

Research Performance Progress Report Northern Gulf Institute

NA16OAR4320199

July 1, 2019 to June 30, 2020

**Biscayne Bay Florida
National Park Service**



NGI
NORTHERN GULF INSTITUTE
a NOAA cooperative institute



DEPARTMENT OF COMMERCE RESEARCH PERFORMANCE PROGRESS REPORT (RPPR)

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| AWARD INFORMATION | |
|---|---|
| 1. Federal Agency: Department of Commerce / NOAA | 2. Federal Award Number: NA16OAR4320199 |
| 3. Project Title: Proposal to Re-form the Northern Gulf Institute | |
| 4. Award Period of Performance Start Date: 10/01/2016 | 5. Award Period of Performance End Date: 09/30/2022 |
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| REPORTING INFORMATION | |
| Signature of Submitting Official: Whitley Alford | |
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| RECIPIENT ORGANIZATION | |
| 20. Recipient Name: MISSISSIPPI STATE UNIVERSITY | |
| 21. Recipient Address: 245 BARR AVE MCARTHUR HALL, MISSISSIPPI STATE, MS 39762-5227 USA | |
| 22. Recipient DUNS:075461814 | 23. Recipient EIN:646000819 |

ACCOMPLISHMENTS

24. What were the major goals and objectives of this project?

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 addresses problems of significant importance and relevance to NOAA and the nation and the research covers a breadth of topics within the NGI themes.

The primary research goals outlined in the strategic plan are: (1) to understand the structure, function, and services of ecosystems across land-sea, ocean-atmosphere, and coastal waters-deep sea interfaces; (2) to synthesize information across disciplines to reduce uncertainty and to forecast ecosystem responses; and (3) to develop applications that address regional management needs.

NGI's four research themes are: (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.

25. What was accomplished under these goals?

The success of the NGI Mission is in 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. Peer-reviewed documentation of NGI-funded research provides an established metric for the quality, rigor, and significance of research. 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. Under the guidance of NGI the following significant accomplishments were achieved:

Federal, State, and Civilian employees were trained in the latest GIS techniques and technologies and the data available from the Digital Coast repository. Funding for HPC support for OAR researchers produced a new supercomputing system, currently ranked as the 68th most powerful 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) has been compiled and tested on Orion.

NGI Researchers, in collaboration with AOML personnel have analyzed long-term water quality trends in Biscayne Bay and developed a watershed model for a representative portion of Biscayne Bay. NGI has been designated by NOAA as the CI for Gulf of Mexico Hypoxia and hindcasting models now being used to increase understanding of seasonal hypoxia patterns.

In collaboration with CIMAS personnel, AOML, and SEFSC personnel, NGI Researchers have developed a model that provides an important tool to address questions related to ocean acidification and other processes that impact the Gulf of Mexico and its natural resources. NGI Researchers have 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 Stepped-Frequency Microwave Radiometer (SFMR) developed by NGI Scientists has become the primary tool used for collecting aircraft-based estimates of the surface wind speed in tropical cyclones. NGI Research is developing a product for air-sea interactions (fluxes of heat, moisture and momentum). In collaboration with NOAA and other researchers, NGI has quantified the structural turbulence on the continental shelf and slope of the Gulf of Mexico. Our research teams have 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. Additional NGI research has 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. In collaboration with personnel at the LMRFC and OWP, NGI Researchers have demonstrated the value and efficacy of using runway launched UAS to assist in flood forecasting and in validating inundation models. Researchers within NGI have performed some of the preliminary unmanned maritime systems research in preparation for standing up the NOAA Unmanned Systems Operations Program at Gulfport, MS. Our team members have also 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). By specifically addressing NOAA research objectives for a Weather-Ready Nation and Climate Adaptation and Mitigation. NGI Researchers contribute to the NOAA AI strategy to use Artificial Intelligence to better leverage available weather data. Please see the individual project reports for more information.

Attach a separate document if more space is needed for #6-10, or #24-50.

ACCOMPLISHMENTS (cont'd)

26. What opportunities for training and professional development has the project provided?

NGI researchers and partners continued to provide timely updates to local stakeholders concerning topics and conditions of the region. Concept and topic specific releases, classes and multi-disciplinary workshops for further professional development were provided to both the public and private sectors.

NGI team members regularly attend programming workshops, seminars on leadership, ARC GIS classes, and undertake coursework at affiliated universities. Students associated with the NGI attended; AGU, AMS, AAPG, HPC2, US Hydro, software training for GNSS work, and the NOAA Geospatial Summit. Additionally, NGI personnel (including students) receive instruction on operation of the UAS and ASVs and their associated data collection systems.

Many opportunities were made available to undergraduate, graduate and postdoctoral scholars, which often result in enhanced career development. Students involved with NGI have been able to continue their training for participation in the various NOAA field programs. As well as contributing to or authoring NGI and NOAA relevant publications and attending conferences to present their findings.

NGI personnel have also participated in training activities and attended conferences to enhance their knowledge on HPC systems as well as to continually advocate for potential research activities that may be conducted by NOAA and others on the available NGI HPC systems. Training they receive includes computational thinking, software, hardware integration and programming for use in better management of High-Performance Computing assets used to support the NOAA mission.

NGI has also provided resources for 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 professional and workforce development opportunities for individuals concerning environmental 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.

Additional professional development and outreach opportunities have been undertaken to expose not only professionals but students and teachers as well as 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. These will be discussed in depth in the section (Question 16) on Education and Outreach.

27. How were the results disseminated to communities of interest?

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.

ACCOMPLISHMENTS (cont'd)

28. What do you plan to do during the next reporting period to accomplish the goals and objectives?

The NGI and its associated researchers intend to continue to provide high-quality work and dissemination of research findings. NGI will also continue to develop and implement a more comprehensive watershed assessment for the Gulf of Mexico, to include the continued development of a land use GIS database, further hydrologic and biologic assessments, and continually enhanced water quality, oceanographical and meteorological assessments that will be used in future modeling and assessment of the regions conditions.

PRODUCTS

29. Publications, conference papers, and presentations

There were 63 Associated publications generated by this project cycle. These are listed in detail in the attached MS Excel Document.

PRODUCTS (cont'd)

30. Technologies or techniques

Nothing to Report

31. Inventions, patent applications, and/or licenses

Nothing to Report

Attach a separate document if more space is needed for #6-10, or #24-50.

PRODUCTS (cont'd)

32. Other products

In addition to publications generated by the associated research, the NGI Education & Outreach team produces a quarterly newsletter of current events, notices and relevant research based upon requested researcher submissions, to the NGI Website as both a Newsletter and as Blog posts These can be viewed at <http://www.ngi.msstate.edu/portal/> and <http://www.ngi.msstate.edu/portal-blog/> respectively.

PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS

33. What individuals have worked on this project?

Robert Moorhead- Director NGI
Steve Ashby- Associate Director NGI
Jonathan Harris- Outreach Coordinator
Whitley Alford- Program Administrator

PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS (cont'd)

34. Has there been a change in the active other support of the PD/PI(s) or senior/key personnel since the last reporting period?

Melanie Jennings was added as a PD last July to help with the submission of proposals on Grants Online.

35. What other organizations have been involved as partners?

Besides NOAA, LA office of Coastal Protection and Restoration, MS Department of Marine Resources, MS Department of Environmental Quality, RESTORE Council, Gulf of Mexico Research Initiative (GoMRI), GRIIDC, the NOAA RESTORE Science Program, the National Academies of Science Gulf Research Program, and Florida A&M University

PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS (cont'd)

36. Have other collaborators or contacts been involved?

AOML: NGI has placed several postdoctoral associates, and recently an assistant research professor, at AOML. Since (timewise) that relationship was initiated, recently 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.

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. 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. The relationship has 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-UASScience-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.

IMPACT

37. What was the impact on the development of the principal discipline(s) of the project?

Additional information about processes associated with associated regions of study was developed. These findings were made available as recommendations to local stakeholders and resource managers and used to influence additional studies to be conducted in the future. On the matter of the "Gulf Dead Zone", The Hypoxia Task Force was informed about the extent of the hypoxia zone in 2019. Interactions with stakeholders in the watershed of the MS River were increased. The hypoxia zone east of the MS River was highlighted in several presentations and was highlighted again for those who did not know of its existence.

IMPACT (cont'd)

38. What was the impact on other disciplines?

An increased understanding on the impacts and influences of independent interactions among separate scientific disciplines.

39. What was the impact on the development of human resources?

These projects provide the opportunity to train the next generation of experts in their respective fields, including training graduate students in NOAA-relevant disciplines, which is often augmented by personal mentoring by NOAA scientists from associated line offices. These interactions will provide good candidates for the future NOAA mission workforce. They have provided hands on experience to dozens of undergraduate and graduate students. The results of these projects may lead to increases in human resources by number and skill as understanding of the associated environment is enhanced and improved. Additionally, the graduate students involved have refined their research skills and have become familiar with the peer review publication process.

IMPACT (cont'd)

40. What was the impact on teaching and educational experiences?

The NGI through its associated Education & 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, and alongside the various states departments of education, as well as through individual teachers and students, including training and professional development for teachers on lesson plan design, incorporation of current scientific data and research, and integration of technology. In addition to directly training and providing professional development opportunities, NGI also actively takes part in outreach, engagement and STEAM related education events. These events include participation by NGI scientists in educational summer camps, and engaging K-12 students and faculty in ocean and atmospheric research and coursework. NGI also takes a great interest in forging community STEAM engagement events, with active demonstrations, displays and activities for students and members of the public.

Projects that the NGI Education and Outreach Team have developed include "Travelling Trunk Shows which include Science based curriculum and equipment packaged and designed to support the national college and career readiness standards and provide STEAM focused interactions to large numbers of schoolchildren, their parents, teachers and administrators. We have also implemented 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.

From a numerical perspective NGI impact on our community has been significant.

NASA Infinity Center Homeschool Mondays and science Saturdays reflect a ticketed attendance of 100-225 visitors per day respectively. The Stennis "Take your kids to work day" events reflect an estimated attendance of 200 school aged children and their siblings. The Mississippi Science Teachers Association Annual Meetings and National Science Teachers Association annual meetings host 2,500 and 30,000 ticketed attendees respectively. The GOMA (Gulf of Mexico Alliance) All Hands Meetings reflect a registered attendance of 450 scientists and professionals. Gulfport Highschool Theatre (Theatrical Production on Climate), Had 500 tickets sold on GHS campus and Impacted 10 additional Mississippi schools with travelling show attendance of approximately 100 students at each school (1000 students total), and an additional impact at the Mississippi Theatre Association Festivals of 25 additional state schools and approximately 750 students and faculty in attendance. Harrison and Hancock County School District (Visiting Faculty lectures, displays and activities) reflected an impact on 12 classrooms of approximately 30 students each with visits (360 students). The Lynn Meadows Discovery Center (Children's Museum displays and activities) reflected ticket sales of 150 tickets plus an uncounted "Family Pass" attendance. Super Computing's SC19 (Super Computing Conference to discuss NOAA use of new HPC systems) posted a registered attendance of 13,000. The Celebrate the Gulf Marine Science Festival reported an estimated attendance of 1,200 visitors. Overall, the NGI Outreach Team has interacted with approximately 50,000 individuals (students, teachers, and professionals) in registered events this year plus hundreds more in "off-the-record" local discussions and interactions. 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.

41. What was the impact on physical, institutional, and information resources that form infrastructure?

Nothing to Report

IMPACT (cont'd)

42. What was the impact on technology transfer?

Nothing to Report

43. What was the impact on society beyond science and technology?

While there is constant evolution in science, we believe that several areas are perhaps due for increased investment. 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?
- Because of these ongoing projects there has been an increase in public understanding of the environment including watershed and associated downstream impacts on water quality, marine habitat environment and climate of the region.

IMPACT (cont'd)

44. What percentage of the award's budget was spent in foreign country(ies)?

0 , null

CHANGES/PROBLEMS

45. Changes in approach and reasons for change

There have been no significant changes reported

CHANGES/PROBLEMS (cont'd)

46. Actual or anticipated problems or delays and actions or plans to resolve them

Please see the attached list of all projects that were extended beyond their originally scheduled project end date, address reasons for the delays and plans to resolve them.

47. Changes that had a significant impact on expenditures

Nothing to Report

CHANGES/PROBLEMS (cont'd)

48. Significant changes in use or care of human subjects, vertebrate animals, biohazards, and/or select agents

Nothing to Report

49. Change of primary performance site location from that originally proposed

Nothing to Report

PROJECT OUTCOMES

50. What were the outcomes of the award?

Numerous presentations and publications improved hazardous weather warnings to the general public, state, local, and professional entities. Increased understanding of physical (e.g., wind, stress, waves, and cyclonic characteristics), chemical (e.g. salinity), and biological (fish dynamics and phytoplankton distribution) processes in the Gulf of Mexico lead to improved simulations and forecasting related to water quality patterns (e.g., salinity and oxygenation) and currents. Coastal resiliency to impacts of sea level rise was enhanced with the ongoing development of a geospatial based decision support tool.

DEMOGRAPHIC INFORMATION FOR SIGNIFICANT CONTRIBUTORS (VOLUNTARY)

Gender:

- Male
- Female
- Do not wish to provide

Ethnicity:

- Hispanic or Latina/o Not
- Hispanic or Latina/o Do not
- wish to provide

Race:

- American Indian or Alaska Native Asian
- Black or African American
- Native Hawaiian or other Pacific Islander
- White
- Do not wish to provide

Disability Status:

- Yes
 - Deaf or serious difficulty hearing
 - Blind or serious difficulty seeing even when wearing glasses
 - Serious difficulty walking or climbing stairs
 - Other serious disability related to a physical, mental, or emotional condition
- No
- Do not wish to provide

Attach a separate document if more space is needed for #6-10, or #24-50.