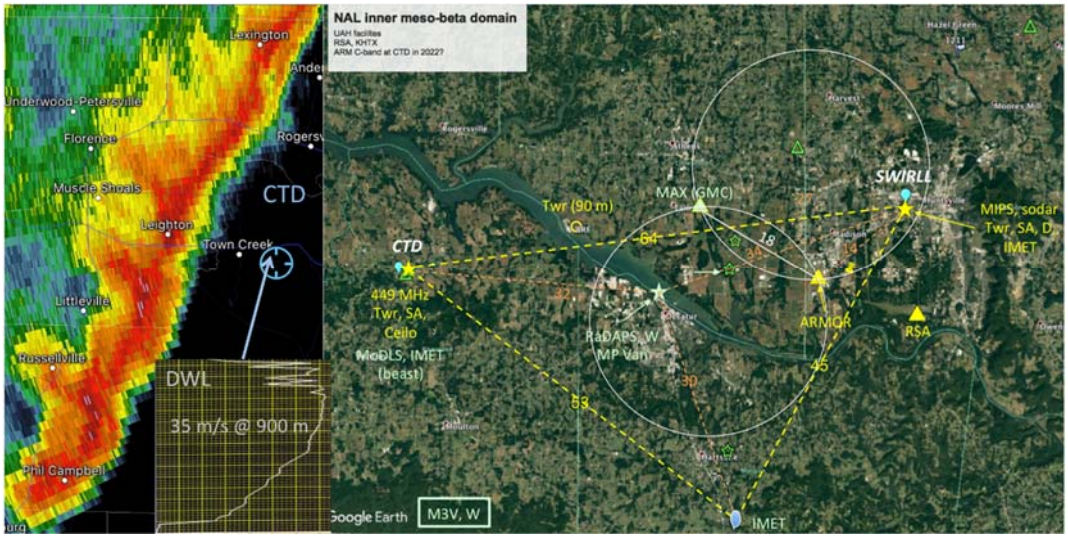
Max Woolsey, an engineer of unmanned maritime systems at the USM SOSE, has been selected as the lead instructor. He holds an MS in Electrical Engineering from the University of Mississippi, is a PhD candidate in Mechanical Engineering at Santa Clara University, and has extensive experience in offshore marine operations and unmanned systems.

A bidding process was opened by USM for a 1000 m buoyancy glider. Kongsberg (now Hydroid) was the low bidder meeting the specifications for a SeaGlider. A purchase order was let and delivery of the SeaGlider to USM in scheduled for June 2020.

18-NGI3-40: *VORTEX-SE 2019 Field Campaign Activities: Mesoscale variability of CAPE, shear, and PBL characteristics*; **18-NGI3-59:** Evaluation and Improvements of Tornado Detection using Infrasound Remote Sensing: Comparative Analysis of Infrasound, Radar, Profiler, and Meteorological Data Sets, and Potential Impacts on NOAA/NWS Operations; and **19-NGI3-88:** VORTEX-SE 2020 Field Campaign Activities: Observations of the Environment and Evolution of Non-Classical Tornadic Storms
PI: Kevin Knupp

Project Description: These grants supported field campaign activities during the 2018-2019 and 2019-2020 severe weather seasons (Nov-Apr). The first year of this two-year sequence involved participation in the NOAA Meso18-19 field campaign, in which UAH established a small meso-β scale domain over northwestern Alabama and extreme northeastern Mississippi, nested within the much larger Meso18-19 domain that covered much of the Southeast. Standout Intensive Operational Periods (IOPs) included 3 March and 17 April. Although the 3 March case was outside of the UAH domain, a supercell storm produced a long-track EF-4 tornado that passed close to the Maxwell AFB WSR-88D radar. Likewise, another violent EF3 tornado passed within 2 km of the Columbus AFB WSR-88D radar on 17 April 2019, producing devastating damage to primarily forested regions.

The 2019-2020 season was the most active over the domain since VORTEX-SE (VSE) operations started in Spring 2016. The network for this season also covered NW Alabama, including a NOAA 449 MHz radar wind profiler (RWP) at the Courtland Airport (CTD). UAH profiling systems were also deployed at CTD to complement the NOAA RWP on 11 Jan; 5 and 12 Feb; 3, 24 and 28 March; and 8 Apr (and likely on 12 Apr) 2020. The figure below shows a Quasi-Linear Convective System (QLCS), whose pre-storm environment was comprehensively sampled on 12 February 2020 by profiling instruments at CTD, and later by profilers at the SWIRLL site. The inset in the lower left shows the wind profile at the locations shown. This case illustrates a common type (i.e., QLCS) of Non-Classical Tornadic Storm (NCTS), which, along with the boundary layer ahead of the QLCS, is the research focus of this project.



Network configuration for IOP4 on 12 Feb 2020. The radar image (left) shows an approaching QLCS that moved over the CTD profiling site. The real-time DWL wind speed profile, shown in the lower left (speed varies from 0 to 35 m/s and height from 0 to 1500 m AGL), typifies high shear common to these cases.

18-NGI3-40*: VORTEX-SE 2019 Field Campaign Activities: Mesoscale variability of CAPE, shear, and PBL characteristics*; **18-NGI3-59**: Evaluation and Improvements of Tornado Detection using Infrasound Remote Sensing: Comparative Analysis of Infrasound, Radar, Profiler, and Meteorological Data Sets; and **19-NGI3-88**: VORTEX-SE 2020 Field Campaign Activities: Observations of the Environment and Evolution of Non-Classical Tornadic Storms
PI: Kevin Knupp

Project Description: The following projects are related to the general theme of *Non-Classical Tornadic Storms* (NCTS) and their pre-storm boundary layer. These research activities are utilizing data from radar and profiling platforms at the SWIRLL location on the UAH campus, and the remote Courtland Airport (CTD) site 64 km WSW of the SWIRLL site. Profiler systems at CTD include the NOAA 449 MHz wind profiler with RASS, 10-m tower, sonic anemometer, and Doppler wind lidar for every IOP except one; and balloon soundings for many of the IOPs. Profiler systems at SWIRLL include a 915 MHz radar wind profiler, microwave profiling radiometer, ceilometer, X-band profiling radar, Doppler sodar, and 10-m tower. The ARMOR radar has been operational for all IOPS, and the MAX radar for some.

Characteristics of Quasi-Linear Convective Systems (QLCS). This research is examining the role of horizontal shearing instability in the formation of mesovortices (the parent circulation of tornadoes) within QLCSs (Conrad and Knupp 2019). Planned research during the next 6 months will investigate the properties of mesovortices (shear, depth, frequency of occurrence) within QLCSs using data from the ARMOR and MAX radars, and the WSR-88D radars at Columbus AFB (KGWX) and Hytop (KHTX).

Boundary Layer (BL) properties and processes ahead of QLCSs include analysis of the characteristics of stratocumulus (Sc) clouds (prominent in most cold season events) such as cloud base height, cloud fraction, cloud thickness, and static stability within the subcloud layer. A recently started study utilizing soundings from balloons and ground-based remote sensing is documenting thermodynamic profiles ahead of QLCS and supercell storms. This component will be closely coupled with the Sc cloud work. Two other BL foci include rapid temporal changes associated with the Afternoon to Evening and Rain-Induced Transitions (AET and RIT). Both processes involve low level stabilization via cooling (change in net radiation or evaporation), which reduces turbulent momentum fluxes, and hence increases low-level wind shear. Comprehensive data sets documenting the AET for both clear and cloudy conditions have been recently acquired at the CTD and SWIRLL profiling sites. The RIT involves cooling at much smaller horizontal scales that can be documented with citizen weather stations. An undergraduate student is examining methods to evaluate the quality of CWS data within or near the research domain for various meteorological conditions expected during severe weather scenarios. This work will also utilize higher-quality data from an AL mesonet project initiative spearheaded by Baron Critical Weather Institute.

The relationship between infrasound (IS) and tornadoes has benefited from a close collaboration between UAH and the University of Mississippi National Center for Physical Acoustics (NCPA). Analysis of a comprehensive case study (19 March 2018) of a long-tracked EF2 tornado will correlate IS data (NCPA) with dual Doppler analyses of flows within the parent supercell storm (UAH).

Tornado and tornado damage characteristics. Analysis of WSR-88D data and a detailed damage survey obtained from aircraft imagery is revealing some interesting patterns from a violent (EF3+), large (2 km path width) tornado that formed and moved very close to the KGWX WSR-88D radar on 4/17/19. Measurements correlating tree damage and Doppler velocity measurements are needed over forested areas; they will be beneficial to the small community of tree damage experts and EF scale committee members who are refining techniques to evaluate EF-scale intensity from tree damage patterns.

19-NGI3-69: AOML-NGI South Florida Water Quality Data Analysis
PI(s): Steve Ashby and Anna Linhoss

Project Description: NOAA/AOML and Florida partners have been coordinating water quality sampling in South Florida and Biscayne Bay for more than 20 years. Preliminary analysis shows warning signs of eutrophication (Boyer et al., 2009; Meeder and Boyer 2001), which is especially concerning because the benthic habitats in south Florida (coral reefs, seagrass, and hard-bottom) depend on oligotrophic conditions. Based in large part on warning signs of eutrophication, NOAA recently designated Biscayne Bay as one of ten Habitat Focus Areas (HFA) across the country. The first goal in the Biscayne Bay HFA plan is to "by 2020, understand major sources of nutrients that contribute significantly to phytoplankton and algal blooms in Biscayne Bay and work with resource managers to enhance policies and management approaches for improving water quality." This work is particularly timely as Miami-Dade County approved a fertilizer ordinance in March 2020 to reduce the nutrient load entering Biscayne Bay.

The aims of the AOML-NGI South Florida Water Quality Data Analysis are to 1) analyze existing data to determine long-term trends in water quality and 2) develop, calibrate, and validate a water quality model for Biscayne Bay. Since the project inception (October 2016), our project team has finalized the analysis of long-term water quality trends and has developed a watershed model for a representative portion of Biscayne Bay.

Our analysis of long-term water quality data in Biscayne Bay showed that chlorophyll *a* and phosphate concentrations have increased throughout Biscayne Bay, which is a primary indicator of eutrophication (Millette et al., 2019). Moreover, chlorophyll *a* concentrations in the northern Bay, where circulation is restricted, and in the nearshore Bay are increasing at a higher rate than the rest of the Bay. This suggests that increases in chlorophyll *a* are due to local nutrient sources from the watershed. These northern and nearshore Bay areas are also where recent seagrass die-offs have occurred, suggesting an urgent need for management intervention. This is in contrast with the state of Florida listing of Biscayne Bay as a medium priority impaired body of water.

We also conducted an analysis of a picophytoplankton bloom (2005-2008) to determine if there were any long-term impacts on the system (Millette et al., 2018). The bloom coincided with a massive mortality of sponges and caused massive mortality of the seagrass. We used long-term water quality data collected to compare environmental conditions before (1995–2004) and after (2009–2014) the bloom. We found that after the bloom, baseline chlorophyll *a* concentration significantly increased 45%, at the stations most impacted by the bloom. Before-After Control-Impact analysis suggested these changes were directly related to the bloom. Since the bloom ended, the system has not returned to its original status, suggesting a lasting impact from the bloom on the ecosystem.

Based on these reports, we have developed a watershed/water quality model of the Coral Gables waterway. The Coral Gables waterway was chosen as a representative, test watershed for Biscayne Bay because its citizens and city government are actively dedicated to improving water quality. We are currently collecting field data of water flow and quality to calibrate and validate the model. This model is specifically designed to represent how management actions impact water quality. We are also writing a review paper of watershed modeling in coastal systems to evaluate modeling best practices. Our next step will be to develop a hydrodynamic water quality model that will link flow from the watershed to Biscayne Bay to understand how local management decisions will impact Biscayne Bay as a whole.

Title: Transition of Machine-Learning Based Rapid Intensification Forecasts to Operations
PI: Andrew Mercer

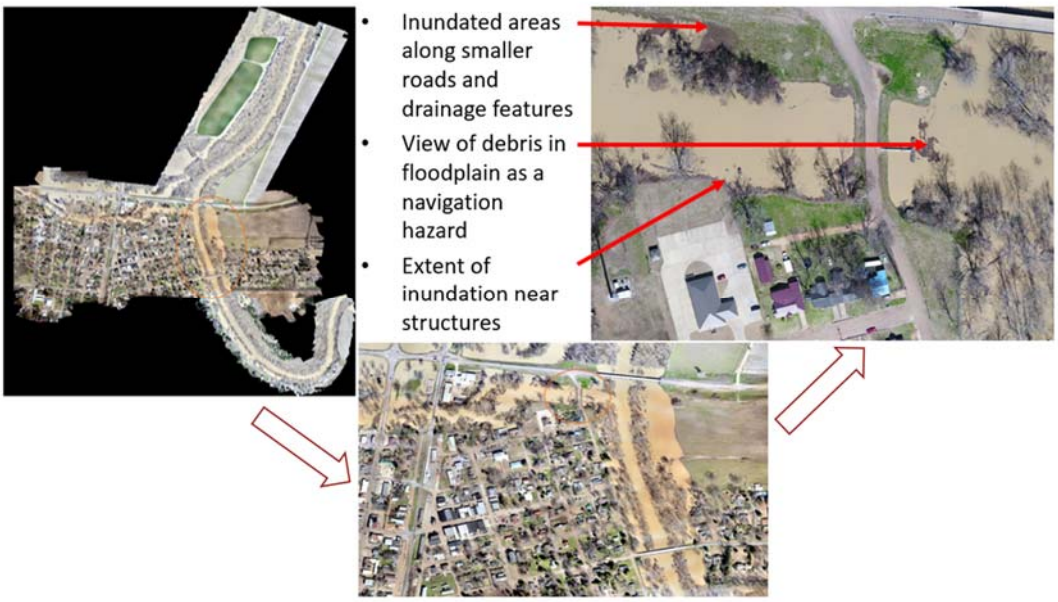
Project Description: Atlantic Basin tropical cyclones, particularly major hurricanes, are a consistent threat to Northern Gulf resources and infrastructure. Rapid intensification (RI), defined as a 30 knot increase in peak wind speed in 24 hours, remains a poorly forecasted quantity in tropical cyclone forecasts, yet is critical as all major hurricanes undergo RI at least once in their life cycle. Forecast skill values remain only about 15% better than climatology, which we attributed to the linear statistical methods employed to make forecasts as well as limitations in the predictor sets used in operational RI forecasting. As such, the purpose of this project was to build a machine-learning based RI forecast scheme for testing in the Joint Hurricane Testbed experiments at the National Hurricane Center. The scheme utilized a novel unsupervised learning technique that employed GFS analyses to identify features that are most helpful in discriminating RI and non-RI environments. These predictors were identified among varying domain sizes to emphasize outer band structures versus inner-core structures, and the optimal discriminating fields were retained and added to the existing SHIPS-RII predictors (which are currently used operationally to make RI forecasts) to develop a new classification predictor set. A fully cross-validated support vector machine (SVM) classifier was built from these predictors to predict Atlantic RI on 3605 tropical cyclone timesteps. Results from the training phase showed skill improvements of up to 18% better than climatology (roughly a 20% improvement over the performance baseline seen in the SHIPS-RII). Afterwards the classifier was tested directly on 2017-2019 Atlantic Hurricane season cases to identify its performance in true forecast mode. Testing remains ongoing through the 2019 hurricane season, and the model will be included again in the 2020 Joint Hurricane Testbed for further evaluation. The work presented in this study is a first effort at implementing machine learning methods for an operational RI forecast task.

19-NGI3-77: Enhanced Seasonal Landfalling Hurricane Outlook
PI: Andrew Mercer

It is expected that improved seasonal outlooks for landfalling Atlantic tropical cyclone activity will allow Northern Gulf entities to prepare resources for the eventual impacts of such events. However, to date most seasonal outlook systems have utilized statistical methods to predict such impacts. This newly funded study will address this problem by utilizing Atlantic Warm Pool (AWP) modulation to predict changes in the frequency of landfalling Atlantic Hurricanes. The primary research goal of the project is to advance our understanding of the physical mechanisms that control the influence of the AWP on tropical cyclone steering flow (and resulting landfall). This work will be done by utilizing the National Multi-Model Ensemble Phase-2 retrospective forecast data to first quantify the seasonal predictability of the AWP and its associated modulation on the steering flow. First, we will analyze climate model simulations for the AWP modulation at lead times of up to 6 months before the beginning of the Atlantic Hurricane Season. Next, we will develop a simple generalized beta advection model that will quantify the propagation associated with the AWP modulations assessed in the first phase. Finally, a seasonal outlook for landfalling Atlantic Hurricanes that is based on these modeled frameworks will be developed with the hope of improving seasonal outlooks for landfalling tropical cyclones.

19-NGI3-84: Sensing Hazards with Operational Unmanned Technology for the River Forecasting Centers (SHOUT4Rivers), phase 2
PI(s): Robert Moorhead and Jamie Dyer

Project Description: Unmanned aerial systems (UASs) have been shown to be cost-effective and efficient data collection platforms for many NOAA research endeavors. To seek to determine the optimal observing and processing systems for the NOAA/NWS's River Forecast Centers (RFCs), requirements were collected at two workshops (Feb 2012 and September 2014). This three-year project addresses three of the five highest priorities (rapid response, detection of changes, and model verification). The research is a field experiment: develop a rapid response UAS team to collect data for high impact weather events (e.g., floods) to determine the cost and feasibility of UAS exploitation, as well as the data impact. The interaction has included OWP, LMRFC, and WGRFC. We first exploited hand-launched UAVs, later moving to 180# UAVs, and are now moving to even larger UAVs. Exploiting the larger UAVs created a better match to the RFC's coverage and resolution requirements. Multiple times in 2019 we imaged about 50 mi^2/hour at 6-inch GSD for 5 hours per day with the 180# aircraft and should be able to collect at the same resolution and hourly rate for 12 hours/day with the larger aircraft. The NGI team collects and transmits georeferenced imagery in almost real-time. Mosaics are produced in the days following the flights for situational documentation and algorithm verification. The research has led to a better understanding of water storage and flow patterns under moderate and major flood conditions at several locations. Visible (RGB) imagery is used to highlight general land use/cover, whereas the NIR and Red bands allow us to create a land/water mask easily.



The data, having higher spatial resolution and accuracy than satellite data, allow hydrologists to assess current conditions of river channels and surface runoff (inundation, floodplain storage, active routing channels, etc.). They can assimilate this information into hydrologic models to improve analysis fields and short-term forecasts, as well as to verify or calibrate hydrologic models to improve microscale water level prediction. The data allow definition of areas with complex hydrologic and/or hydraulic processes (impact on built structures, navigation channels, roadways, etc.) to highlight at-risk areas. The higher resolution allows improved channel representations, which improves surface runoff estimates and channel routing. Change in stream density influences runoff rate, while storage impacts stage-discharge relationship pre- and post-flood. The value of this research has been promulgated in NOAA Research News.

18-NGI3-41: Modeling Climate Impacts on Fish Larvae Mortality in the Gulf of Mexico and **18-NGI3-52**: Development of Environmentally-Driven Larval Mortality and Age-0 Abundance Indices for a Suite of Coastal Pelagic Species in the Gulf of Mexico
PI(s): Steven Morey, Mike Stukel, Taylor Shropshire, and Eric Chassignet

Project Description:

Abundance indices for economically important pelagic and coastal-pelagic fishes in the Gulf of Mexico (GoM) suffer from a number of deficiencies due to the variety of target methods and low occurrence rates. Consequently, management reference points from these stock assessments are associated with a high degree of uncertainty. Recent stock assessments have recommended that abundance indices of age-0 fish would provide a better signal of the incoming year class strength to inform assessment models and better resolve the stock recruitment relationship. Given the difficulties in developing age-0 indices from surveys, the goal of this research is to develop a simulation approach using a bio-physical modeling framework to understanding the environmental drivers of age-0 abundance. The impacts of this work will facilitate better estimates of recruitment for important GoM fisheries that can also form the basis for applications in other management regions, and an improved understanding of the marine ecosystem and fishery response to climate variability and change.

A coupled physical-biogeochemical model of the GoM has been developed during these related projects to simulate the prey concentration for fish larvae of coastal-pelagic and pelagic species including bluefin tuna. The model uses hydrodynamic data from a HYCOM 20-year reanalysis to force a biogeochemical model in an "offline" fashion within the MITgcm framework. The biogeochemical model is based on the NEMURO model, adapted for the GoM (NEMURO-GoM). NEMURO-GoM has been extensively validated against satellite and *in situ* observations, including model-data comparisons of mesozooplankton biomass with the multi-decadal SEAMAP surveys. NEMURO-GoM is used to investigate the spatiotemporal variability in diet and secondary production of the mesozooplankton community, which serves as an important prey source for larval fish.

To complete the coupled bio-physical modeling system, and an individual-based model (IBM) has been incorporated into NEMURO-GoM to simulate the transport of fish larvae throughout the GoM. As the simulated larvae encounter different environmental conditions, including prey concentration, starvation is computed based on ingestion and metabolic requirements. Mortality due to predation is also estimated based on parameterizations from the biogeochemical model. The result of this coupled modeling approach is an improved estimate of the larval mortality and thus age-0 abundance. This modeling approach is applied to evaluate the interannual variability in larval mortality, as well to estimate changes in abundance under future climate scenarios.

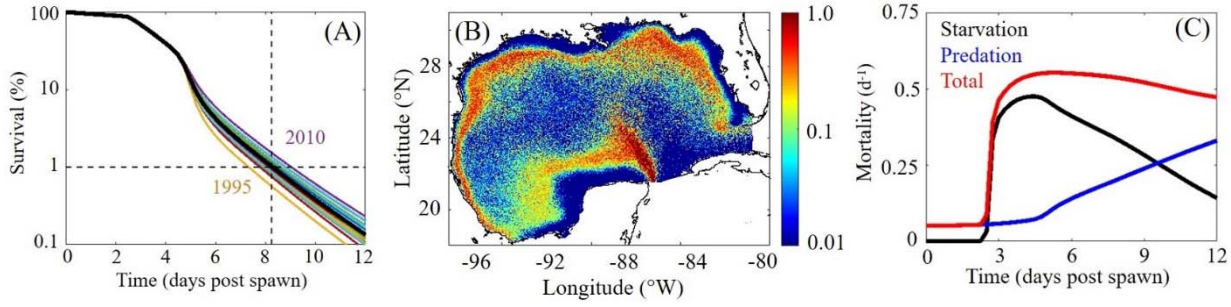


Figure (A-C): Temporal variability in survival from egg to postflexion of larval tuna for each spawning period over the 20 years simulation (A). Spatial variability in survival based on where simulated eggs were initialized (B). Estimates of starvation and predation based mortality as a function of age (C).

16-NG13-03: National Weather Service Social Science Curriculum Delivery FY17
PI: Laura Myers, Director and Sr. Res Sci, Center for Advanced Public Safety, The University of Alabama

A pilot series of courses was developed for a training program in social science applications for meteorologists and meteorology professionals. Students learned how to interpret social science research, as well as conduct basic social science research in their field discipline. The courses were designed to provide students with an applied social science research overview, developed through each course of the program, culminating in a presentation and prospectus with policy recommendations from their research. The first course of the pilot was delivered in person. Courses two through four were delivered online with participants. The final course was delivered in person. Dr. Myers has continued to support next phases of work with students, several of which have been represented at national conferences and published in professional journals.

19-NG13-74: Social Science Applications for Coastal Resiliency (SSACR)
PI: Laura Myers, Director and Sr. Res Sci, Center for Advanced Public Safety, The University of Alabama

The Social Science Applications for Coastal Resiliency (SSACR) curriculum has been developed and will be presented to expose weather, water, environmental, and emergency management professionals to collaborative social science research. Students will learn about the structure and methodologies of applied social science research that complements the needs of the weather and water enterprises to incorporate human factors analysis. Participants will learn about the relevant social science disciplines for weather and water (including oceanic, fisheries, availability, quality, and vulnerability) research and how each discipline can be used to incorporate human factors analysis into research studies. Applied examples will cover the topic areas of the societal understanding of water, heavy downpour events to include mudslides and debris flows, droughts, and water quality. Learners will be able to conceptualize and evaluate social science studies and also collaborate with social scientists in the research process.

17-NG13-19: NOAA Weather Information and Dissemination All Hazards Needs Assessment Verification Project
PI: Laura Myers, Director and Sr. Res Sci, Center for Advanced Public Safety, The University of Alabama

A stakeholder analysis of warning dissemination partners included an analysis of actual warning modes and case studies of warning dissemination knowledge management. The results of these analyses were synthesized to determine the nature of the warning dissemination process and the role of warning modes in dissemination. The results highlighted variations in location context, weather vulnerabilities, current communication networks as primary needs of the public and the weather alert enterprise in warning dissemination. Multimodal telecommunication considerations in emergency and disaster management situations include voice, data, imagery and videos. Affected populations require advance knowledge from multiple sources and at least one capability that guarantees transmission under severely non-optimal conditions. The NOAA Weather Radio All Hazards (NWR) broadcast remains the most viable alert mode for the public and commercial enterprises; especially in rural, marine and coastal areas. There is no direct replacement for the NWR broadcast due to limited or no other coverage by alternative modes; including the most prolific mode, the cellular telephone. Mobile applications for cellular telephones have made a big impact on both younger and more established generations by offering different user-friendly notification capabilities.

Title: Gulf of Mexico Research Initiative Support Project
PI(s): Jay Ritchie and Maggie Dannreuther

Project Description: The Northern Gulf Institute (NGI) was a founding member of the Gulf of Mexico Research Initiative (GoMRI), providing research and program administration support, information system development, web content development and web design, and education and outreach support.

GoMRI, a BP commitment of $500 million over 10 years, funds an independent academic research program designed to study the impacts of the oil, dispersed oil, and dispersant on the ecosystems of the Gulf of Mexico and affected States in the context of improving fundamental understanding of the dynamics of such events and their environmental stresses and public health implications. GoMRI will also develop improved spill mitigation, oil and gas detection, characterization and remediation technologies. The ultimate goal of GoMRI is to improve society's ability to understand, respond to and mitigate the impacts of petroleum pollution and related stressors of the marine and coastal ecosystems, with an emphasis on conditions found in the Gulf of Mexico. Knowledge accrued will be applied to restoration and to improving the long-term environmental health of the Gulf of Mexico.

Research/Program Admin **-** NGI is an integral part of the program administration of GoMRI. Oversight and compliance activities, include project quarterly report monitoring and data collection; tracking publications, presentations, participants, and students, documenting attribution and data compliance, and tracking of all peer-reviewed publications. The team provides assistance in the support of GoMRI Annual Meeting, other meetings and presentations and participates as administrative unit (AU) representative at Consortium All-Hands Meetings. The team developed and directs the GoMRI Scholars program (323 scholars) including the bi-annual nominations processes and tracking of graduate students. The team developed and produces the GoMRI Research Board Newsletter and helps coordinate with AU/grants unit (GU) on contractual reporting to BP.

InfoSystem Development –NGI developed the GoMRI Research Information System (RIS) to capture project information and is currently tracking 269 projects, 4,315 people, 1,366 journal articles, 5 books, 103 book chapters, and 5,143 conference presentations reported during the GoMRI program. The RIS provides administrative record-keeping for key metrics of the program and feeds the data-driven research website that provides a public interface to the GoMRI activities.

Web Content/Design –NGI developed the GoMRI Research page (27K pageviews, 6K users during past year) to provide access to information on GoMRI-funded projects (e.g., research information, geographic scope, scientists), provide program information, highlight activities, and provide news and event information. The team is also responsible for creating web content (620 stories written) for the GoMRI web page (90K pageviews, 43K users during past year) providing publication highlights, project overviews, research reviews, GoMRI scholar highlights, and announcements. The team also developed the GoMRI Education page (5K pageviews, 2K users during past year) to highlight GoMRI Education and Outreach activities and archive educational products developed by GoMRI projects. Additionally, the team provides an administrative dashboard for internal use with program metrics and compliance tracking.

Education and Outreach – NGI is the Communications Team lead, provides outreach liaison and support for GoMRI and for GoMRI-funded projects, and manages the GoMRI Education page. This role includes the production of bi-weekly GoMRI eNews Newsletter (135 issues) highlighting GoMRI web content, publications, and program and consortia activities.

Title: Improving Accessibility and Comprehension of Tornado Warnings in the Southeast for the Dead, Blind, and Deaf-Blind and **Title**: Geospatial Threat Personalization and its Influence on Warning Risk Perception and Protective Actions
PI: Kathleen Sherman-Morris

Project Description: The main goal of the first project is to improve the communication of tornado warning information to historically vulnerable populations. Mississippi State focused on the population of people who are blind. To meet this goal, we conducted two rounds of interviews.

The most significant outcome from the first round of interviews was that this population would like a greater level of geographic description in the communication of tornado warnings. This is relevant not just for people who are blind, but also for those driving in cars or similar situations where vision is limited. The most important types of information were neighborhood specific (as defined by the participant) details and trajectory information (where will the tornado be when).

The lack of audio for television warning crawls posed a barrier to some participants. Problems were reported with the crawl information not being read and for text information requiring too much time to cycle back to the beginning (e.g. NOAA weather radio warning information). While most participants were very able to respond to a warning, one constraint to action stood out. Six participants reported having no shelter or a lack of transportation to get to a shelter since they could not drive themselves.

Our participants appeared similar to the "general public" in how participants responded to tornado warnings. Most depended on phones as well as television. Similar to research with sighted individuals, many people interviewed would prefer to know when the tornado was expected to be in their neighborhood as opposed to receiving a warning for their whole county. Confirming the warning was important for most. Many did this through television with some having plans for personal phone calls.

Following up on the results from the first round of interviews, a second round presented participants with 4 warnings that varied the level of geographic description. Preliminary results suggest that more information in a warning may not always be better for everyone. Participants typically rated the lower detail warning and the higher detail warning the same. When ratings were different, the lower detail and higher detail warnings were each sometimes rated more helpful and perceived as worse. When the warning was personalized, the higher level of detail was rated more helpful by several participants. Some of the comments indicated additional geographic detail led to confusion. We plan to examine the data further to see if patterns might exist based on sight (some vs. no usable vision) or location.

The second project builds on the idea of geographic detail with a general population. Specifically, it seeks to answer three questions. 1)What are the geographic components that define a person's personalized risk area? 2) Does this personalized risk area differ based on personal characteristics or characteristics of the warnings? And 3) Where a person's concept of their personalized risk area is different from an objective map view, does either have a dominant influence on risk perception? This project will involve face to face interviews and an online survey. We have not yet begun the in-person interviews, which were planned for the first year. These have been delayed by the current COVID-19 crisis and we are currently examining the best way to keep the project moving forward.

19-NGI3-79: Geospatial analysis of deep-sea environments using ROV video data with the Coastal and Marine Ecological Classification Standard (CMECS)
PI: Adam Skarke

Project Description:
Motivation: NOAA NCEI maintains a vast repository of remotely operated vehicle (ROV) video data that is an oceanographic resource with immense value for the scientific community. However, for scientists not directly involved in the collection of those video data, the amount time and effort required to review tens to hundreds of hours of video in order to determine its potential value to their research is often prohibitive. Accordingly, the goal of this project is to develop open-source automated video data mapping tools, based upon the widely adopted CMECS classification standard, to enhance utilization of NCEI ROV video data. The resulting tools and the digital maps they generate will allow scientists, otherwise unfamiliar with NCEI ROV video holdings, to rapidly evaluate the abundance and spatial distribution of features of interest, and thus the applicability of NCEI video data to their research goals.

Project Summary: This project supports personnel to design an automated system for the digital mapping of seafloor substrate observed in video data acquired during dives of the ROV Deep Discoverer aboard NOAA Ship *Okeanos Explorer*. The primary objective of this project is the production of a series of open-source Python scripts, and associated standard operating procedure (SOP) documentation, that automate the generation of color-coded seafloor substrate maps (Fig. 1) and resultant GIS polygon files from ROV and shipboard data. The substrate classes will be categorized with Coastal and Marine Ecological Classification Standard (CMECS), which has been broadly adopted by NOAA. The source data used are scientific annotations created in Ocean Networks Canada's (ONC) SeaTube v2 software, by scientists participating in NOAA Ship Okeanos Explorer expeditions, as well as navigation data and environmental sensor observations from the NOAA ROV Deep Discoverer. Although *Okeanos Explorer* and Deep Discover substrate data are used to develop this approach, the resulting scripts are designed to be vehicle and vessel independent to the greatest degree possible. Additionally, the scripts are designed to be scalable to incorporate not just substrate observations, but any CMECS compliant feature class annotations (e.g. coral species). This project builds on approaches initially developed through a collaboration between the NOAA Office of Ocean Exploration and Research (OER), the National Centers for Environmental Information (NCEI), the Northern Gulf Institute at MSU (Ruby, 2017).

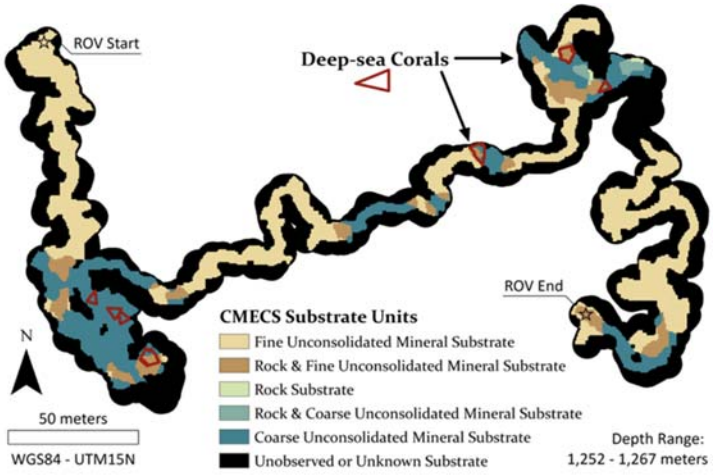


Figure 3 Example CMECS compliant seafloor substrate map (Etnoyer, 2018)

Project Status: Representative imagery of each CMECS substrate class from the project data set has been complied by NOAA collaborators P. Etnoyer and R. Bassett. An undergraduate researcher (Jacob Freemen) is working with the PI to prepare initial Python scripts for data extraction, parsing, CMECS conversion, and visualization. Jacob has been admitted to MSU and a graduate starting in the August 2020 and will base his master's thesis research on this project.

19-NGI3-68: U.S. Research Vessel Surface Meteorology Data Assembly Center (DAC)
PI(s): Shawn R. Smith and Mark A. Bourassa

Project Description: The central activity of the 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/). This initiative improves the quality of and access to surface marine weather (e.g., winds, air temperature, pressure, moisture, rainfall, and radiation) and near-surface ocean (e.g., sea temperature and salinity) data collected with ship-owned automated instrumentation on research vessels (RVs). Each RV recruited to SAMOS sends a daily email containing one-minute averaged weather and surface oceanographic observations to the DAC. Preliminary processing links the observations with vessel- and instrument-specific metadata (e.g., instrument height, type, units) and conducts automated quality control (QC) tests on all the observations. Preliminary data are available within five minutes of email receipt via the web https://samos.coaps.fsu.edu/html/data_availability.php. Scientific visual QC results in research-quality products that are available ten days after the original data collection date. SAMOS data are distributed free of charge and proprietary holds and archived at the National Centers for Environmental Information (NCEI)-Maryland on a monthly basis. Smith et al. (2018) provides full details on the SAMOS QC procedures and data and metadata distribution practices.

SAMOS data from FSU address the core mission of NOAA's Global Ocean Monitoring and Observing Program (https://globalocean.noaa.gov/) to "**provide and support high quality global ocean observations**". We focus on observations critical to understand variations in **sea surface temperature, salinity, surface currents** (via the winds)**, and air-sea exchanges of heat, momentum, and freshwater**. Specifically, the DAC provides high-quality data to research and operational users to identify, quantify, and model the physical and thermodynamic processes governing ocean-atmosphere interactions. Such processes are key to understanding of how marine weather systems evolve, how these systems impact the ocean, and how the oceans impact the weather. SAMOS data are used to evaluate satellite observations of winds, air and sea temperatures, humidity, and salinity that are in turn used by weather/ocean modeling centers to provide daily, weekly, and seasonal forecasts. Frequently, RV observations are made in remote, hard-to-observe ocean locations (e.g., Arctic and Southern Oceans) making them highly valuable to these user communities. The **societal benefits** of the SAMOS initiative include improved weather and climate models (via a better understanding of ocean-atmosphere interactions) and forecasts (via validated satellite measurements) that allow the public and private sector to make decisions affecting agricultural productivity, energy use, and daily life. Finally, data collection by RVs contributing to SAMOS represent a significant investment by the American taxpayer. Submission by the DAC of complete and well-documented SAMOS datasets to NCEI ensures these data are preserved for future generations of scientists, policy makers, and the public.

For the period 1 October 2016 – 1 April 2020, the DAC has received, quality processed, distributed, and archived 19,531 days of SAMOS observations, corresponding to over 26 million 1-minute data records, from 33 RVs. The PIs note that SAMOS data processing for 12 of these RVs is supported by NSF and one (the *Falkor*) by the Schmidt Ocean Institute. NOAA funding supports the remaining 20 RVs.

Project Reference: Smith, S. R., K. Briggs, M. A. Bourassa, J. Elya, and C. R. Paver, 2018: Shipboard automated meteorological and oceanographic system data archive: 2005–2017. *Geosci Data J.*, **5**, 73–86. https://doi.org/10.1002/gdj3.59

19-NGI3-78: Building NOAA Omics and Bioinformatics Capacity for Reproducible and Efficient Analysis of Environmental Samples
19-NGI3-71: Bioinformatics to Support Ecosystem Fisheries, and Blue Economy Omics Applications
17-NGI3-33: Bioinformatics to Aid Ecosystem Understanding, Research Transition, and Development of a Next-Gen Workforce
16-NGI3-13: Continuation of Comparative Metagenomics to Indicate Sites Under Anthropogenic Pressure: Year 2

PIs: Luke Thompson, Shiao Wang
Project Description: The theme of this work, supported by NGI over the past 3.5 years, is *Building NOAA's Omics and Bioinformatics Capacity*. NOAA has recognized the need for integrating genomics, transcriptomics, and other omics technologies to support its mission, but this vision requires increased capacity for sample processing and bioinformatics analysis, supported by an influx of workforce expertise, to implement that vision. This project began with the support by AOML's Ocean Chemistry and Ecosystems Division of Dr. Luke Thompson, an expert in environmental and microbial genomics. Since that time, Dr. Thompson has been the lead author on analyses of marine and environmental microbial communities, developed tools for the analysis of environmental genetic data, and helped build AOML's omics program by developing computational and data sharing resources and, as an Assistant Research Professor, hiring a postdoc to build on AOML's environmental DNA (eDNA) efforts.

Building AOML's omics program has included the development of metadata standards (A in Fig. 1), methods for high-throughput DNA extraction (B), processing of raw data to observation tables (C), and analysis of environmental datasets (D). In the development of computational tools and data sharing resources, Dr. Thompson has created or contributed to the development of several bioinformatics tools and workflows. The tools include a shotgun metagenomic analysis tool called HUMAnN2 (Franzosa et al., Nat Meth, 2018), a statistical tool for compositional datasets including microbiome datasets (Martino et al., mSystems, 2019), and the next generation of a widely used amplicon sequence analysis tool called QIIME 2 (Bolyen et al., Nat Biotech, 2019). Building on the functionality of QIIME 2, Dr. Thompson created a bioinformatics workflow called Tourmaline, which allows rapid and reproducible analysis of amplicon sequence data. That tool is hosted on the newly created AOML GitHub organization, which allows AOML scientists to collaborate on software and share their code with other scientists and the public. Using these tools to advance NOAA's research efforts, Dr. Thompson has led several large studies of marine and environmental communities. Most notably, Dr. Thompson was the lead author with 301 co-authors on a massive meta-analysis of over 25,000 microbiome samples collected through the Earth Microbiome Project (Thompson et al., Nature, 2017), a widely influential study that has been cited over 500 times to date. Dr. Thompson also led a study of global ocean metagenomes, which required the development of several new computational approaches (Thompson et al., AEM, 2019).

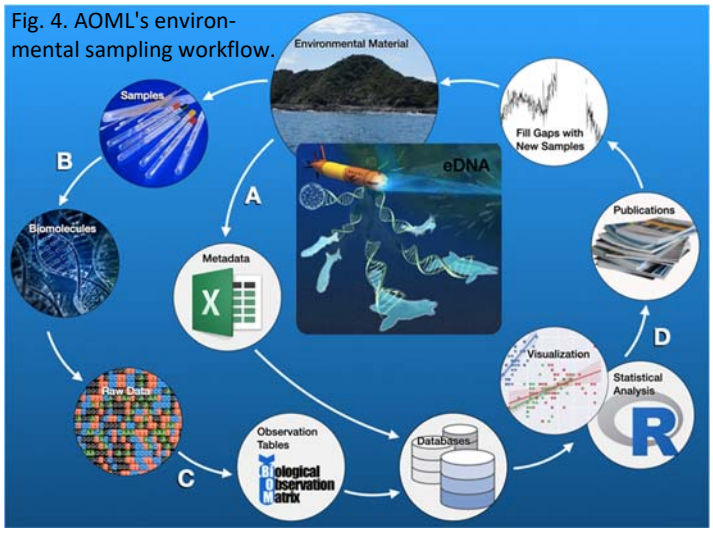


Fig. 4. AOML's environmental sampling workflow.

Title: Understanding how the complex topography of the deepwater Gulf of Mexico influences water-column making processes and the vertical and horizontal distribution of oil and gas after a blowout
PI(s): Zhankun Wang

Project Description: The goal of the project is to understand the nature of ocean turbulence on the continental shelf and slope of the Gulf of Mexico and its relationship to the mixing and diffusion of contaminant constituents (e.g. oil/gas). This is a collaborative research with Dr. Kurt Polzin (Lead PI at WHOI), Dr. John Toole at WHOI and Dr. Steve DiMarco (Lead PI at TAMU). It is a four-year project funded by Gulf of Mexico Research Initiative (GoMRI) from January 2016 to December 2019. We conducted an integrated multi-platform observational field effort that made direct observations of turbulence and mixing in the outer slope region of the Gulf of Mexico near the BP Macondo well site and across the northwestern Gulf of Mexico. Three field campaigns have been conducted with sampling locations shown in the figure below. The main objective of this project is to quantify turbulence-induced dispersion, both vertical and horizontal. The project is specifically targeted to GoMRI Theme 1, which addresses the impact of the physical environment on the distribution, dispersion, and dilution of contaminants. The research work includes an innovative sampling design that uses a Slocum deepwater ocean buoyancy (Model G2) Gilder. The glider is outfitted with a Rockland Scientific µRider microstructure profiler to directly measure ocean turbulence. Together with the High Resolution turbulence Profiler (HRP), vertical microstructure profiler, deep moorings, traditional CTD rosette and ship-board ADCPs, we directly obtained the key turbulent and fine scale quantities in the water-column from the surface up to 2000 m water depth. The observational results showed that turbulence is strongest in the thermocline and enhanced turbulent layers were often formed below the thermocline and near the bottom revealing the “pancake-like” structure of the turbulent field in the Gulf of Mexico. The results of this project could lead to significant improvements in the parameterizations presently used in modern plume dispersal models. The quantification of the turbulent field allowed a vastly improved forecast capability of present and planned numerical models. It is expected that quantification of the linkages between the full water-column turbulent field and physical forcing phenomena of the northern Gulf of Mexico such as the Loop Current, Loop Current Eddies, bottom intensified Topographic Rossby Waves (TRW), internal waves, and surface and near bottom trapped inertial oscillations, will be established.

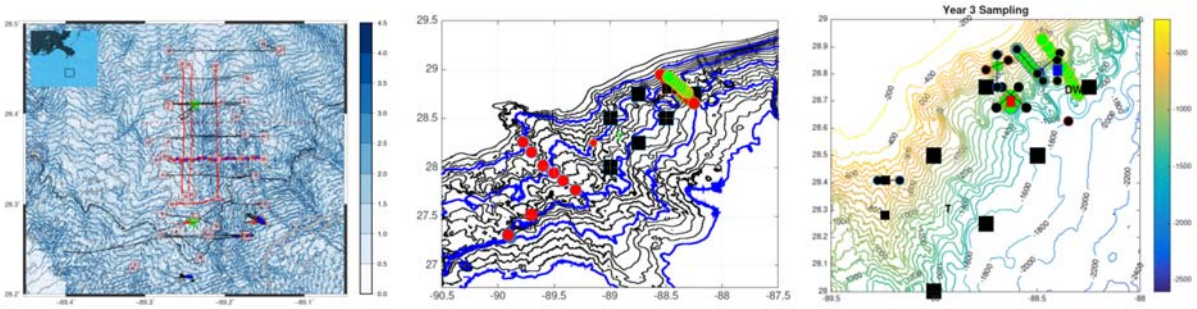


Figure: Sampling During GoMIX cruises. (left panel) Ship’s track and locations of stations occupied during GoMIX I cruise (Year 2016); (middle panel) Sampling during GoMIX II cruise (Year 2017); (right panel) Sampling during GoMIX III cruise (Year 2018).

Appendix B: Publications (sorted alphabetically by first author's surname)

Ahern, K., Bourassa, M., Hart, R., Zhan, J., and Rogers, R., 2019, *Observed Kinematic and Thermodynamic Structure in the Hurricane Boundary Layer During Intensity Change*, Mon. Wea. Rev.

Allen, P.J., R.J. DeVries, D.A. Fox, and W.G. Anderson, 2018, *Reconstructing life history of Gulf Sturgeon through trace element and 87Sr/86Sr analysis of pectoral fin spines*., **Environmental Biology of Fishes, 101, 469-488.**

Amato, K.R., J.G. Sanders, S. Song, M. Nute, J.L. Metcalf, L.R. Thompson, J.T. Morton, A. Amir, V. McKenzie, G.Humphrey, G. Gogul, J. Gaffney, A. Baden, G. Britton, F. Cuozzo, A. Di Fiore, N. Dominy, T. Goldberg, A. Gomez,M.M. Kowalewski, R. Lewis, A. Link, M. Sauther, S. Tecot, B. White, K. Nelson, R. Stumpf, R. Knight and S. Leigh., 2018*, Evolutionary trends in host physiology outweigh dietary niche in structuring primate gut microbiomes*, **The ISME Journal.**

Angulo, R., Costa, A., A., DiMarco, S., Ledwell, J. R., Polizn, K. L., and Wang, Z., 2016, *Boundary Mixing along the Northern Deep Water Gulf of Mexico*, **Ocean Sciences Meeting**.

Anton. A., N. Geraldi, C. Lovelock, E. Apostolaki, S. Bennet, J. Cebrian, D. Krause-Jensen, N. Marba, P. Martinetto, J. Pandolfi, J. Santana, and C.M. Duarte, 2019, *Global ecological impacts or marine exotic species* **Nature - Ecology and Evolution.**

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Thompson, L., 2018, *The Earth Microbiome Project: revealing global patterns of microbial distribution* (invited), **University of Oulu, Finland.**

Thompson, L., 2018, February 2018, *Global characterization of microbial taxonomic and functional diversity in the Earth Microbiome Project* (invited), **Omic Biomonitoring Workshop, Max-Planck-Institute for Marine Microbiology, Bremen, Germany.**

Thompson, L., 2018, *Mapping the microbes of Earth* (invited), **San Diego Microbiology Group.**

Thompson, L., 2017, December 2017, *A communal catalogue of Earth's microbes* (invited), **Scripps Institution of Oceanography.**

Thompson, L., 2017, *The Earth Microbiome Project: lessons from a massive metagenetic survey* (contributed)., **ICES Annual Science Conference, Fort Lauderdale.**

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Thompson, L., 2018, *EMP500: multi-omics of diverse microbial environments in the Earth Microbiome Project* (invited), **17th International Symposium on Microbial Ecology, Leipzig, Germany.**

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Thompson, L., 2018, *Multi-omics of Earth's microbial communities,* **San Diego State University.**

Thompson, L., 2018, *Standards-enabled metagenomics and metabolomics of Earth's microbial communities,* **International Microbiome and Metagenomics Standards Alliance.**

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Thompson, L., 2019, *Incorporating environmental DNA into global ocean observing systems: opportunities and challenges,* **OceanObs'19, Honolulu, Hawaii, Panelist for Special Session.**

Thompson, L., 2019, *Applications and tools for environmental DNA*, ***University of Southern Mississippi, Hattiesburg.***

Thompson, L., 2019, *Environmental DNA tools and applications for oceans and the Great Lakes,* **Scripps Institution of Oceanography.**

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Van Cooten, S. and Moorhead, R., 2020, *The Use of Unmanned Aerial System Imagery in the 2018-2019 Mississippi River Flood Event to Enhanced NWS Flood Forecasting and Decision Support Services., **100th Annual Meeting, American Meteorological Society,* 34th Conference on Hydrology.**

Van Cooten, S. and Moorhead, R., 2019, *Flood Detection and Analysis Session: Surveying and Mapping,* **Commercial UAV Symposium, Las Vegas, NV.**

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Villas Boas, A.B., Ardhuin, F., Ayet, A., Bourassa, M.A., Chapron, B., Brandt, P., Brandt, P., Farrar, J.T., Fewings, M.R., Fox-Kemper, B. and Gille, S.T., 2019, *Integrated observations and modeling of global winds, currents, and waves: requirements and challenges for the next decade,* **Frontiers in Marine Science**

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Wang, Z., Polzin, K., DiMarco, S., Toole, J., Ruiz Angulo, A., Tenreiro, M., 2018, *Topographic Enhancement of Diapycnal Diffusivity on the Continental Slope in the Northern Gulf of Mexico and Its Application to the Oil Droplet Dynamics,* **Ocean Sciences Meeting**

Wang, H., Enwright, N.M., Darnell, K.M., LaPeyre, M.K., Cebrian, J., Kim, S.-C., Bunch, B., Stelly, S.J., Couvillion, B.R., Dalyander, P.S., Mickey, R.C., and Segura, M., 2020, *Seagrass Habitat Suitability*

Modeling for the Alabama Barrier Island Restoration Feasibility Assessment at Dauphin Island In: Enwright, N.M., Wang, H., Dalyander, S.P., and Godsey, E., eds., *Predicting barrier island habitats and oyster and seagrass habitat suitability for various restoration measures and future conditions for Dauphin Island,* **Dauphin Island Sea Lab, Alabama.**

Waxler, R., G. Frazier, C. Talmadge, K. R. Knupp, B. Goudreau, and C. Hetzer, 2019, *Detection and Tracking of Tornadic Storms in the Southeast with Arrays of Infrasound Sensors,* **Special Symposium on Meteorological Observations and Instrumentation**

Weigel, A., R. Griffin, K. Knupp, A. L. Molthan, and T. A. Coleman, 2018, *Using GIS to Investigate Land–Atmosphere Interactions Involved in Tornadogenesis,* ***34th Conference on Environmental Information Processing Technologies,*** **AMS Annual Meeting**

Weilin, H., and Arnone, R., 2017, *Special Section Guest Editorial: Recent Advances in Geophysical Sensing of the Ocean: Remote and In Situ Methods.,* **Journal of Applied Remote Sensing 11(3), 032401 (17 August 2017). https://doi.org/10.1117/1.JRS.11.032401.**

Wessel, C., K. Swanson, T. Wetherall, and J. Cebrian, 2019, *Accumulation and distribution of marine debris on barrier islands across the northern Gulf of Mexico,* **Marine Pollution Bulletin.**

Yingling, N., T. Kelly, T. Shropshire, K. Selph, M. Landry, A. Knapp, S. Kranz, and M. Stukel, 2019, *Phytoplankton nutrient uptake and growth dynamics in the spawning region of Atlantic Bluefin Tuna in the oligotrophic Gulf of Mexico,* **Gulf of Mexico Oil Spill and Ecosystem Science Conference**

Zarzar, C., Dash, P., Dyer, J., Moorhead, R., and Hathcock, L., 2020, *Development of a Simplified Radiometric Calibration Framework for Water-Based and Rapid Deployment Unmanned Aerial System (UAS) operations.,* **Drones.**

Zarzar, C., Dash, P., Dyer, J., and Moorhead, R., 2017, *Quantifying Atmospheric Effects on Unmanned Aerial System Imagery.,* **Special Symposium on Meteorological Observations and Instrumentation, 97th American Meteorological Society Annual Meeting, Seattle, WA**

Appendix C: Students Supported

Student	Academic Unit	Degree	Date Completed	Thesis/Dissertation Title
Bianca Prohaska	FSU	Ph.D.	Dec-19	*Physiological Ecology of Elasmobranchs in the Gulf of Mexico and Northwestern Atlantic*
Cheston Peterson	FSU	Ph.D.	Ongoing	
Bryan Keller	FSU	Ph.D.	May-20	*The Spatial Ecology of the Bonnethead, Sphyrna Tiburo: Migration, Parturition and Magnetic-Based Navigation*
Jasmin Graham	FSU	M.S.	May-20	*Analysis of Large Juvenile and Adult Smalltooth Sawfish (Pristis Pectinata) Movements: Evaluating Bycath Risk and Identifying Critical Habitat*
William Conner McCall Parker	FSU	Undergraduate	May-17	
Adam Preston Stallard	FSU	M.S.	Aug-17	*Comparing SAMOS Document Search Performance Between Apache Solr and Neo4j*
Justin Palmer Stow	FSU	Undergraduate	May-20	*Analyzing Gaps and Hurricane Rain Cover to Aid in New NASA Satellite Proposal*
Ian Terry	FSU	Undergraduate	N/A	
Jonathan Reynes	FSU	Undergraduate	N/A	
Taylor Shropshire	FSU	Ph.D.	Ongoing	
Heather Holbach	FSU	Ph.D.	Dec-16	*Wave and Wind Direction Effects On Ocean Surface Emissivity Measurements In High Wind Conditions*
Kyle Kevin Ahern	FSU	Ph.D.	Dec-19	*Hurricane Boundary Layer Structure During Intensity Change: An Observation and Numerical Analysis*
Daneisha Shanike Blair	FSU	M.S.	ongoing	*Surface Oil Transport in Two-Way Coupled Model*
Renee Joye Richardson	FSU	Ph.D.	ongoing	*Ocean Surface Stress for Hurricane Force Winds*
John Daniel Steffen	FSU	Ph.D.	Dec-18	*Barrier Layer Development local to Tropical Cyclones*
Justin Palmer Stow	FSU	Undergraduate	ongoing	*Analyzing Gaps and Hurricane Rain Cover to Aid in New NASA Satellite Proposal*
Alicia Paight	DISL	Undergraduate	Dec-19	
Jada Winters	DISL	Undergraduate	Ongoing	
Jeff Coogan	DISL	Ph.D.	Feb-19	*An investigation of estuarine physics in Mobile Bay*
Joshua Bergeron	USM	M.S.	Aug-17	*Non-thesis degree/Category A Hydrography*
Ashley Boyce	USM	M.S.	Aug-19	*Non-thesis degree/Category A Hydrography*
Shara Gremillion	USM	M.S.	Aug-19	*Non-thesis degree/Category A Hydrography*
Denis Karamagi	USM	M.S.	Aug-18	*Non-thesis degree/Category A Hydrography*
Johnson Oguntuase	USM	Ph.D.	Ongoing	
Jennifer Rhodes	USM	M.S.	Aug-19	*Non-thesis degree/Category A Hydrography*
Dennis Wilson	USM	M.S.	Aug-17	*Non-thesis degree/Category A Hydrography*
Agno Rubim de Assis	USM	M.S.	Ongoing	*Non-thesis degree/Category A Hydrography*
Anthony Lyza	USM	Ph.D.	Dec-19	*An Initial Investigation of the role of the Northeastern Alabama Plateaus in Modifying the Near-Storm Environment of Potentially Tornadic Storms*
Barrett Goudeau	UAH	M.S.	Dec-18	*A Case Study on the Usage and Efficacy of Infrasound Monitoring Arrays as a Means of Tornado Detection*
Chris Lisauckis	UAH	M.S.	Dec-18	*Cold-Season Severe QLCS Events over North AL: Climatology, Cloud, and Boundary Layer Characteristics*
Dustin Conrad	UAH	M.S.	Dec-17	*Doppler Radar Observations Of Horizontal Shearing Instability In Quasi-Linear Convective Systems*
Michael Graham	UAH	M.S.	Ongoing	
Kalitta Kauffman	UAH	M.S.	Ongoing	
Dean Meyer	UAH	Undergraduate	Ongoing	
Amanda Lee	UAH	Undergraduate	Ongoing	
Jacob Wiley	MSU	Ph.D.	Ongoing	
Hossein Lotfi	MSU	Ph.D.	Ongoing	
Jacob Freeman	MSU	Undergraduate	Ongoing	
Taylor Pechacek	MSU	M.S.	Ongoing	*Assessing Communication of Weather Emergencies to the Blind and Low*
Craig Croskery	MSU	Ph.D.	Ongoing	
Cole Vaughn	MSU	Ph.D.	Ongoing	
Derek Rosseau	MSU	M.S.	May-19	*Estimating Near-Surface Vertical Heat Fluxes Using a Small Unmanned Aerial Vehicle (sUAV)*
Rebecca Gilpin	MSU	M.S.	Ongoing	
Cary McCraine	MSU	M.S.	May-20	

Appendix D: NGI Project List

Project #	MSU Award #	Inst	PI	Project Title	NOAA LO	Period of Performan	Award Amoun
Cooperative Agreement							
NA16OAR4320199							
19-NGI3-93	191001-363513-3J	USM	Steven Howden	Underwater Glider Operations and Science in the Gulf of Mexico: A Public-Private Partnership	NOS	9/1/18 - 8/31/20	$ 964,466.00
19-NGI3-88	191001-363513-4G	UAH	Kevin Knupp	VORTEX-SE 2020 Field Campaign (Risk Reduction) Activities: Observations of the Environment and Evolution of Non-Classical Tornadic Storms	OAR	9/1/19 - 8/31/21	$ 533,140.00
19-NGI3-86	191001-363513-3H	USM	Frank Hernandez	Continuation of Secure Archival Storage for NOAA/NMFS Preserved Specimens at USM's Plankton Archival Facilities	NMFS	5/1/18- 09/30/20	$ 39,102.00
19-NGI3-85	191001-363513-4C	UAH	Phillip Bitzer	Bayesian Merging of GLM Data With Ground-Based Networks	NESDIS	8/1/17 - 7/31/20	$ 237,918.00
19-NGI3-84	363527-191001-021000	MSU	Robert Moorhead	SHOUT4Rivers	OAR	10/1/17 - 9/30/20	$ 1,339,800.00
19-NGI3-80	363517-191001-021000	MSU	Steve Ashby	Hypoxia National Office Technical Assistance, Observations, Monitoring, and Coordination	NOS	10/1/16 - 9/30/20	$ 1,249,874.00
19-NGI3-79	363547-191001-021000	MSU	Adam Skarke	Geospatial analysis of deep-sea environments using ROV video data with the Coastal and Marine Ecological Classification Standard (CMECS)	NCEI	9/1/19 - 08/31/21	$ 19,190.00
19-NGI3-78	191001-363513-3K	USM	Luke Thompson	Building NOAA Omics and Bioinformatics Capacity for Reproducible and Efficient Analysis of Environmental Samples	OAR (AOML)	10/01/19 - 09/30/21	$ 301,329.00
19-NGI3-77	363546-191001-021000	MSU	Andrew Mercer	Enhanced Seasonal Landfalling Hurricane Outlook	OAR (AOML)	10/1/19 - 09/30/21	$ 236,851.00
19-NGI3-76	191001-363513-1B	FSU	Dean Grubbs	Determination of Movement Patterns and Reproductive Status of Adult Smalltooth Sawfish	NMFS	10/1/16 - 9/30/20	$ 182,186.00
19-NGI3-75	363545-191001-021000	MSU	Just Cebrian	Improvements to NDBC Weather Buoy/C-Man Archive Process	NWS	9/1/19 - 6/30/20	$ 60,000.00
19-NGI3-74	191001-363513-2D	DISL	Laura Myers	Social Science Applications for Coastal Resiliency (SSACR)	NWS	10/1/19 -06/30/20	$ 15,072.00
19-NGI3-73	191001-363513-3L	USM	Frank Hernandez	Recent Declines in Coastal Migratory Pelagic Species Along the US Gulf and South Atlantic Bight and Potential Impact of Large-scale Ocean Circulation Changes	OAR (AOML)	10/01/19 - 09/30/21	$ 231,088.00
19-NGI3-71	191001-363513-3I	USM	Shiao Wang	Bioinformatics to Support Ecosystem Fisheries, and Blue Economy Omics Applications	OAR (AOML)	10/1/18 - 9/30/20	$ 226,810.00
19-NGI3-70	191001-363513-1C	FSU	Mark Bourassa	Climate Variability in Ocean Surface Turbulent Fluxes	OAR	10/1/16 - 9/30/20	$ 328,652.00
19-NGI3-69	363518-191001-021000	MSU	Steve Ashby	AOML-NGI South Florida Water Quality Data Analyses	OAR (AOML)	10/1/16 - 9/30/21	$ 759,287.00
19-NGI3-68	191001-363513-1D	FSU	Shawn Smith	U.S. Research Vessel Surface Meteorology Data Assembly Center	OAR	10/1/16 - 9/30/20	$ 1,051,242.00
19-NGI3-64	340561-191001-037000	MSU	John Cartwright	Regional Geospatial Modeling	NOS	10/1/16 - 9/30/20	$ 9,292,317.00
19-NGI3-40	363544-191001-021000	MSU	Steve Ashby	Examination of HWRF at the land and ocean interface	OAR (AOML)	10/1/19 - 09/30/20	$ 116,365.00
18-NGI3-61	191001-363513-2C	DISL	Brian Dzwonkowski	Improving Historical Data Access for Coastal Application	NMFS	10/1/18 - 06/30/20	$ 12,518.00
18-NGI3-59	191001-363513-4F	UAH	Kevin Knupp	Evaluation and Improvements of Tornado Detection Using Infrasound Remote Sensing: Comparative Analysis of Infrasound, Radar, Proflier, and Meteorological Data Sets, and Potential Impacts on NOAA/NWS	NWS	10/1/18 - 9/30/20	$ 480,941.00
18-NGI3-58	191001-363513-3A	USM	Brian Connon	University of Southern Mississippi Mapping Center	NOS	10/1/16 - 8/31/20	$ 4,567,569.00
18-NGI3-57	363516-191001-021000	MSU	Pat Fitzpatrick	Examination and Validation of Reconnaissance Field Program Data in Multiple HWRF Frameworks	OAR (AOML)	10/1/16 - 9/30/19	$ 211,890.00
18-NGI3-53	191001-363513-1H	FSU	Mark Bourassa	Hurricane 3-D Wind Structure Analysis Using Stepped-Frequency Microwave Radiometer Surface Wind Measurements	OAR (AOML)	10/1/18 - 9/30/20	$ 97,909.00
18-NGI3-52	191001-363513-1G	FSU	Steve Morey	NOAA Fisheries and the Environment (FATE): Development of Environmentally-Driven Larval Mortality and Age-0 Abundance Indices for a Suite of Coastal Pelagic Species in the Gulf of Mexico	OAR (AOML)	7/1/19 - 6/30/20	$ 44,436.00
18-NGI3-51	191001-363513-3D	USM	Bob Arnone	Calibration and Validation of NOAA VIIRS Ocean Products for Monitoring Oceans	NESDIS	10/1/16 - 12/31/19	$ 374,004.00
18-NGI3-50	363538-191001-021000	MSU	Mike Brown	Mesoscale Variability Experiment Using Full-Tropospheric Soundings	NWS	10/1/18 - 9/30/19	$ 47,403.00
18-NGI3-49	191001-363513-4E	UAH	Kevin Knupp	Advancing Meteorological and Operational Detection of Mesoscale Kinematic and Thermodynamic Variability	OAR	9/1/18 - 8/31/20	$ 201,319.00
18-NGI3-43	191001-363513-3G	USM	Frank Hernandez	High-Resolution Modeling of the Ocean Acidification in the East and Gulf Coasts of the U.S.	OAR (AOML)	3/1/18 - 7/31/19	$ 56,185.00
18-NGI3-41	191001-363513-1F	FSU	Steve Morey	Modeling Climate Impacts on Fish Larvae Mortality in the Gulf of Mexico	OAR (AOML)	7/1/17 - 6/30/20	$ 138,252.00
18-NGI3-40	191001-363513-4D	UAH	Kevin Knupp	VORTEX-SE 2019 Field Campaign Activities: Mesoscale Variability of CAPE, Shear, and PBL Characteristics	OAR	9/1/18 - 8/31/20	$ 442,892.00
17-NGI3-38	363533-191001-021000	MSU	Steve Ashby	Enhanced Coastal Data Development and Information Services: Scientific Support for Partner Agencies	NESDIS	7/1/17 - 9/30/19	$ 1,040,770.00
17-NGI3-35	363532-191001-021000	MSU	Steve Ashby	Enhanced Coastal Data Development and Information Services: CEDAC	NESDIS	7/1/17 - 9/30/21	$ 1,231,122.00
17-NGI3-33	191001-363513-3F	USM	Shiao Wang	Bioinformatics to Aid Ecosystem Understanding, Research Transition, and Development of a Next-Gen Workforce	OAR (AOML)	10/1/17 - 9/30/19	$ 154,421.00
17-NGI3-32	191001-363513-1A	FSU	Mark Bourassa	Further Refinements to Stepped-Frequency Microwave Radiometer Surface Wind Measurements in Hurricanes	OAR (AOML)	10/1/16 - 9/30/19	$ 223,736.00
17-NGI3-31	191001-363513-4B	UAH	Kevin Knupp	VORTEX-SE 2018 Field Campaign Activities: High-CAPE, Low-Shear Emphasis	OAR	8/1/17 - 7/31/19	$ 527,319.00
17-NGI3-30	363531-191001-021000	MSU	Trey Breckenridge	HPC Support for OAR	OAR	10/1/17 - 9/30/21	$ 9,587,728.00
17-NGI3-28	191001-363513-3C	USM	Frank Hernandez	Predicting the impact of anthropogenic climate change on physical and biogeochemical processes in the Northern Gulf of Mexico	OAR (AOML)	10/1/16 - 9/30/18	$ 197,234.00
17-NGI3-19	191001-363513-2B	DISL	Laura Myers	NOAA Weather Information and Dissemination All Hazards Stakeholder Needs Assessment Verification Project	NWS	10/1/16 - 9/30/18	$ 239,917.00
17-NGI3-18	363525-191000-021000	MSU	Pat Fitzpatrick	Improvements to TAO delayed-mode data processing: Phase II enhancements	NWS	7/1/17 - 9/30/17	$ 44,028.00
17-NGI3-17	191001-363513-3E	USM	Monty Graham	Continuation of Secure Archival Storage for NOAA/NMFS Preserved Specimens at USM's Plankton Archival Facilities	NMFS	4/1/17 - 3/31/18	$ 19,551.00

16-NGI3-13	191001-363513-3B	USM	Shiao Wang	Continuation of Comparative Metagenomics to Indicate Sites Under Anthropogenic Pressure: Year 2	OAR (AOML)	10/1/16 - 9/3/18	$ 128,800.00
16-NGI3-11	191001-363513-4A	UAH	Kevin Knupp	Core infrastructure enhancements, operations, and preliminary research activities supporting VORTEX-SE 2017 field campaign	OAR	10/1/16 - 9/30/18	$ 318,588.00
16-NGI3-04	332581-191001-027000	MSU	Peter Allen	Development of Trace Element and Strontium Isotope Water Chemistry Baseline Data for the Pearl River Watershed	NMFS	10/1/16 - 5/31/18	$ 40,338.00
16-NGI3-03	191001-363513-2A	DISL	Laura Myers	National Weather Service Social Science Curriculum Delivery FY17	NWS	10/1/16 - 9/30/17	$ 29,611.00
16-NGI-01	191001-363513-1E	FSU	Shawn Smith	Task 1 for Research Vessel	OAR	10/1/16 - 9/30/17	$ 8,119.00
16-NGI-01	363513-191001-021000	MSU	Robert Moorhead	Program Management Support (Task I)	OAR	10/1/16 - 9/30/21	$ 1,589,984.93
						Total CA Funding	**$ 39,241,273.93**
Other Funding							
NA19NOS4730207	340572-191001-038000	MSU	John Cartwright	Regional Geospatial Modeling Grant 2019	NOS	10/1/19 - 09/30/24	$ 4,139,856.00
NA18OAR4590435	363540-191001-021000	MSU	Trey Breckenridge	HPC Support for OAR Phase II	OAR	10/1/18- 09/30/21	$ 12,000,000.00
NA19OAR4590411	363548-191001-021000	MSU	Jamie Dyer	Developing New Capabilities and Research Applications for the National Water Model Over the Southeastern US	OAR	9/1/19 - 08/31/21	$ 1,477,676.00
NA19OAR4590410	361451-193000-021000	MSU	Trey Breckenridge	HPC Support for OAR Phase III	OAR	10/1/19 - 09/30/23	$ 11,000,000.00
NA18OAR4170438	363541-191001-021000	MSU	Robert Moorhead	Coastal Science Research, Data Development, and Information Services (Base Award)	OAR	09/01/18- 08/31/22	$ 5,176,381.00
NA18OAR4170438	361453-191001-021000	MSU	Justo Cebrian	Coastal Science Research, Data Development, and Information Services (NRDA Turtle Project)	OAR	9/1/18- 08/31/22	$ 75,399.00
NA18OAR4170438	Waiting on OSP to Award	MSU	Steve Ashby	Coastal Science Research, Data Development, and Information Services (GCERC Outreach and Training)	OAR	9/1/18 - 08/31/22	$ 88,631.00
NA17OAR4590140	363526-191001-021000	MSU	Andrew Mercer	Transition of Machine-Learning Based Rapid Intensification Forecasts to Operations	OAR	7/1/17 - 06/30/20	$ 203,373.00
NA17OAR4590198	363528-191001-021000	MSU	Kathleen Sherman-	Improving Accessibility and Comprehension of Tornado Warnings in the Southeast for the Dead, Blind, and Deaf-Blind	OAR	9/1/17 - 8/31/20	$ 103,434.00
NA19OAR4590219	363549-191001-021000	MSU	Kathleen Sherman-	Geospatial Threat Personalization and its Influence on Warning Risk Perception and Protective Actions	OAR	9/1/19 - 08/31/21	$ 135,305.00
231637-00	365441-191001-021000	MSU	Jarryl Ritchie	GOMA BP Gulf of Mexico Research Initiative Web Support Project	GoMRI	1/1/17 - 12/31/20	$ 2,312,953.00
16561900/A101430	365688-191001-021000	MSU	Zhankun Wang	Understanding how the complex topography of the deepwater Gulf of Mexico influences water-column making processes and the	GoMRI	1/1/19 - 12/31/19	$ 42,475.00
						Total Other Funding	**$ 36,755,483.00**
						Total NGI Funnding	**$ 75,996,756.93**
***** only the most recent project year is shown in the project number column**							

Appendix E: Example of attempt to execute Strategic Plan with NOAA (Aug 24, 2018 version)

Forecast of Expected NGI awards for next 3 years

This document presents a forecast of the projects I believe that various NOAA programs will probably want to fund NGI to execute over the last 2 years of the present 5-year award and the first year of the expected renewal award. This is being developed, in part, because it has come to my attention that the NOAA OAR Cooperative Institute Program Office (CIPO) has expected other OAR programs, OAR labs, and other Line Offices to provide an indication of the amount that they intend to fund an OAR-managed CI well before June each year, even if GMD has already awarded a multi-year award. Given the recent timing of the budget from Congress and the desire of most NOAA federal employees to fund internally first, it appears that CIs will need to assist the OAR CIPO in estimating what funding might be coming. Secondly, until Congress passes a budget, I realize it would be inappropriate for any federal employee to put in writing, including in an email, any intent to fund anything that is not in the President's budget. Several of NGI's largest projects are Congressional plus-ups:

- The OAR/AOML funding is the result of a Congressional plus-up to the Coasts, Oceans, and Great Lakes PPA and apparently the Congressional intent is for a third of that $2M to go to NGI. This funding has persisted for over 5 years.
- The VORTEX-SE funding has persisted for 3 years and with Senator Shelby being chair of the Senate Appropriations Committee, it is expected to continue for several more years. Whether the funding is from OAR/OWAQ or NWS is unclear.
- The NOS Regional Geospatial Modeling related funding has persisted for over 10 years under some name.
- The NOS Mapping Center funding has persisted for 3 years and is expected to continue for the foreseeable future.

Finally, it appears that the other Line Offices are not respecting OAR's policy, rules, and guidelines on providing them appropriate and timely information.

The table below is sorted first by university and then by award amounts in FY18 (awarded between 7/1/18 and 9/30/18). The titles are from the FY18 funding. I will note in the text which ones are multi-year awards and the award period. It does NOT include several competitive awards which have been associated with NGI. Multi-year awards are noted with red text in the discussion.

Project #	Project Title	FY18	FY19	FY20	FY21	NOAA LO	University	PI
F1	U.S. Research Vessel Surface Meteorology Data Assembly Center	$225,380	$230,000	$230,000	$230,000	OAR/CPO	FSU	Smith
F2	Hurricane 3-D Wind Structure Analysis Using Stepped-Frequency Microwave Radiometer Surface Wind Measurements	$101,434	$110,000	$110,00	$110,000	OAR/AOML	FSU	Bourassa
F3	Climate Variability in Ocean Surface Turbulent Fluxes	$84,482	$84,482	$84,482	$84,482	OAR/CPO	FSU	Bourassa
F4	Modeling Climate Impacts on Fish Larvae Mortality in the Gulf of Mexico	$72,024	$72,000	$72,000	$72,000	OAR/AOML	FSU	Morey
F5	NOAA Fisheries and the Environment (FATE): Development of Environmentally-Driven Larval Mortality and Age-0 Abundance Indices for aSuite of Coastal Pelagic Species in the Gulf of Mexico	$46,036	$46,000	$46,000	$46,000	OAR/AOML	FSU	Morey
F6	Determination of movement patterns and reproductive status of adult smalltooth sawfish	$45,000	$45,000	$45,000	$45,000	NMFS	FSU	Grubbs
M1	Regional Geospatial Modeling Grant 2018	$3,402,144	$4,000,000	$4,000,000	$4,000,000	NOS/directed	MSU	Samson
M2	Sensing Hazards with Operational Unmanned Technology for the River Forecasting Centers (SHOUT4Rivers), phase 2	$400,000	$400,000	$400,000	$400,000	OAR	MSU	Moorhead
M3	Hypoxia National Office Technical Assistance, Observations and Monitoring, and Coordination Support Activities	$398,508	$400,000	$400,000	$400,000	NOS	MSU	Ashby
M4	AOML-NGI South Florida Water Quality Data Analyses	$396,000		$95,000		OAR/AOML	MSU	Ashby
M5	Examination and validation of reconnaissance field program data in multiple HWRF frameworks	$80,000	$80,000	$80,000	$80,000	OAR	MSU	Fitzpatrick
M6	NCEI/SSC					NESDIS	MSU	Moorhead
M7	Development of Trace Element and Strontium Isotope Water Chemistry Baseline Data for the Pearl River Watershed		$42,000	$0	$42,000	NMFS	MSU	Allen
M8	Improvements to TAO delayed-mode data processing: Phase II enhancements		$45,000	$0	$45,000	NWS	MSU	Fitzpatrick
M9	Mesoscale Variability Experiment using Full-Tropospheric Soundings (VORTEX-SE)	$49,110	$49,000	$49,000	$49,000	NWS	MSU	Brown
UAH1	Evaluation and Improvements of Tornado Detection using Infrasound Remote Sensing: Comparative Analysis of Infrasound, Radar, Profiler, and Meteorological Data Sets, and Potential Impacts on NOAA/NWS	$498,255	$0	$500,000	$0	OAR/OWAQ	UAH	Knupp
UAH2	VORTEX-SE 2019 Field Campaign Activities: Mesoscale variability of CAPE, shear, and PBL characteristics	$458,836	$460,000	$460,000	$460,000	OAR/directed	UAH	Knupp
UAH3	Advancing meteorological and operational detection of mesoscale kinematic and thermodynamic variability: An improved understanding of its sources within the boundary layer during tornado and severe weather events in the Southeast	$208,566	$200,000	$200,000	$200,000	OAR/OWAQ	UAH	Knupp
UAH4	Bayesian Merging of GLM Data With Ground-Based Networks		$100,000			NESDIS	UAH	Bitzer
UAH5	Optimizing Geostationary Lightning Mapper Use in AWIPS		$35,504	$36,571	$0	NESDIS	UAH	Knupp
USM1	University of Southern Mississippi Mapping Center	$1,572,980	$1,600,000	$1,600,000	$1,600,000	NOS/directed	USM	Howden
USM2	Underwater Glider Operations and Science in the Gulf of Mexico: A Public-Private Partnership	$499,352	$499,352	$499,352	$499,352	OAR/OER	USM	Howden
USM3	Bioinformatics to support ecosystem fisheries, and blue economy 'omics applications	$115,437	$120,000	$130,000	$130,000	OAR/AOML	USM	Wang
USM4	Calibration and validation of NOAA VIIRS Ocean Products for Monitoring Oceans	$114,995	$130,000	$130,000	$130,000	NESDIS	USM	Arnone
USM5	High-resolution modeling of the ocean acidification in the East and Gulf Coasts of the U.S.	$58,208	$60,000	$60,000	$60,000	OAR/AOML	USM	Hernandez
USM6	Continuation of Secure Archival Storage for NOAA/NMFS Preserved Specimens at USM's Plankton Archival Facilities	$20,255	$0	$20,000	$0	NMFS	USM	Graham
D1	Improving historical data access for coastal application	$13,602	$0	$0	$0	NMFS	Page | 93	Collini
D2	National Weather Service Social Science Curriculum Delivery FY17		$10,000	$10,000	$10,000	NWS	DISL/UA	Myers
D3	NOAA Weather Information and Dissemination All Hazards Stakeholder Needs Assessment Verification Project		$80,000	$80,000	$80,000	NWS	DISL/UA	Myers
	Total		$8,898,338	$9,227,405	$8,772,834			

FSU

F1 was funded at $414K (FY16) and $219K (FY17). Forecast based on FY17 & FY18 annual funding.

F2 was funded at $114,360 (FY16) and $114,079 (FY17). Single year awards, but funding has been consistent. Forecast is flat.

F3 was funded at $84,482 (FY16) and $84,482 (FY17). Forecast based on consistent, single-year funding over last 3 years.

F4 was funded at $0 (FY16) and $72K (FY17). (2-year multi-year award starting in FY17). No FY16 funding due to 2 year funding in FY14. Forecast is flat.

F5 was a new project in FY18. Forecast based on total amount of funds that OAR/AOML seems to award annually.

F6 was funded at $64,509 (FY16) and $25,000 (FY17). Forecast based on average funding over last 3 years.

MSU

M1 was funded at $2.8M (FY16) and $3.0M (FY17). Forecast based on FY18 award. This project has been funded at a multi-million dollar level, under some title, and via some program for over 10 years. NOS was unable to fund the project to the level they wanted in FY18 due, in part, to other program managers funding multiple years and this project requiring more approvals due to its size. This is why the awarded amount is green; I am still not sure what the final FY18 amount will be.

M2 was funded at $0 (FY16) and $400K (FY17). Forecast based on multi-year award and discussion with program manager.

M3 was funded at $324,590 (FY16) and $213,504 (FY17). Forecast assumes, with little confidence, flat annual funding.

M4 was funded at $142K (FY16) and $153K (FY17). 5-year award made in FY16; ~2.5 years funded in FY18; forecast is the balance.

M5 was funded at $66,498 (FY16) and $71,644 (FY17). 2-year multi-year award starting in FY16; forecast based on FY18 funding

M6 was funded at $0 (FY16) and $2.3M (FY17). Due to timing issues and the NGI funding ceiling, this project was not funded via NGI in FY18 and probably will not be for the foreseeable future. However, given the scope of the work, this is exemplary CI Task 2 work.

M7 was funded at $42,194 (FY16). The PI reported the program manager has indicated a desire to fund more work, but has yet to find the funds.

M8 was funded at $45,921 (FY17). NDBC has indicated they have more funding and want to fund Dr. Fitzpatrick and Yee Lau in the near future. History indicates the funding may be not be annual or consistent.

M9 was funded under an external competition for 2 years in FY16 and associated with NGI. Forecast assumes flat funding.

UAH (growing component of NGI)

UAH1 was a new project in FY18. It is funded for 2 years (through 9/30/20). Forecast is based on FY18 funding.

UAH2 was funded at $319K (FY16) and $550K (FY17). Forecast based on average funding over 3 previous years.

UAH3 was a new project in FY18. Forecast assumes flat funding

UAH4 was funded at $0 (FY16) and $103K (FY17). NESDIS told the PI, but not NGI, that they expected a new proposal for FY18, although it was a multi-year award. Thus no funding in FY18. Forecast based on PI meeting NESDIS and OAR expectations.

UAH5 was to be a new project in FY18. NESDIS didn't move quick enough to fund this in FY18, but has indicated an intent to fund in FY19 & FY20 at the amount indicated.

USM

USM1 was funded at $1.5M (FY16) and $1.5M (FY17). Forecast based on continued flat funding.

USM2 was a new project in FY18. Forecast for FY19 based on two-year award made in FY18. Forecast for FY20 and FY21 based on continued flat funding.

USM3 was funded at $129K (FY16) and $161K (FY17). Forecast for FY19 based on two-year award made in FY18. Forecast in FY20 and FY21 based on average funding over 3 previous years.

USM4 was funded at $170K (FY16) and $105K (FY17). Forecast based on average funding over 3 previous years.

USM5 was funded at $126K (FY16) and $75K (FY17). Forecast based on FY18 funding.

USM6 was funded at $20K (FY16) and $0 (FY17). Forecast based on average funding over 3 previous years.

DISL

D1 was a new project in FY18. It was likely one time funding, so forecast is $0 for next 3 years.

D2 was funded at $30,973 (FY16) and $0 (FY17). Forecast based on average funding over 3 previous years.

D3 was funded at $100,000 (FY16) and $149,998 (FY17). Forecast based on average funding over 3 previous years.

LSU

LSU had not led an NGI project in recent years, but is funded on at least one project (Hypoxia).

Appendix F: Executive Council, Advisory Council, Council of Fellows, and Organizational Chart

The NGI Executive Council:

- John Cortinas, Ph.D., OAR AOML Director, Lead Technical PM for NGI
- Alan Leonardi, Ph.D., OAR OER Director
- Libby Jewett, Ph.D., OAR Oceans Portfolio Steward
- Joe Pica, Ph.D., NESDIS/NCEI, Deputy Director
- Paul Scholz, Ph.D., NOS CFO/CAO
- Steve Thur, Ph.D., NOS National Centers for Coastal Ocean Science, Director
- Mel Landry III, Ph.D., NMFS NOAA Restoration Center
- Julie Jordan, Ph.D., MSU Interim VP Research and Economic Development
- Gordon Cannon, Ph.D., USM VP Research
- Gary K. Ostrander, Ph.D., FSU VP Research
- Sam Bentley, Ph.D., LSU VP Research and Economic Development
- Bob Lindquist, Ph.D., UAH VP Research and Economic Development
- John Valentine, Ph.D., DISL Director
- Robert Moorhead, Ph.D., MSU, NGI Director (ex-officio)
- Gary Matlock, Ph.D., acting OAR CI Program Director (ex-officio)

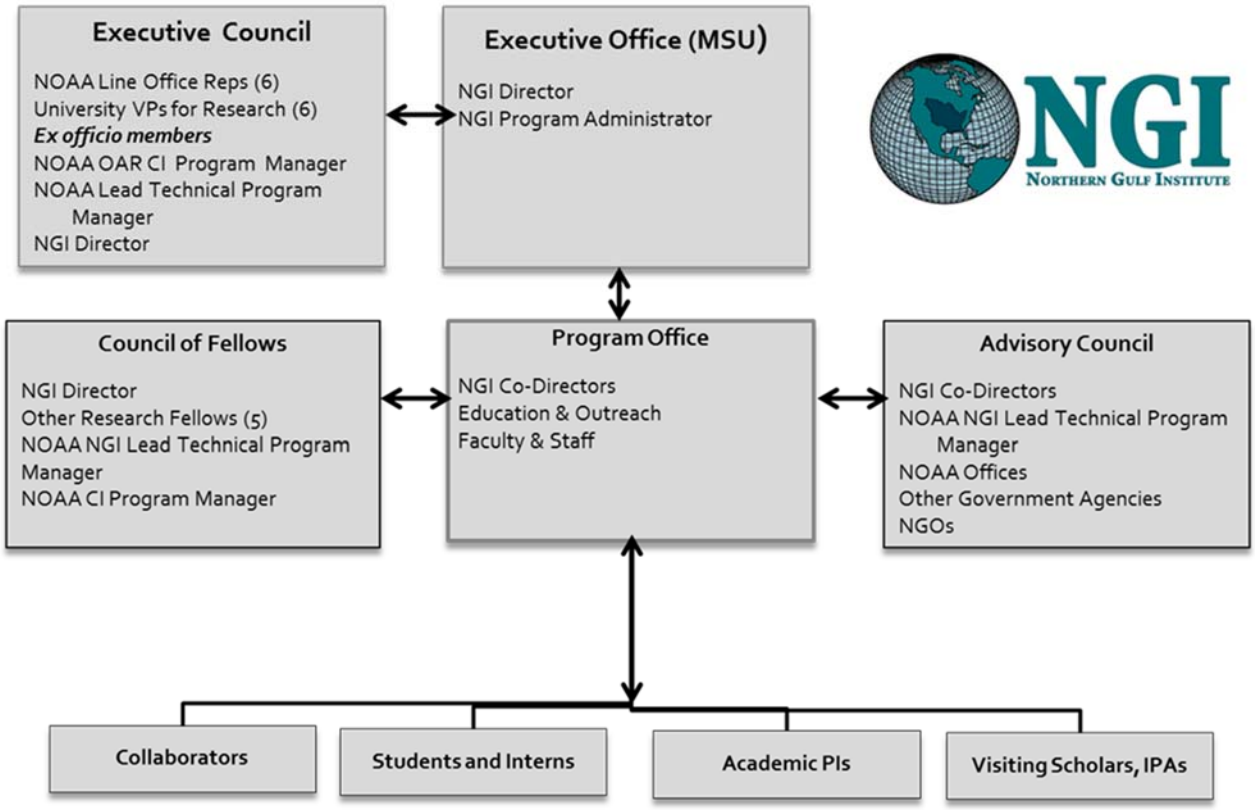
The NGI Advisory Council serves as the principal interface to the regional stakeholder community. The members help us identify and prioritize research and educational needs in the Gulf of Mexico region. The NGI Advisory Council members are:

- Steven Ashby, Ph.D., MSU/NGI Co-Director (Co-Chair)
- Monty Graham, Ph.D., USM/NGI Co-Director (Co-Chair)
- Duane Armstrong, NASA Stennis Space Center
- David Brown, Ph.D., NOAA National Weather Service, Southern Region
- Laurie Bowie, Gulf of Mexico Alliance
- Alyssa Dausman, Ph.D., Gulf Coast Ecosystem Research Council
- Lisa Desfosse, Ph.D., NOAA National Marine Fisheries Service
- Ayesha Gray, Ph.D., Grand Bay National Estuarine Research Reserve
- Judy Haner, The Nature Conservancy
- Julien Lartigue, Ph.D., NOAA RESTORE Act Science Program
- Kristen Laursen, NOAA Fisheries Service
- Sharon Mesick, NOAA National Centers for Environmental Information
- Paul Mickle, Ph.D., Mississippi Department of Marine Resources
- Helmut Portmann, NOAA National Data Buoy Center
- Buck Sutter, Ph.D., Gulf Coast Ecosystem Restoration Council
- LaDon Swann, Ph.D., MS-AL Sea Grant Consortium
- Suzanne Van Cooten, Ph.D., NOAA National Weather Service LMRFC
- Jeff Waters, Ph.D., US Army Corps of Engineers
- Chuck Wilson, Ph.D., GOMRI Chief Scientist

The Council of Fellows is composed of senior scientific and technical representatives from each NGI member academic institution, in addition to the Director. The Council is chaired by the NGI Director. 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 Fellows participate in regular teleconferences to remain up to date between face-to-face meetings. The NGI Council of Fellows consists of:

- Robert Moorhead, Ph.D., Mississippi State University (chair, NGI Director)
- Steve Ashby, Ph.D., Mississippi State University (MSU Co-Director)
- Joe Griffitt, Ph.D., University of Southern Mississippi (USM Co-Director)
- Eric Chassignet, Ph.D., Florida State University
- Robert Twilley, Ph.D., Louisiana State University
- John Valentine, Ph.D., Dauphin Island Sea Lab
- Kevin Knupp, Ph.D., University of Alabama Huntsville

The NGI Organization Chart:



Appendix G: Review Team

Denise Reed
Professor Gratis
Pontchartrain Institute for Environmental Sciences
University of New Orleans

Denise J. Reed is a nationally and internationally recognized expert in coastal marsh sustainability and the role of human activities in modifying coastal systems with over 30 years of experience studying coastal issues in the United States and abroad. Dr. Reed has served as s a Distinguished Research Professor in the University of New Orleans' Department of Earth and Environmental Sciences and spent five years as Chief Scientist at The Water Institute of the Gulf. She has served on numerous boards and panels addressing the effects of human alterations on coastal environments and the role of science in guiding restoration, including the NRC Committee on Sustainable Water and Environmental Management in the California Bay-Delta, and has been a member of the USACE Environmental Advisory Board and the NOAA Science Advisory Board. Dr. Reed received her B.S. degree in Geography from Sidney Sussex College, and her M.A. and Ph.D. degrees from University of Cambridge.

Ben Kirtman
Professor of Atmospheric Sciences
University of Miami, Rosenstiel School of Marine and Atmospheric Science

Director
Cooperative Institute for Marine and Atmospheric Studies

Director
Center for Computational Science Climate and Environmental Hazards Program

Ben Kirtman is a Professor of Atmospheric Sciences at the University of Miami's Rosenstiel School of Marine and Atmospheric Science. He uses atmosphere-ocean general circulation models to study the predictability and variability of the Earth's climate system. Kirtman teaches graduate courses on the general circulation of the atmosphere and El Niño/Southern Oscillation, and climate prediction and predictability. He also teaches dynamic meteorology and atmospheric thermodynamics to undergraduates. He mentors graduate students in the Meteorology and Physical Oceanography graduate program, as well as post-doctoral researchers.

Kirtman's research is a wide-ranging program designed to understand and quantify the limits of climate predictability from days to decades. His research also involves understanding how the climate will change in response to changes in anthropogenic (e.g., greenhouse gases) and natural (e.g., volcanoes) forcing. This research involves hypothesis testing numerical experiments, using sophisticated state-of-the-art climate models and experimental real-time prediction. His group uses and has access to a suite

of climate models, climate data, and high performance computational platforms.

Kirtman received his B.S. in Applied Mathematics from the University of California-San Diego and his M.S. and Ph.D. from the University of Maryland-College Park. He was a Research Scientist at the Center for Ocean-Land-Atmosphere Studies and a tenured Associate Professor at George Mason University before joining the Rosenstiel School in 2007. Kirtman has published over 100 peer-reviewed papers focused on understanding the variability of the climate system on time scales from days to decades.

Jane Smith
Senior Research Scientist
U.S. Army Engineer Research and Development Center

Dr. Jane McKee Smith is the Army Senior Research Scientist for Hydrodynamic Phenomenon, stationed at the U.S. Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory in Vicksburg, Miss. Smith's research focus is on coastal hydrodynamics, including nearshore waves and currents, wave-current interaction, shallow-water wave processes, and storm surge. Her projects include theoretical and numerical studies as well laboratory and field experimentation.

Dr. Smith is the co-developer of the STWAVE numerical spectral wave model that is used throughout the world for coastal project planning and design. Smith was the wave modeling lead investigator for the Interagency Performance Evaluation Task Force evaluation of Hurricane Katrina. She also led development of a system to quickly forecast hurricane waves, storm surge, and inundation for the Hawaiian Islands.

Smith has over 200 professional publications. She is Chair of the Coastal Engineering Research Council of the American Society of Civil Engineers (ASCE) and served as President of the Governing Board of the Coasts, Oceans, Ports and Rivers Institute of ASCE (2013-14). She serves on the Editorial Boards of the Elsevier journal Coastal Engineering and the ASCE Journal of Waterway, Port, Coastal and Ocean Engineering. Smith is an Adjunct Professor at Mississippi State University, and she serves on Master's and Ph.D. Committees at the University of Florida, Louisiana State University, Mississippi State University, and Texas A&M University.

Smith's honors include National Academy of Engineering (2019), South Dakota State University (SDSU) Distinguished Engineer (2015), ASCE Distinguished Member (2014), SDSU Distinguished Alumni (2013), ASCE Government Civil Engineer of the Year (2010), and Waterways Experiment Station Woman of the Year (1987). Smith earned a Ph.D., from the University of Delaware in Civil Engineering with a focus on Coastal Engineering, and a M.S. from Mississippi State University and a B.S. from South Dakota State University, both in Civil Engineering. She is a Professional Engineer, a Coastal Engineering Diplomate (Academy of Coastal, Ocean, Port and Navigation Engineers), and a member of ASCE and the American Geophysical Union.

Richard Fulford
Ecosystem Ecologist
U.S. Environmental Protection Agency

Dr. Richard Fulford is an ecosystem ecologist from the US EPA Office of Research and Development's Gulf Ecosystem Measurement and Modeling Division. He received a Bachelor of Science in zoology from the University of Oklahoma, Master of Science in fisheries from Louisiana State University, and his Doctorate in zoology from North Carolina State University. He specializes in quantitative modeling of marine and estuarine ecosystems with the objective of understanding ecosystem resilience and sustainability. His work has included analysis of recruitment dynamics of yellow perch in Lake Michigan, food web analysis of oysters and eutrophication in Chesapeake Bay, and habitat modeling of forage fish in coastal Gulf of Mexico. He is currently leading a national-scale project to model human-environmental interactions with an ecosystem services approach. Dr. Fulford's primary interest is how energy flows through ecosystems, either vertically through food webs, horizontally through behavioral interactions, or how this energy is used by people. Aquatic ecosystems provide a fruitful platform for this research as they are highly productive, highly connected, and are home to a large proportion of the human population.

LaDon Swann
Director
Mississippi-Alabama Sea Grant and Sea Grant Aquaculture Liaison

LaDon Swann is the director of the Mississippi-Alabama Sea Grant Consortium and serves as the national Sea Grant aquaculture liaison. He is responsible for implementing practical solutions to coastal issues through competitive research, graduate student training, extension, outreach and K-12 education in Alabama and Mississippi. In his national role as a Sea Grant aquaculture liaison, he works to strengthen the Sea Grant aquaculture portfolio. He has conducted research on shellfish aquaculture and habitat restoration, and he has many years of experience designing, delivering and evaluating adult education programs.

The Tennessee native worked 10 years with the Illinois-Indiana Sea Grant College Program at Purdue University, where he earned a Ph.D. in curriculum and instruction for adults. His bachelor's and master's degrees were obtained from Tennessee Technological University in wildlife and fisheries management and fisheries biology. He also served as a U.S. Peace Corps aquaculture volunteer in Togo, West Africa.