SECOORA Annual Meeting
Wilmington, North Carolina
June 18-19, 2019 | Website | All Meetings are Open

Operate and Maintain UNCW Moored Stations as part of SECOORA

Lynn Leonard, University of North Carolina Center for Marine Science

As part of the larger SECOORA coastal observing enterprise, and in cooperation with partners that include US Army Corps of Engineers (USACE) and UCSD Coastal Data Information Program (CDIP), UNCW's Coastal Ocean Research and Monitoring Program (CORMP) operates nine real-time coastal and offshore moorings in NC and SC and one non real-time station offshore of NC. The real time systems provide hourly reports of core meteorological and oceanographic parameters (www.cormp.org). In Year 3, CORMP partnered with the UNCW Shellfish Research Hatchery and the N.C. Coastal Reserve to provide weather and water quality data from a pier-based station located at UNCW's Center for Marine Science. CORMP also added one mid and one near-bottom conductivity/temperature sensor below the 2 surface moorings located in southern Onslow Bay, NC. In Year 3, CORMP hosted two UNCW undergraduate interns, one undergraduate Honors student, and one high school intern from New Hanover County Schools' Marine Science Academy. CORMP staff also aided the development and delivery of a new course entitled "The science, technology and policy of ocean observing". In this course, 16 BS Oceanography majors explored the history and evolution of NOAA's Integrated Ocean Observing System (IOOS) and worked with CORMP technicians to service, instrument, and trouble-shoot the three meteorological buoys that were deployed from the RV Savannah in April 2019.

CORMP implements QARTOD for real-time data QA/QC and uses an interactive QA/QC reporting tool, developed in partnership with Second Creek Consulting, to flag suspect or failed data. All data, including QARTOD flags, are archived on CORMP servers and provided to SECOORA. In fall 2018, CORMP migrated its data collection processes and web/data services to the Amazon Cloud in anticipation of power outages associated with Hurricane Florence. This action allowed for uninterrupted delivery of buoy data to NOAA's National Weather Service (NWS), Emergency Managers, and other key stakeholders during the storm. It also established a "back-up" protocol that can be easily activated during power outages, server maintenance interruptions, or other emergencies.

CORMP data are ingested for use by local, state, and government agencies, private industry, and academic partners. Some examples include: the USACE (Wave Information Study and hurricane model validation), USCG Search and Rescue, SECOORA's Marine Weather Portal, and NOAA's NWS (Coastal Waters Forecasts, Marine Hazards warning, and rip current forecasts). By providing observations in the Carolinas portion of the SECOORA footprint, CORMP fills what would otherwise be large gaps in coastal oceanographic 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; Coastal Hazards; and Living Marine Ecosystems.

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 five 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). Data from all five stations are also sent to the GCOOS portal.

In Year 3, the COMPS web interface, http://comps.marine.usf.edu/, was redesigned in collaboration with Second Creek Consulting, LLC. This new web services capable site applies full QARTOD QC to all data served from the site.

Sites collecting water level and surface meteorological parameters at Big Carlos Pass, Clam Bayou, Fred Howard Park, Aripeka, and Shell Point have remained operational with minimal down time. Additionally, the Clam Bayou site collects a suite of water quality parameters in partnership with YSI/Xylem. The Big Carlos Pass site collects water temperature/salinity and fish acoustic data in collaboration with Jim Locascio at Mote Marine Lab.

COMPS water level and wind data were used by NOAA Weather Forecast Offices in Tallahassee and Tampa and at NHC during and after Hurricane Michael. Data from the COMPS site at Shell Point showed a peak storm tide of just over 3 m during the storm. Other COMPS water level sites showed storm tides of approximately 1 m in the Tampa Bay area as Michael passed.

M. Luther, S. Meyers, and J. Scudder are working with St. Petersburg and Pinellas County water management staff to develop predictive tools based on short-term climate forecasts to help mitigate future 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 recent wastewater releases on dissolved oxygen, chlorophyll, and turbidity. This work is funded by the Tampa Bay Environmental Restoration Fund through the Tampa Bay Estuary Program.

M. Luther and S. Meyers are working with the Tampa Bay Estuary Program, the U.S. Fish and Wildlife Service, and the Tampa Port Authority to analyze Automatic Identification System (AIS) vessel tracking data to estimate the impacts of ship wakes on critical marine Habitat in Tampa Bay. A report on this effort is at https://www.tbeptech.org/TBEP_TECH_PUBS/2019/TBEP_06_19_Ship_Wakes.pdf. They are mining the AIS data for other Maritime Domain Awareness applications, such as identification of optimal vessel transit windows and automated anomaly detection, in collaboration with the port authority, the Tampa Bay Pilots, ARES Security, and Gatehouse Maritime.

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 is for a coordinated program of coastal ocean observing and modeling. It partially supports four West Florida Shelf (WFS) real-time ocean-atmosphere buoys (C10, C12, C13, C21), a West Florida Coastal Ocean Model (WFCOM) that downscales from the deep-ocean, across the shelf and into the estuaries by nesting FVCOM in the GOM HYCOM, a much higher resolution Tampa Bay Coastal Ocean Model (TBCOM) that includes Tampa Bay, Sarasota Bay, the Intra-Coastal Waterway and the inlets connecting these with the adjacent Gulf by nesting FVCOM in WFCOM, plus two non-real-time subsurface moorings and satellite altimetry/surface geostrophic currents analyses. Both real-time observations and modeled nowcast/forecasts are served at http://ocgweb.marine.usf.edu and supplied to SECOORA and NOAA.

Mooring C21 and TBCOM are relatively new additions to our SECOORA/COMPS portfolio facilitated by a competitive Restore Act grant from Pinellas Co. The high resolution TBCOM opened several new application opportunities, including hurricane storm surge and water quality simulations that already have and will attract new potential members to SECOORA. The first test of TBCOM was a simulation of the Tampa Bay response to Hurricane Irma (Chen et al., 2018). TBCOM accurately simulated the water level variations, the drying and subsequent flooding that occurred, and both the efflux and influx of water of ecological importance. TBCOM for red tide tracking was then used by Hillsborough Co. OEM for their weekly (multi-county) advisories and by Pinellas Co. for beach cleanup intelligence. C21 offers environmental intelligence for one of the most utilized inlets of Pinellas Co. TBCOM (which depends on WFCOM) led to a new engagement with the Tampa Bay Estuary Program in regard to their ocean acidification interests. We were provided a nominal grant to collaborate with USGS scientists making CO2-related observations in Tampa Bay. We then expanded this collaboration by inviting these USGS scientists to affix CO2-related sensors to our C12 mooring. Our newest client is the City of Tampa for a fresh water diversion study, and we are also in discussion with Sarasota Co. regarding their water quality interests. In other words, increased outreach effort to generate increased stakeholder use of our SECOORA assets was an ongoing activity over the past year.

With stakeholder applications in mind, we emphasize the coordinated observing and modeling nature of our SECOORA efforts, an example being our approach to the *Karenia brevis* red tide phenomenon on the WFS. Observations tend to be too sparse to fully describe a complex system and models alone tend to be fraught with errors; when combined we achieve the benefits of both. An example is given by our explanation of why the 2018 red tide was so severe and also why it was one of the rare examples when *K. brevis* appeared simultaneously on Florida's west, Panhandle and east coasts (Weisberg et al., 2019). Moored observations and model nowcasts/forecasts allowed us to guide a glider mission, and the moored observations also provided a veracity test of the model simulations, enabling us to track the delivery of *K. brevis* to the nearshore and to document when and why it also went to the Panhandle and east coasts. Such coordinated approach also led to multiple public outreach engagements via public lectures and media (print, radio and TV) articles and interviews. Through such a science-driven approach, we are able to provide information of great importance to a variety of stakeholder Finally, our SECOORA/COMPS activities on the WFS helped to secure two new NASEM grants as part of their UGOS Program. We are funded to deploy a real-time mooring at a WFS location termed the "pressure point," and we are also funded for three new HF-radar installations looking across the Florida Current to Cuba.

Installations at the Dry Tortugas and Key West will also provide radial coverage over the southwest portion of the WFS, adding to our SECOORA/COMPS assets. This new HF-radar project is joint with SECOORA colleague, N. Shay.

In summary 2018/2019 was a period of new discovery and much expanded stakeholder interactions.

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

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

The University of South Florida, Ocean Circulation Group adhered to its statement of work to maintain a coordinated program of coastal ocean observations and models, including observations made with High Frequency Radars (HFR). We continue to operate and maintain three (3) US IOOS/SECOORA identified priority CODAR system HFR sites (Naples, Venice and Redington Shores), along with two (2) WERA HFR sites (Venice and Ft. DeSoto Park) overlooking our instrumented mooring array. Data are sent to SECOORA, NOAA NDBC, and the IOOS National HFR CORDC Network (HFRNet) for integration, display and dissemination. Plots of the data are also being posted on the USF College of Marine Science COMPS Ocean Circulation Group web site (http://ocgweb.marine.usf.edu). We continue to work with other SECOORA region HFR operators to standardize operations, data delivery, display and dissemination, maintain data integrity and provenance, provide accuracy estimates of surface currents and develop common data products for stakeholders. The combined average CORDC up-time for HFR data received from December 1, 2018 through May 31, 2019 by all five USF HFR sites was >90%.

SECOORA focus areas entail real-time generation and distribution of offshore surface current and direction data for integration into ocean models supporting:

- USCG Search and Rescue (SAR) Operations.
- Improved boater safety.
- Oil spill tracking.
- Red tide tracking.

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

Dana K. Savidge, Catherine R. Edwards, Skidaway Institute of Oceanography, UGA

Two shore-based surface current measuring WERA HF-radar systems are installed on St. Catherine's and Jekyll Islands, along the coast of Georgia. Surface velocity measurements from these systems cover a shelf area extending approximately 100 miles alongshelf and 100 miles out to sea. A dense grid of measurements at ~3.5mile spacing are updated every half hour, and are used for model verification (R. He, NCSU), assist in glider navigation (C. Edwards, SkIO) and support continuing scientific analysis of shelf circulation and Gulf Stream variability. The St.Catherine's (CAT) HFR continues to operate, with minimal repairs planned in the near future. However, two consecutive years of hurricane damage in 2016 and 2017 incapacitated the transmit and receive antenna arrays on the Jekyll Island (JEK) HFR. In fall 2016 (Year 1), Hurricane Matthew caused significant physical damage to approximately half the antennas. Because of the nature of the beam-forming equipment, it was possible to restore operation at somewhat reduced range and spatial resolution without replacing the damaged antennas. But in fall 2017 (Year 2), Hurricanes Irma and Maria destroyed the remaining external components (antennas and cables) of the Jekyll system, as well as the boardwalk on which the majority of antennas were deployed, and exacerbated ongoing erosion at the Jekyll site. To restore operation of the Jekyll system, SkIO has been awaiting beach renourishment and boardwalk rebuild (scheduled for early summer 2019), along with needed funding from SECOORA for replacement parts. SkIO technician B. Hefner will soon oversee purchasing and redeployment of complete transmit and receive antenna arrays to reactivate the Jekyll nominal surface current measurement capability to pre-Matthew range and resolution.

In addition, four leased 13MHz medium range WERA radars installed in North Carolina (in spring 2017 for an NSF project) have been purchased with SECOORA funding, based on the very favorable lease to own agreement governing their original deployment. Combined with the UNC CODAR systems in the area, either of the southernmost two systems overlooking Raleigh Bay extend areal coverage there significantly. With the conclusion of the NSF project in spring 2019, the more northern 2-3 systems will be relocated to extend overall HFR shelf coverage within the SECOORA footprint. B. Hefner has made significant progress finding and initiating permitting for two sites north of Cape Canaveral FL - a region where their range (about 75 miles) is appropriate to the societal and research needs to which they will contribute.

HF Radar Operation and Maintenance in Long Bay, SC

George Voulgaris, University of South Carolina

The University of South Carolina is 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 about 95% and 88% of the time for the GTN and CSW stations, respectively. Surface currents are measured every 30 minutes and the data are available to the national HF radar network within 45 min of data collections. Hurricane Florence made landfall on September 14, 2018, near Wilmington, NC north of the CSW site. Although there was no catastrophic damage to the system, power outages and antenna destructions by significant coastal erosion led to system downtime. After emergency repairs were carried out, the systems were online within a few weeks but the cumulative effect of Florence and the hurricanes the year before has deteriorated the effective range of the system by 25-30%. Data delivery is continuous to date and the performance of our systems (in terms of operational uptime) exceeds the average of all

IOOS HF radar systems. We continue to update our climatology data monthly (since 2012) although since September 2018 our range is slightly reduced.

In addition, we have continued examining the ability of the HFR systems to provide wave spectral information. A model for the inversion of the Doppler spectra has been developed (Alattabi et al., 2019) that treats swell and wind-waves separately, and the method has been published as Open Source Code (Cahl et al., 2019) for the IOOS HF Radar community and others to use and further evaluate. We evaluated the model using VHF radar data from a past deployment which coincided with several in-situ wave sensors. The model inversion comparisons with in-situ data revealed wave height RMS differences ranging from 0.16 to 0.25 m as the radar beam angle increases from 22° to 56°. The work initiated last year for the development of a method that combines beamforming analysis with the MUSIC algorithm (beamscan) is still under progress and the subject of a PhD thesis research. This method aims at increasing radial velocity accuracy (Cahl et al., in prep 2019).

Coastal erosion continues to affect our installations and the antenna arrays are found closer to the beach every year and in turtle nesting areas at GTN. We continuously monitor the situation and take measures to avoid interference with the turtle nesting.

References

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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

UNC Chapel Hill operates three high frequency radar installations along the North Carolina coast. During the last year the main challenge faced was operations of the CORE site, located on Core Banks north of Cape Lookout at the National Park Service's Great Island Campground. This is a remote site, accessible only by boat. CORE had two issues during the reporting period. The first was a failure of its air conditioning unit in mid-May 2018 which subsequently caused intermittent shutdowns (due to overheating) and eventually to a (low-power) transmitter failure on August 9. There were long delays in getting a new air conditioning unit (and the older one repaired, to provide a backup), because these are DC powered, necessary as this is a low-power site. There was an issue with the vendor, and the lack of air conditioner led to excessive heat in the CORE shed over the summer. Working with CODAR, Tony Whipple (at UNC IMS) was able to identify and replace a failed component in the transmitter and bring it back on line August 30. The second issue was that the site was significantly impacted by Hurricane Florence. Staff visited the site prior to the storm to lay down and tie down the solar panels and drop the wind generator. CORE reported through most of the storm, but the site was one of the locations where there was overwash into the back bay behind the barrier island, depositing several feet of sand around the base of the antennas and solar array. Subsequent bulldozing by the National Park Service cut cabling to the antennas. There was no access possible to the site until October 17 when staff were able to assess damage, order cabling and lightning arrestors and get the site back online on 16 Nov 2018. The system is performing well though

we have seen some oddities from the loop antennas. A concern is that storm damage may be slowly impacting the performance, similar to the behavior seen at HATY after its receive antenna was knocked down during Hurricane Maria in 2017.

Two of the NC HFR site operated well over the last year, providing observations over 98% of the time, over ranges of, on average, 180 km or more. The CORE site was available 78.5% of the last year as a result of the issues reported above, but when reporting, provided similar range coverage.

The installations also support a National Science Foundation study of Processes driving Exchange At Cape Hatteras (PEACH). The NC radars provide surface current information over a large fraction of the PEACH domain. The PEACH project has deployed a large array of in-water equipment and added 4 WERA higher-resolution/ high frequency radar systems within the NC CODAR network. The radial vectors from both types of systems provide coverage in Raleigh Bay that was previously unavailable from the CODAR systems alone. A new total vector product is being produced utilizing all the systems, available at: nccoos.org/platforms/hfradar/.

One of the WERA systems will be retained, to become part of the SECOORA HFR system, to provide improved coverage along the NC coastline. We have completed an assessment of data coverage and quality for various configurations of the available systems and expect to finalize the decision shortly. Based on data collected in February 2018 we anticipate the adding one WERA to the network will increase coverage by roughly 5100 km^2. Details will be provided as part of the PI's presentation at the annual meeting.

SECOORA High Frequency Radar Sensing of the Florida Current in South Florida

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

The goal of the UM HF Radar component, consistent with the goals of the National HF Radar network, is focused on the operating HF Radar sites for 24 hours of operations seven days a week across the Florida Straits. Specially, the HF radars in South Florida monitor the Florida Current. Our progress over the past year has been primarily focused on operations at the Dania Beach site where the radar has been operational for more than 98% of the time, and laying the ground work for a North Key Largo Site through extensive negotiations with the Florida Department of Environmental Protection and successfully completing the NOAA NEPA process. In addition, we have provided guidance to FIT assisting them on their WERA deployments. Finally, we are working on installing an HF radar on Ocean Cay south of Bimini that will look westward across the Florida Straits at no cost to IOOS or SECOORA. This five station setup will provide unprecedented measurements at 1 km resolution at 15 to 20 minute intervals resolving not only the Florida Current but also the evolving surface wave/wind fields.

Another major research accomplishment over the past year was to conduct aircraft operations prior, during and subsequent to the passage of hurricane Michael (2018) over the eastern Gulf of Mexico. Briefly, these marine operations included atmospheric and oceanic expendables and remotely sensed surface wind and directional wave measurements from the NOAA WP-3D and SIO drifter and APEX-EM float (temperature, salinity and current) deployments from the USAF WC-130J working with the 53rd Weather Squadron.

East Central Florida High Frequency Surface Coastal Mapping Radar

George Maul, Florida Institute of Technology (FIT)

FIT received funding to expand the SECOORA HFR coverage along the east coast of Florida through the deployment of two 13.5 MHz WERA at Sebastian Inlet State Park (SISP) and Patrick Air Force Base (PAFB). Both HFRs have been ordered and delivery is expected during Summer 2019. FIT has requested permission from SISP to deploy the WERA and is currently waiting on the state park to provide feedback on required permits and conditions for site use. Dr. Maul has also been actively engaging with PAFB officials to formally request siting on base property. Dr. Maul has met with PAFB officials throughout 2019 and will continue to respond to information requests from PAFB and the DoD. Finally, Dr. Maul is also working with the FCC to apply for licenses to operate the WERA.

Marine Weather Portal: Upgrades and Stakeholder Requested Enhancements

Jennifer Dorton, Southeast Coastal Ocean Observing Regional Association

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 SECOORA, 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 3 of the project, the project team presented the MWP at the 2018 Oceans conference, hosted in Charleston, SC. The team also participated in the Charleston Boat Show and highlighted the MWP functionality to boaters and mariners attending the event.

SECOORA Regional Glider Observatory

Catherine R. Edwards, Skidaway Institute of Oceanography, University of Georgia Chad Lembke, University of South Florida; Ruoying He, North Carolina State University; Harvey Seim, University of North Carolina at Chapel Hill; Fumin Zhang, Georgia Tech

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. Field and shore-based responsibilities are pooled among the participants, taking to advantage of complementary assets. In year 3, SECOORA purchased a new G3 glider to address issues of the aging fleet of the regional operators. The new glider, "Franklin", will be operated out of SkIO, and was deployed in May 2019 for his "maiden" mission.

Deployments in year 3 focused on basin-scale surveys to maximize the geographic range, with SECOORA mapping missions deployed from Cape Canaveral and Gray's Reef National Marine Sanctuary. The Kennedy Space Center Ecological Program and Gray's Reef National Marine Sanctuary provided vessel support at no cost, and the missions were coordinated with the Florida Atlantic Cooperative Telemetry (FACT) Network. Students from UNC, UGA, and Georgia Tech have contributed to glider observatory efforts, and one journal paper and three conference papers have been published or are in press based on glider observations and path planning algorithms developed to optimize navigation. Several additional missions in the SECOORA footprint were conducted by observatory PIs who are also involved in the NSF-funded PEACH project at Cape Hatteras.

The SECOORA glider observatory also joined forces with collaborators at NOAA, Rutgers, and other academic institutions to use gliders to better predict hurricane intensity, as the model skill for storm intensity has not increased at the same pace as for hurricane track models. Two gliders were deployed into the path of Hurricane Florence, which bisected the two gliders, located off North Carolina and at the GA/SC border. The data from these two gliders was shown to significantly increase model skill of the Navy GOFS3.1 operational ocean models which assimilate glider and other profile data, compared to the then-default ocean boundary conditions provided by GOFS3.0 (no glider data assimilation). The SECOORA glider data provided critical information about stratification, heat content, and Gulf Stream location, and were used in briefings to NOAA/Navy partners to demonstrate the impact of the overall project, leading to new funding to expand the Hurricane Gliders program to the South East Atlantic in 2019-2020.

GIT has developed new path planning/path following algorithms that have been tested in simulation mode for both modeling products and HF-radar derived short term current predictions at Cape Hatteras. The simulations have also provided guidance for when and how averaging can be used to minimize computational time and maintain the ability to provide waypoints within 1-2 minutes after the glider has surfaced and established communications with shore. Year 4 efforts will test these capabilities in missions off GA, SC, and new HF radar installations off FL.

SkIO and UNC also have developed and automated data visualization products to aid piloting. The codes detect which gliders are operational, automatically convert binary data into ASCII, make plots of engineering and science data, publish them to a website, and update a Google

Maps-based app within minutes of glider data transmission.

These codes have been modified to accept data from local and remote dockservers, including Webb's new Slocum Fleet Management Control (SFMC) software. In year 3, SkIO upgraded its original dockserver system to the SFMC, which includes logging, archiving, and advanced user administration capabilities. SkIO SFMC, dockserver, and imageserver systems are now maintained on emergency power (generator back-up), and the SFMC system is compatible with facilities at USF and TAMU, all of which serve as back-ups in the event of network and/or extended power failure.

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.

The primary goal of this effort is to support 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.

To contribute to the efforts of building a regional observatory, we have implemented 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.

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 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 Disaster Recovery Partnership

Debra Hernandez

The Southeast coastal region is vulnerable to a variety of disasters that can impact the vitality and long-term viability of its coastal communities. Planning for the disaster recovery process provides an opportunity to build resilience to future hurricanes, flooding, and other hazards. The Southeast Disaster Recovery Partnership (SDRP) was established to strengthen the ability of the Southeast's coastal economy and environment to recover from the next coastal storm. This Partnership connects disaster recovery stakeholders with the training, resources, information, and industry support that coastal communities need to effectively bounce back.

SECOORA coordinates the Partnership, which is currently funded by a NOAA Regional Coastal Resilience award. Under this grant, the Partnership's work has three components. First, it supports projects in the states of North Carolina, South Carolina, Georgia and Florida that provide critical information, training, and resources to coastal communities to implement the National Disaster Recovery Framework or build disaster recovery capacity more broadly. Second, the Partnership builds the capacity of the public and private sectors to work together in implementation of the Economic Recovery Support Function of the NDRF. Third, the partnership builds a regional network of disaster recovery stakeholders that exchange knowledge across federal, state, and local governments and with non-governmental partners (academia, private sector, non- profits, etc.).

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. In particular, the deepening of Charleston Harbor to accommodate larger vessels 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. In Year 2, SC Department of Natural Resources (SCDNR) and the ACE Basin National Estuarine Research Reserve (NERR) worked with partners, Army Corps of Engineers - Charleston District (ACOE-CD), US Coast Guard (USCG), Charleston Port, and SECOORA, to establish the Charleston Harbor water quality monitoring station. The site was chosen such that it would be co-located with a US Army Core of Engineers – Charleston District wave monitoring site. The water quality monitoring station is configured to be consistent with NERR System-Wide Monitoring Plan protocols and operations. The site was installed in November 2017 and destroyed on August 30, 2018. From January to August 2018, the mean and range for each parameter are as follows: water temperature 20.7 (3.1 - 31.3) ^{o}C, salinity 29.4 (9.8 - 35.6) psu, dissolved oxygen 95.3 (61.2 - 146.1) % saturation or 7.4 (4.1 - 11.7) mg/L, pH 8.0 (7.5 - 8.3), turbidity 14 (3 - 2979) FTU, and water depth 3.12 (1.7 - 4.6) m.

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

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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 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 the 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 recreational contact 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, 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.

We continue to maintain the mobile app howsthebeach.org and provide public access to daily estimates of swimming beach bacteria levels for the Myrtle Beach, SC, Sarasota, FL, Charleston, SC, and Kill Devil Hills, NC. These sites are located at http://howsthebeach.org/ and more specifically: http://howsthebeach.org/myrtlebeach; http://howsthebeach.org/sarasota; http://howsthebeach.org/charleston; and http://howsthebeach.org/killdevilhills. In addition, detailed daily reports are provided to

interested beach managers and public health officials in SC and FL. We also worked with the Charleston Waterkeeper to develop a newsletter for distribution via their established communication network.

As part of this effort, SECOORA along with the SC Department of Health and Environmental Control, the NIEHS-funded Oceans and Human Health Center for Climate Change Interactions (OHHC2I) and the Interstate Shellfish Sanitation Conference (ISSC) co-sponsored the Nowcasting / Forecasting of Swimming Beach and Shellfish Harvesting Waters Workshop in Georgetown, SC. The workshop brought together beach managers and shellfish managers from NC, SC and FL and the EPA and FDA. Led by the EPA Virtual Beach staff and our PIs, two days of discussion and training on the use of Virtual Beach and R as tools to support nowcasting and forecasting of water quality conditions in our swimming beaches and shellfish harvesting waters was held. Discussions led by the FDA about the potential utilization of such decision support tools as have been developed by our collective efforts for regulatory management of shellfish harvesting waters was encouraging. We will be following up with both the EPA and FDA as part of our ongoing efforts supported by SECOORA and our OHHC2I. In addition, the continued development of the VB toolbox and sustained EPA support is invaluable to not only our efforts but to similar efforts all around the country. As freshwater HABs and the flushing of these HABs in to our estuarine / marine environments is a critical and expanding public health concern. As part of our continuing SECOORA and OHHC2I efforts, and in collaboration with the EPA, we will be exploring the use of the VB toolbox for the development of site-specific empirical forecasts in SC.

Extending the work done for the beach water quality projects, our research team provided the app for http://howsmyscriver.org based on needs of the Saluda River Monitoring Coalition, which was formed to monitor sections of the Saluda, Broad and Congaree rivers. This project monitors fecal coliform along eleven (11) sampling sites weekly during the recreation season, May to September.

In conjunction with our nowcasting efforts of recreational waters we have initiated a project with the City of Folly Beach, SC to provide site-specific water quality data and nowcasts for both the swimming beaches and the shellfish harvesting waters of Folly River on the backside of the island. We are working with the SECOORA WebCAT project to integrate video feeds from the Folly Beach Pier with (under development) automated feature extraction algorithms to identify and summarize beach utilization during times of weather, currents and water quality warnings.

Georgia Department of Natural Resources Coastal Receiver Array

Chris Kalinowsky, Georgia Department of Natural Resources, Coastal Resources Division

The Georgia Department of Natural Resources Coastal Resources Division (CRD) maintains an array of 24 autonomous acoustic receivers in Georgia's nearshore and offshore waters along St. Simons Island. The purpose of the Coastal Receiver Array (CRA) project is to track the movements of animals tagged with Vemco telemetry tags. The array consists of an inshore/nearshore component where 8 VR2W receivers are attached to navigation buoys along the St. Simons shipping channel and an offshore

component consisting of 16 VR2W receivers anchored to the seafloor, ranging from 6-24 miles offshore. Receivers record the presence of acoustically-tagged animals passing within 300 meters. Georgia's CRA complements similar projects conducted by other state, federal, academic, and non-governmental groups but is the only one of its kind in Georgia marine waters. The detection data for tagged animals are shared with other researchers, locally, regionally via the FACT Network and the Atlantic Cooperative Telemetry Network (ACT), and internationally. These data are used to better define the migration and habitat preferences of many coastal migratory species. This information is being used by resource managers to guide current and future resource management.

To date, over 670 individual tagged animals have been detected representing 41 different species, inclusive of threatened and endangered species. Included in this number are Atlantic Sturgeon, loggerhead sea turtles, Kemp's ridley sea turtles, Tripletail, Red Drum, Tiger Sharks, and White Sharks. These data have been shared with 46 different research groups from 10 different state, federal, and non-governmental organizations. Data from this project are providing new and exciting discoveries in the movements and migrations of marine animals. Recently data from Georgia's CRA were used as part of the South Atlantic Fishery Management Council (SAFMC) Southeast Data, Assessment, and Review (SEDAR) Atlantic Cobia Stock Identification Workshop. The results from this workshop were used to provide stock delineation guidance to the SAFMC SEDAR 2019 Atlantic Cobia Stock Assessment.

Implementation and management of a cloud-based telemetry data sharing system for the FACT Network

Joy Young, The FACT Network

The FACT Network, established in 2007, is a grassroots collaboration dedicated to improving the conservation and management of aquatic animals. FACT facilitates data-sharing between researchers using acoustic telemetry technology, providing a community for scientists, and builds stakeholder partnerships. Currently, the FACT Network has 283 individual members from 93 partner groups including academic institutions, state and federal government agencies, non-profit organizations, private consulting firms, zoological institutions, and private citizens. The FACT Network includes over 46 individual acoustic receiver arrays encompassing over 1,500 acoustic receiver stations from New York to the Florida Keys, Bahamas, and U.S. Caribbean and 1,964 active tag deployments in 45 aquatic animal species. Including retired tags, 5,681 acoustic tags have been deployed in 94 species of aquatic animal life.

Funding provided to SECOORA by the NOAA Animal Telemetry Network (ATN), has allowed data-sharing in the FACT Network to grow from a person-to-person process facilitated by a volunteer to the implementation of a cloud-based data sharing system (aka 'the node') overseen by a SECOORA funded data manager. After two major data processing events, the node houses 110.2 million lines of animal detection data and metadata for 4,966 acoustic tags from 100 tag and array studies. The size and scope of the node are expected to grow as historic datasets are uploaded and more FACT members adopt the online, semi-automated system.

FACT members manage their data online at Research Workspace. Submitted tag metadata and detection data are cross-matched within FACT and other regional nodes (e.g. Ocean

Tracking Network), increasing the scope of each individual study. The transition to the node allowed FACT to function as a data-sharing platform, making data sharing cost-effective without scaling issues. Moving forward, FACT will foster communication between researchers, stakeholders, and lawmakers to identify the specific goals and legal obligations of making telemetry data public while also not causing undue harm to study animals or the environment.

Recent papers:

Young J., Bowers B., Reyier, E., Morley, M., Ault, E., Gallagher, R., Ellis, R. (in press). The FACT Network: Philosophy, Evolution, and Management of a Grassroots Collaborative Coastal Tracking Network. Marine and Coastal Fisheries.

Southeast Ocean and Coastal Acidification Network (SOCAN)

Leslie Wickes, Thrive Blue LLC http://www.socan.secoora.org

The Southeast Ocean and Coastal Acidification Network was formed through a partnership with NOAA's Ocean Acidification Program and SECOORA. SOCAN provides a platform to cultivate partnerships and exchange knowledge to expand acidification science and engagement in the Southeast. Since it's founding in 2016, SOCAN has led workshops to synthesize regional acidification science, to engage North Carolina, South Carolina and Georgia stakeholders and to prioritize acidification monitoring locations. In the last year, SOCAN has focused on communicating acidification as a water quality issue in the context of long-term environmental change. The recently launched SOCAN website synthesizes this information and new state-based pages seek to distill this knowledge to state and local levels. In an effort to build capacity, SOCAN has partnered with multiple academic groups to pursue funding opportunities and launched a new Capacity Building Working Group. Partnering with the Gulf of Mexico Coastal Acidification Network (G-CAN), SOCAN is currently identifying gaps, needs and opportunities to expand engagement in Florida.

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 pCO2 variability with seasonal changes being apparent. During summer months, GRNMS acts as a CO2 source to the atmosphere while during winter months it is a CO2 sink. The benthic community at GRNMS has proven to be hardy enduring large seasonal swings of seawater CO2 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 CO2 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 CO2 over time.

All data transmitted from the buoy is sent to the Pacific Marine Laboratory, NOAA, Seattle WA for quality assurance monitoring. Real-time data can be graphically viewed at https://www.pmel.noaa.gov/co2/story/Grays+Reef. Additionally, data that has been processed through the quality control and assurance process can be accessed through the website.

A Georgia Southern University student is currently u**sing** the Gray's Reef ocean acidification data to better understand how the changing water quality may affect Oculina coral. The student is applying the Gray's Reef data to growth patterns in the corals to see how higher carbon dioxide levels in the seawater affect the coral's growth.

SECOORA Data Management and Communications Services

Kyle Wilcox, Axiom Data Science

As a member of IOOS, SECOORA has a mandate to collect, organize, and provide access to regional oceanographic data. These data need to be quality reviewed, easily understandable, easily discoverable, electronically accessible, and well organized to allow researchers, policy makers, industry, and the general public to make well-informed decisions. To satisfy this mandate, SECOORA supports a web-based data portal for the entire region providing ocean, coastal, and relevant watershed environmental data and information products.

The goals of the SECOORA data management system are to: i) curate multiple data streams from the sensors and models supported by SECOORA as well as from independent data providers, ii) document the data using IOOS-approved metadata standards, iii) provide these data to users via standard services and data products, and iv) archive the data in appropriate long-term archives. The SECOORA Data System is based on a service-oriented architecture that employs interoperable systems to enable data discoverability via web services and catalogs. The vision of SECOORA data management is to be recognized in the ocean observation community as a trusted leader in data quality, interoperability and discoverability.

SECOORA partners with Axiom Data Science to provide a standards-based lifecycle data management framework that maximizes the discoverability, accessibility, and usability of data and information products and ensures their sustained use. SECOORA leverages Axiom's data systems that also support AOOS, CeNCOOS, IOOS Environmental Sensor Map, and the Animal Telemetry Network DAC to use common infrastructure which enables the dedication of more funds to system advancements and innovation than would otherwise be possible. The relationship between SECOORA and Axiom is a collaborative partnership designed not only to serve the needs of SECOORA, but also to allow for greater contributions to the larger IOOS community. SECOORA works closely with Axiom to develop and update data management plans, statements of work, facilitate the flow of data, and ensure a coordinated end-to-end system.

Key DMAC accomplishments during FY18 include:

- Implementation of QARTOD and quality flag display in the portal
- Re-architecture of portal search
- Portal release updates (v2.9-2.10)

- New Hurricane Tracking tool
- Collection and consolidation of historical regional observations
- Migration from SOS to ERDDAP data services
- Sensor monitoring dashboard
- Support and tool development for the WebCAT and FACT programs