Marine Weather Portal: Upgrades and Stakeholder Requested Enhancements

Jennifer Dorton, UNCW Center for Marine Science

Regional coastal ocean observing systems, as part of the IOOS initiative, provide opportunities for increased access to meteorological and oceanographic data over and beyond the data that NOAA and other federal agencies have been able to provide. One of the challenges faced by IOOS-funded organizations is how to aggregate data from multiple sources in a meaningful way for stakeholders. SECOORA members have worked together since 2007 to develop and continuously improve the Marine Weather Portal (MWP), hosted on the SECOORA website. The MWP aggregates data provided by the NOAA National Data Buoy Center, National Weather Service (NWS), National Estuarine Research Reserves, IOOS Regional Associations, and other sources into a map-based product specifically developed for the marine community.

The goals of the Marine Weather Portal (MWP) are to: 1) provide 24/7 access to critical marine weather information for the commercial and recreational marine communities in the southeast US and Gulf coast regions; 2) make NOAA and other provider data more widely accessible on one website; and, 3) provide the site in a customizable format which the NWS offices can use for their Marine landing page. The MWP allows users to access standardized map-based marine weather pages, color coded active hazards, marine observations, point-and-click coastal waters forecasts, and detailed five-day marine forecasts, among other features.

The MWP was developed by meteorologists, web designers, data managers, and outreach personnel with the University of North Carolina Wilmington, University of South Carolina, Second Creek Consulting LLC, and NWS offices in coastal states across the Southeast and Gulf of Mexico. The MWP is currently used to disseminate standardized, consolidated marine information for the SECOORA and Gulf of Mexico Ocean Observing System regions: http://mwp.secoora.org. During Year 2 of the project, the MWP team will identify additional modeling data, forecast products, and other applications which could be disseminted on the MWP. This will require that the project team continue working with NWS offices in the southeast to identify products of highest need for stakeholders.

Southeast Coastal Ocean Observing Regional Association (SECOORA): Regional Glider Observatory

Catherine R. Edwards, Skidaway Institute of Oceanography, University of Georgia

The SECOORA regional glider observatory was established in July 2016 as a cooperative effort among five institutions (SkIO/UGA, USF, UNC, NCSU, GIT) to use autonomous underwater vehicles called gliders to provide regional 4-D information about temperature, salinity and density structure, dissolved oxygen, chlorophyll concentration, and fisheries data to SECOORA stakeholders and partners. With field and shore-based responsibilities pooled among the participants to take advantage of complementary assets, four gliders were deployed in September 2016 in the South Atlantic Bight (SAB), collecting approximately 26,000 profiles over 59 glider-days. Partners at NOAA/NC-COS, Vemco, and the Ocean Tracking Network (OTN) provided additional acoustic instrumentation to collect fisheries data, using the gliders as mobile platforms to listen for tagged fish and other animals, as well as ambient biological and environmental noise. Year 1 efforts established the backbone of infrastructure, including the development of new tools to aid piloting, to optimize glider navigation and data collection using input from real-time model and observational data, and to contribute collected data to national glider data repositories used to constrain and improve operational ocean models. Modeling products constrained by assimilation of three-dimensional temperature and salinity fields provide powerful tools for stakeholders involved in management efforts. The glider observatory is highly leveraged through partnerships with NOAA's Gray's Reef National Marine Sanctuary, NASA's Kennedy Space Center Ecological Program, and NOAA's SEFIS program, each of which contributed vessel support and/or personnel efforts. A webinar shortly after deployment was used to further facilitate dissemination of glider data among SECOORA partners and stakeholders. Year 2 efforts will build on these early successes, further development of data management and visualization for data exploration and scientific use, and strengthen connections with collaborators in coastal ocean modeling, fisheries management, and the recreational and commercial fishing industry.

Southeast Coastal Ocean Observing Regional Association (SECOORA): Supporting Resilient Ecosystems, Communities and Economies -- A Coupled Marine Environmental Assessment and Prediction System for the Southeastern U.S. Coastal Ocean in Support of Effective Marine Ecosystem-Based Management, Efficient Marine Operations, and Resilient Coastal Communities

Dr. Ruoying He, Department of Marine, Earth and Atmospheric Sciences, North Carolina State University

In the southeastern U.S., the Loop Current/Florida Current/Gulf Stream system unites shelf seas from Louisiana to Florida in the Gulf of Mexico and from Florida to North Carolina along the east coast. This strong, deep ocean feature flows along the

continental shelf in the entire SECOORA footprint, strongly affecting circulation on adjacent continental shelves and providing a conduit for transport of nutrients, heat and marine organisms between the sub-regions of the coastal southeastern United States. The development of a regional coastal observatory in the service of societal goals elaborated in the national plans therefore requires a *regional-scale* approach, and a combination of modeling, observations, and data management.

To contribute to the efforts of building a regional observatory, we have implement an advanced regional marine environment assessment and prediction capability for SECOORA by using *a suite of fully coupled ocean-atmosphere-wave-marine ecosystem prediction models informed and updated continuously though data assimilation*. This system will predict coastal ocean conditions over the entire SECOORA footprint with a high degree of scientific accuracy, and update and transmit such information to stakeholders in a timely and clear fashion.

The primary goal of this effort is to supports all four of the SECOORA theme areas, as the ability to model and predict regional marine environmental conditions, transport of heat, organisms, nutrients and pollutants bears materially upon climate change, coastal hazards, safe and efficient marine operations, water quality and living marine resource management.

Benefits include the ability to inform coastal managers of the paths and intensities of storms and the resulting wave and water level buildup along the coast, when and where polluted water could move across the shelf into our coastal areas, define likely receipt zones for harmful algal blooms, define habitat interconnectivity for commercially important fish or crustacean species, and to help determine physical processes affecting the lifecycles of those species.

Stakeholder groups include U.S. Coast Guard, NOAA National Marine Fisheries Service, NOAA Office of Response and Restoration, Bureau of Ocean Energy Management, NC Department of Environmental Quality, SC DNR, GA DNR, Florida Fish and Wildlife Conservation Commission, and the South Atlantic Fishery Management Council.

Southeast Coastal Ocean Observing Regional Association (SECOORA): Supporting Resilient Ecosystems, Communities and Economies, Operate and Maintain UNCW Moored Stations as part of SECOORA

Lynn Leonard and Jennifer Dorton, University of North Carolina Center for Marine Science

As part of the larger SECOORA coastal observing enterprise and in cooperation with partner data providers that include US Army Corps of Engineers (USACE) and UCSD Coastal Data Information Program (CDIP), UNCW operates nine real-time coastal and

offshore moorings in NC and SC. These systems provide hourly reports of core meteorological and oceanographic parameters. UNCW follows QARTOD requirements for data QA/QC, provides all data to SECOORA, and archives the data on UNCW servers. Real-time mooring data are ingested for use in existing products and applications by local, state, and federal agencies and industry partners (e.g. University of South Carolina, SECOORA, NWS, USACE, Roffer's Ocean Fishing Forecasting Service, FryingPanTower.com) as well as those under development. Currently, supported applications include: 1) data verification points to support hind-casting and real time applications (USACE Wave Information Study, USCG Search and Rescue, Voulgaris HF Radar surface current velocity study); 2) daily validation of the Coastal Waters Forecast and rip current forecasts produced by NOAA NWS offices; 3) meteorological and physical oceanographic data for data poor areas of Onslow Bay and Long Bay; 4) observational data to support continued operation and enhancement of ongoing and proposed SECOORA products such as the Marine Weather Portal and How's the Beach: Water Quality and You; and 5) long-term data records for assessment of environmental change. By providing observations in the Carolinas portion of the SECOORA footprint, the observational data provided by UNCW fills what would otherwise be large gaps in coastal oceanographic and estuarine observations, including areas not covered by existing HF Radar or federal assets in the region. The UNCW observing program supports SECOORA goals in the areas of Marine Operations and Coastal Hazards.

The UNCW mooring program has contended with two challenges this funding period. The first, Hurricane Matthew, caused extensive damage to sensors and communications equipment to the FRP2 mooring, located off of Fripp Island, SC. Other moorings sustained minor damage but were still reporting after the storm. Our second challenge is with area boaters hitting the moorings. We have sustained major damage to three moorings due to ship strikes in 2016/17.

Incorporation of Passive Acoustics and Acoustic Telemetry on an Established Regional Coastal Ocean Observatory to Measure Fish Sound Production and Behavior as an Indicator of Ecosystem Function

James Locascio, Mote Marine Laboratory

The role of ocean observatories continues to broaden as the need for data from multiple sensor types is required to understand ecosystem processes and potential impacts from anthropogenic sources and climate change. Overall, sensors capable of measuring levels of secondary productivity reflective of ecosystem function, which can be reliably incorporated into ocean observatories for long term monitoring, are almost non-existent. Hydrophones used to detect or transmit acoustic signals probably represent the only choice well suited for this purpose.

In this SECOORA funded project an existing coastal ocean monitoring station at Big Carlos Pass, operated by USF's Coastal Ocean Monitoring Station, was re-engineered to include hydrophones for measuring ambient sound production and acoustic encoded tags to track movement and migration patterns of fishes. The main sources of ambient underwater sound in the study area include fishes, invertebrates (snapping shrimp), boats, and marine mammals. Fish sound production is associated with courtship and spawning and is used as a proxy measure of reproduction. Acoustic tags implanted in fish transmit a unique code which is detected by a receiver when the signal is within range. Initial tests indicate the high power tags (162 dB re: 1μ Pa) have an effective range of approximately 100 m. The acoustic receivers and transmitters provide a source of biological data which has not previously been possible to collect on the same time scales as the environmental data at these monitoring stations. The collective suite of sensors is designed to capture high resolution data on the ecosystem level.

The project team, with the assistance of Axiom, added an encoding and decoding algorithm for the new GOES satellite data format. Data are transmitted via acoustic modem to GOES satellite and stored to the SECOORA database. Despite some logistical challenges and delays, the station at Big Carlos Pass is functional as proposed. Acoustic tagging of fishes is scheduled for the 2017 field season. Students from the Florida Gulf Coast University are participating in field work. Fish tag IDs belonging to other researchers which are detected and logged at the Big Carlos Pass will be made available through regional data sharing networks.

Maintain and Operate Priority USF COMPS Inshore Coastal Stations

Mark E. Luther, PI, Jeff Scudder and Clifford Merz, Co-Investigators, University of South Florida College of Marine Science

University of South Florida College of Marine Science continues to maintain the COMPS in-shore Coastal Stations to the extent possible with the resources available. Data from these sites are sent to SECOORA and the NOAA National Data Buoy Center (NDBC) and to the Global Telecommunication System (GTS) via NDBC. Data also are sent to the GCOOS portal.

The rebuilding of the Big Carlos Pass site was completed in August. The steel radio mast was replaced with a hinged fiberglass mast. All sensors and wiring were replaced. In collaboration with Mote Marine Lab, the active and passive fish acoustic sensor systems were integrated with the meteorological and oceanographic sensor suite. Both GOES satellite telemetry and cellular IP modems are active and data are being received. Decoders for the GOES data stream have been developed by Axiom but there are still issues with the fish acoustic data.

M. Luther met with St. Petersburg City Council and officials from the mayor's staff to discuss relevance of marine observations and modeling efforts to recent wastewater

releases into Tampa Bay and surrounding waters. Data from the water quality station on Clam Bayou have been very useful for assessing the impacts of the wastewater releases on dissolved oxygen, chlorophyll, and turbidity. We are working with city staff from St. Petersburg and from Gulfport to quantify the occurrence of low DO events and to distinguish naturally occurring from wastewater related events.

Unfortunately, co-PI and chief field engineer, Jeff Scudder, suffered a major brain stem stroke in late August and has only recently returned to work part-time. It is uncertain if or when he may return to full-time work. His absence has impacted our operations but Cliff Merz has stepped it to assist, along with some part-time staff.

Southeast Coastal Ocean Observing Regional Association (SECOORA): Supporting Resilient Ecosystems, Communities and Economies Operate and Maintain Gray's Reef Ocean Acidification Buoy

Scott Noakes, The University of Georgia

Operation of the Grays Reef time-series mooring has been a multi-organization effort which has successfully collected high-resolution data since 2006. The mooring is located in the South Atlantic Bight (SAB) offshore Georgia, USA and within the boundaries of Gray's Reef National Marine Sanctuary (GRNMS). It sits along the divide between the inner and middle shelf with water depths of 20 m. Water chemistry is primarily controlled by the middle shelf oceanic dynamics, but during heavy rain events, it can be affected by freshwater plumes coming from the numerous rivers along the Georgia and South Carolina coast. Temperature, salinity and biological activity also play a major role in the pCO_2 variability with seasonal changes being apparent. During summer months, GRNMS acts as a CO_2 source to the atmosphere while during winter months it is a CO_2 sink. The benthic community at GRNMS has proven to be hardy enduring large seasonal swings of seawater CO_2 and pH. At this point, it is unclear at what point the benthic community will experience detrimental effects of the decreasing seawater pH. It is clear that for the ten year monitoring effort, the atmospheric and seawater CO_2 has been increasing annually causing the seawater pH to decrease. Research planned for the sanctuary will be aimed at determining how these organisms cope with the seasonal changes and how they will adapt to rising seawater CO_2 over time.

Integrated Decision Support and Management Tools for Adaptive Public Health Practices: An Early Warning System for Swimming Beach and Shellfish Harvesting Waters

Dwayne E. Porter, PhD and Geoff I. Scott, PhD, Dept. of Environmental Health Sciences
Arnold School of Public Health, University of South Carolina

Bacterial pollution of coastal waters has important public health, economic, and social implications, particularly for tourism and shellfish industries. Bacterial pollution is a major cause of water quality impairments, resulting in a loss of ecosystem services. These losses impact the recreational and commercial fishing and shellfish industries, tourism, and also contribute to public health concerns related to primary contact with bacterial-laden waters and consumption of contaminated shellfish.

This project builds on the PIs existing collaborative community-based research efforts with local and regional decision makers to develop and implement a robust decision-making support system to advance the overarching goals of the Integrated Coastal Ocean Observing Act of 2009 and specifically addresses the SECOORA priority theme areas of: Ecosystems, Living Marine Resources, and Water Quality; Coastal Hazards; and, Climate Change. Members of the project team work with resource managers and public health officials in FDA, EPA, ISSC and in MD, NC, SC and FL to develop and implement decision support tools which incorporate rainfall, water temperature, wind, and salinity data for beach recreation water quality management of SC and FL beaches, and prototype tools for SC and MD shellfish harvest area management.

This project leverages resources, data, and skill sets available from the University of South Carolina, University of Maryland Center for Environmental Science, University of North Carolina at Wilmington, SECOORA, state and local resource management and public health agencies, and NOAA's National Weather Service (NWS), Center for Coastal Environmental Health and Biomolecular Research, National Integrated Drought Information System, and Office for Coastal Management / National Estuarine Research Reserve System.

User groups, including resource managers, public health officials and representatives of potentially vulnerable populations (e.g. Ad Hoc Water Quality Modeling Work Group, Charleston Waterkeeper, Lowcountry Alliance for Model Communities), are being convened to provide guidance, input and review in support of tool development. The anticipated products include nowcast tools that use precipitation, water temperature, wind, and salinity data (provided by the NWS, ocean observing systems, and state management agencies) and historic measures of bacteria concentrations to predict *Enteroccocus, fecal coliform* and/or *Vibrio* levels as well as new forecasting products derived by coupling the nowcasting tools and climate change model scenarios.

Enhancing deep-water estuarine monitoring in the SECOORA region through expansion and integration of the National Estuarine Research Reserve System's System-Wide Monitoring Program in the Charleston Harbor

Denise M. Sanger, ACE Basin National Estuarine and Research Reserve, South Carolina Department of Natural Resources

Charleston Harbor is the busiest port in the state of South Carolina. Currently, there is no continuous water quality monitoring of the bottom waters near the mouth of Charleston Harbor. The establishment of a station in Charleston Harbor will provide a multitude of benefits to a variety of stakeholders, including recreational and commercial boating interests, scientists, and managers. In particular, the deepening of Charleston Harbor to accommodate larger vessels may begin as early as late 2017, which may alter salinity regimes and circulation patterns within the harbor. Water quality data before and after this project will be of great value in assessing the project impacts. We have worked with the Army Corps of Engineers - Charleston District (ACOE-CD), US Coast Guard (USCG), SC Harbor Pilots Association, US Geological Survey, National Parks Service, SC Institute for Archaeology and Anthropology, and SC Department of Health and Environmental Control to identify a monitoring site in the lower harbor that will provide stakeholders with the most benefit. The site was chosen such that it would be co-located with an ACOE-CD monitoring site. The site is located adjacent to the shipping channel. The proposed water quality monitoring station will be configured to be consistent with National Estuarine Research Reserves System-Wide Monitoring Plan protocols and operations. The site will include a bottom sonde located adjacent to Fort Moultrie National Park on a soon to be installed structure by the USCG. The site will monitor water temperature, conductivity/salinity, dissolved oxygen, pH, turbidity, chlorophyll fluorescence, fluorescence of dissolved organic matter (FDOM, a proxy for total dissolved organic carbon) and water depth. The installation has been delayed from the original plan due to the collocation and use of another platform than the one we originally proposed to install. However, the partnerships that this provided are a tremendous asset to the program.

Sustaining & Enhancing Coastal Ocean Observing for Regional Applications – HF-RADAR

Dana K. Savidge, Skidaway Institute of Oceanography

Two high-frequency, shore-based WERA radar systems are installed on St. Catherine's and Jekyll Islands, along the coast of Georgia, which provide surface velocity measurements over a shelf area extending approximately 100 miles along the coast and 100miles out to sea. A dense grid of measurements at ~1.5mile spacing are updated every half hour, and are used for model verification (R. He, NCSU) and continuing scientific analysis of shelf circulation and Gulf Stream variability. Two major hurdles were surmounted during the most recent SECOORA sponsored period. First, after the retirement in 2016 of longtime technical staff Julie Amft and Trent Moore, replacement hire Gabe Matthais has come quickly up to speed on radar operation and maintenance. Both Gabe and Dana Savidge attended the Helzel (manufacturer) Operator's Workshop in Hamburg Germany in September to update training and troubleshooting skills. Immediately upon their return, the second major hurdle, Hurricane Matthew, caused significant damage and extensive power outages along the Georgia coastline. The Jekyll Island antenna arrays sustained considerable physical

damage, including dislodging and burial of approximately half the pole/coil/cable assemblages. However due to the robustness and flexibility of hardware deployment options, and with the assistance of Helzel personnel, the Jekyll system resumed operation with the remaining undamaged antennas, upon the restoration of power several weeks after the storm. The St. Catherine's radar system sustained only very slight damage, but was offline for approximately two months, until power was finally restored to the radar's remote location. Otherwise, lightening damage has been a recurrent issue at St. Catherine's, resulting in significantly reduced transmit power and range. Additional electronic protection has now been installed. Finally, four additional WERA radars (funded by NSF) were installed by Savidge and Matthais on the Outer Banks of North Carolina this spring. While not technically a SECOORA product, we intend to explore making these data accessible to the public through SECOORA-funded entities, i.e., the SECOORA website, or the visualization capabilities of the SECOORA-funded R. He group at NCSU.

Southeast Coastal Ocean Observing Regional Association (SECOORA): Supporting Resilient Ecosystems, Communities and Economies – Operate and Maintain University of North Carolina – Chapel Hill IOOS Priority High Frequency Radars in SECOORA

Harvey Seim, University of North Carolina at Chapel Hill

The three high frequency radar installations along the North Carolina coast have operated well over the last year, providing observations 98% of the time over ranges of on average 175 km or more. Maintenance on the installations during late summer 2016 replaced failing components and cabling at several sites and, working with the National Park Service, removed sand from the access road to the HATY site at Buxton, necessary to replace the fuel tank for the backup generator. We attribute the excellent system performance over the last year to these preventative maintenance efforts. Each site faces challenges – the CORE site is remote and accessible only by boat; the HATY site has seen severe coastal erosion and overwash; and the DUCK site has also experienced significant erosion and has the added challenge of coordinated operation with John Hopkins University, whose equipment allows use of a dual transmitter at the site, but which adds considerable complexity. DUCK and HATY have been in place since 2003 and though some components have been replaced, some components are now more than a decade old. The installation is, for the coming 18 months, supporting a National Science Foundation study of Processes driving Exchange At Cape Hatteras (PEACH). The NC radar provide surface current information over a large fraction of the domain of interest to PEACH. The PEACH project has deployed a large array of in-water equipment, as well as nesting a higher-resolution high frequency radar system within the NC radar footprint, and deploying gliders on the shelf and deeper waters. The nested radars will provide an opportunity for direct comparison of two styles of radar systems in a very dynamic environment overlooking the shelf waters and adjacent Gulf Stream. The 10 in-water current sensors will also provide a rich source of validation data for the radar once the in-water sensors are recovered.

Southeast Coastal Ocean Observing Regional Association (SECOORA): Supporting Resilient Ecosystems, Communities and Economies – SECOORA Regional Glider Observatory University of North Carolina - Chapel Hill glider component

Harvey Seim, University of North Carolina at Chapel Hill

A UNC glider was deployed off the central east Florida coast in mid-September of 2016 as part of a coordinated glider survey of the South Atlantic Bight shelf. The intent of the survey was to sample the spatial structure of shelf waters; at present, funding allows this to happen once a year. The glider measured temperature, salinity, pressure, dissolved oxygen, chlorophyll a fluorescence, colored dissolved organic matter, optical backscatter and carries a fish tag receiver as it moved along a sawtooth pattern through the ocean between the ocean surface and bottom. The glider had not been used for several years and challenges included training new staff to operate it. Strong southward currents prevented significant northward movement, led to a decision to move into deeper waters close to the Gulf Stream after two weeks of operation, at which point a small leak in the glider was detected that ended the mission. Fortunately, the research vessel R/V Savannah was nearby and was able to recover the glider soon after the leak was detected. Strong near-bottom maximums in chlorophyll a, a proxy for phytoplankton biomass, were observed, a surprising result for the time of year. Observations have been shared with modeling groups who use the data to either validate their model fields or assimilate the data to improve model performance. The fish tag receiver was on loan from NOAA's Beaufort NC lab. Staff there are eager to have the gliders carry the receivers as a way to acquire additional information on fish locations in the South Atlantic Bight. The project also benefited from support from the NASA Kennedy Space Center; scientists there provided vessel support to deploy the glider.

SECOORA High Frequency Radar Component in South Florida

Lynn K. (Nick) Shay, Dept. of Ocean Sciences, RSMAS, University of Miami

Over the past year, real time data were acquired at three sites *(98% for Virginia Key, 96% for Crandon Park, and 92% for the Dania Beach Site)*. Each site provided hourly radial current data at 2.2 km resolution to the US National Network archive hosted by Scripps Institution of Oceanography. All three sites were functioning during hurricane Matthew's passage. As part of the effort, significant wave heights are estimated from the radar backscattered signals offshore of the Miami area. We continue to assess potential sites for a fourth radar at the Florida Power and Light (FPL) Turkey Point facility. A letter was sent to FPL for a meeting discussing all aspects of the radar. Unfortunately, we are still awaiting a formal response to our request from FPL which is

being reviewed by the Nuclear Regulatory Commission. Thus, finding that fourth site to link into the Crandon Park site continues to be a challenge. In the northern part of the domain at Dania Beach, higher resolution surface current measurements close to Port Everglades are being provided to an Army Corp of Engineers sponsored dredging pilot study administered through Florida Institute of Technology via a South Florida-Caribbean Cooperative Ecosystems Studies Unit (CESU). The CESU program (http://sfc-cesu.com/events/) is a consortium of the National Park Service, Southeast Marine Fisheries, Army Corps of Engineers, Fish and Wildlife, Coast and Geodetic Survey, Bureau of Indian Affairs, San Juan Historical Society, and the University of Miami. Finally, HF radar data are being used to assess sea level rise along Miami Beach since several years of radial and vector current measurements have been acquired as part of SECOORA, including sea level measurements and high resolution, space-based sea surface height anomaly measurements from satellite missions. We hope to identify potential stake holders and funding avenues to address this societal problem over the next 1-2 years since it requires detailed analyses of these existing data sets Dr. Matthew Archer completed a PhD Dissertation entitled *Spatio-Temporal Variability of the Florida Current Velocity Field Between 25°N and 26°N* using HF radar techniques. A revised manuscript will be resubmitted to Journal of Geophysical Research-Oceans in May.

Southeast Coastal Ocean Observing Regional Association (SECOORA): Supporting Resilient Ecosystems, Communities and Economies: HF Radar Operation and Maintenance in Long BAY, SC

George Voulgaris, University of South Carolina

University of South Carolina has been responsible for the operation and maintenance of the US IOOS/SECOORA identified priority WERA system radar sites located at Georgetown, SC (GTN) and Fort Caswell, NC (CSW).

The two sites have been operational for the current funding period providing surface current data for over 95% of the time. Surface currents are measured every 30 min and the data are available to the national HF radar network within 45 min of data collections. In addition, in collaboration with the University of North Carolina at Wilmington, we have embarked on an in-situ evaluation of the HF radar velocities using ADCP data from an instrument deployed in the footprint of the HF radar system. Preliminary analysis has shown that the differences between the ADCP and HF radar measured velocities are highly correlated with the wind velocity vector, in support of the fact that the HF radar measured closer to the sea surface where the wind effect is the maximum and where in-situ sensors fail to measure. Additionally, the data collected to date are used for the creation of monthly and annual climatologies. Finally, data from the stations are appearing in the literature and are used in proposals by other Universities in the area and beyond.

The challenges of the project are related to coastal erosion around the HF radar deployment stations, leading to multiple instances of HF radar antenna relocation. In addition, during Spring – Summer the Georgetown station is in a marine turtle nesting area. Permanent installation of the antennas is not allowed as we are unable to alter the natural environment. Thus, as coastal erosion continues the antenna arrays are found closer to the beach, the area of turtle nesting. We are in continuous communication with the SC Department of Natural Resources in taking measures to avoid interference with the turtle nesting. This is achieved through continuous monitoring and changes of the installation. Although manageable at present, it creates additional costs in modifications and in personnel expenditures. In the long term, if there is not a reversal of the erosional patterns, relocation or decommission of the station might be inevitable.

A coordinated observing and modeling system for the west Florida continental shelf as part of SECOORA

Robert H. Weisberg and Yonggang Liu, College of Marine Science, University of South Florida

This award partially supports three real time ocean-atmosphere buoys on the west Florida shelf (WFS), a west Florida coastal ocean circulation model (WFCOM) that downscales from the deep-ocean, across the shelf and into the estuaries, and satellite altimetry and surface geostrophic currents analyses. Two subsurface moorings are also maintained. Both real time observations and modeled nowcast/forecasts are served at http://ocgweb.marine.usf.edu and supplied to SECOORA. These are also distributed through NOAA. Observations and simulations deliveries to date approach 100%. Stakeholder applications include recreational boating, harmful algal blooms, fisheries, search and rescue and harmful substance tracking. Four recent accomplishments are: 1) seasonal and short term prediction of K. brevis red tide joint with FWC (Liu et al., 2016), 2) an exposition on the origins and pathways of new, deeper-ocean water upwelled onto the WFS (Weisberg et al 2016), 3) an explanation on how Deepwater Horizon oil arrived on northern Gulf beaches (Weisberg et al, 2017) and 4) the WFS wind field structure and fidelity between observed and modeled winds (Mayer et al., 2017). The first relates major red tide occurrences with WFS water properties determined by the circulation. Red tides tend to occur under oligotrophic conditions when K. brevis may out-compete faster growing diatoms, and, when a bloom occurs, we track it daily (http://ocgweb.marine.usf.edu/hab_tracking/HAB_trajectories.html). The second explains the conditions, origins and pathways by which new, nutrient rich water replenish the WFS. In essence, WFS ecology begins with the coastal ocean circulation. The third shows how both the circulation and waves (via Stokes drift) determined DWH oil deposition on the northern Gulf shoreline and discusses the modeling tools required to predict the movement of future oil or other harmful substance spills. Finally, the fourth suggests what is required for improving marine weather forecasting and, as a corollary, for improving upon coastal ocean circulation forecasts driven largely by winds.

Being that ecology begins with the circulation, what we suggest is of fundamental IOOS importance, providing a strong justification for the observational component of IOOS. We continue to leverage SECOORA support, give public outreach lectures and expand our undergraduate summer intern program.

Operate and Maintain University of South Florida IOOS Priority High Frequency Radars in SECOORA

Robert H. Weisberg and Clifford Merz, College of Marine Science, University of South Florida

This award partially supports a USF HF-radar network being maintained on the west coast of Florida. The network consists of three CODAR systems, designated as high priority radars by IOOS, and two WERA systems, all overlooking an array of moored instrumentation (surface meteorology and water column velocity, temperature and salinity), together comprising a unique HF-radar testbed. We are also accumulating parts for a fourth CODAR to be implemented pending adequate support (no other spares presently exist for the three in operation and the newly imposed budget reductions lack provision for site preparations, permits and structures). Data reception over the prior 9-month period exceeded 94% for all 5 HF-radar sites.

Highlights of this year's activities are a book chapter organized by and contributed to Vembu Subramanian (Liu et al., 2017) and a Master of Science thesis by Ben O'Loughlin entitled: Evaluation of Search and Rescue Planning Tools on the West Florida Shelf. Of the approximate 20,000 search and rescue cases conducted by the Coast Guard, 5% of these occur within the coastal waters of the west Florida shelf (WFS). The thesis utilized observations from three surface drifter deployments to evaluate the effectiveness of available surface current models and HF-radar observations in support of WFS search and rescue. HF-radar root-mean-square errors were found to be about 10 cm/s, and objectively mapped HF-radar data out-performed all model simulations, the caveat being when HF-radar was available for the drifter locations. Additionally, comparative model skills showed that the West Florida Coastal Ocean Model (WFCOM) out-performed the other models in use. Strong justification was thereby provided for increasing HF-radar coverage of the WFS and for the implementation of WFCOM in search and rescue applications.

References:

Liu, Y., C. Merz, R.H. Weisberg, B.K. O'Loughlin, and V. Subramanian (2017), Data return aspects of CODAR and WERA high frequency radars in mapping ocean currents, in Observing the Oceans in Real Time, edited by Venkatesan et al., Springer (in press).

Liu, Y., R.H. Weisberg, J.M. Lenes, L. Zheng, K. Hubbard, and J.J Walsh (2016), Offshore forcing on the "pressure point" of the West Florida Shelf: Anomalous upwelling and its influence on harmful algal blooms, J. Geophys. Res.-Oceans, 121, 5501-5515, http://dx.doi.org/10.1002/2016JC011938.

Mayer, D.A., R.H. Weisberg, L. Zheng, and Y. Liu (2017), Winds on the West Florida Shelf: Regional Comparisons between Observations and Model Estimates, J. Geophys. Res.-Oceans, 122, 834-846, doi: 10.1002/2016JC012112.

O'Loughlin, B. (2016) Evaluation of Search and Rescue Planning Tools on the West Florida Shelf, Master of Science thesis, College of Marine Science, University of South Florida, October 31, 2016.

Weisberg, R.H., L. Zheng, and Y. Liu (2016), West Florida Shelf upwelling: Origins and pathways, J. Geophys. Res.-Oceans, 121, 5672–5681, doi:10.1002/2015JC011384.

Weisberg, R.H., L. Zheng, and Y. Liu (2017), On the Movement of Deepwater Horizon Oil to Northern Gulf Beaches, Ocean Modelling, 111, 81-97, doi:10.1016/j.ocemod.2017.02.002.