SECOORA Annual Meeting Principal Investigator Abstracts

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Marine Operations

East Florida Moorings – RDSEA International, Inc.

Development of a "Florida Coastal Ocean Observing System" (FLCOOS™)
Principal Investigator: Rick Cole, RDSEA International, Inc and Dr. Steven Lazarus, Ocean Engineering and Marine Sciences, Florida Institute of Technology

RDSEA International, Inc. (RDSEA, St Pete Beach, FL) in partnership with Florida Institute of Technology (FIT, Melbourne, FL) has set forth plans for the beginning stages of a "Florida Coastal Ocean Observing System" (FLCOOS™) along the east coast of Florida's coastal/littoral zone. SECOORA is to fund two (2) new coastal Met-Ocean surface buoy sites to fill "some" of the data gaps within the region (RCOOS Plan, 3.2: Observing Assets, 3.2.1: Moored Stations, FL East Coast). Fixed surface and subsurface instrumentation are planned for measuring; sea-surface meteorology, wave fields, water- column currents, and density. Buoy systems will be modeled after RDSEA's USF- COMPS-Hybrid coastal buoy system. Peripheral sampling of water-quality, HABs/eDNA, pCO2 and acoustics tracking are also planned. State-of the-art, new technologies will be used with Iridium satellite telemetry of near-rear-time data sets to the SECOORA data portal for stakeholder access.

Goals and Objectives:
Year 1: PI (Cole, Lazarus) meeting at FIT, Melbourne, to discuss initial planning, system deployment locations and data collection. Reach out to local stakeholders with this plan, suggest science and mission input and site location fine-tuning. The 20-25m depth range was the goal with buoy locations to be set within newly funded SECOORA HFR radials installed by FIT (south of Cape Canaveral) and SKIO (north of Canaveral) for data verification support. NOAA's NWS office in Melbourne, is in full agreement of our site location choices. Other sampling does exist in the region with two NWS weather buoys (Met and waves only) to the east of the Cape. CDIP wave buoys also reside along the coast (waves only). Strategic positioning was achieved to get good "separation" away from existing monitoring sites yet remain within HFR radials. Full site surveys were conducted via single-beam bathymetry to find flat-spots away from any existing reef systems. Permitting applications have been filed with the USACE and assigned a project #: SAJ-2022-01541 and a USACE Project Manager, Jacksonville Dist. Standing-by for permits. We also met with the vessel of choice for deployment work for this region of the coast. MV THUNDERFORCE, homeported in Ft Pierce, FL, operated by American Vibracore. We have used this vessel before, in the region, with success.

Year 2: Design, build and deploy one, possibly two systems in 2023, data streaming.

North Carolina and South Carolina Moorings – University of North Carolina Wilmington

UNCW's Coastal Ocean Research and Monitoring Program: Optimization & Enhancement of Observing Elements in the Carolinas

Principal Investigator: Lynn Leonard, University of North Carolina Wilmington

As part of the larger SECOORA coastal observing enterprise, and in partnership with the US Army Corps of Engineers (USACE) and UCSD Coastal Data Information Program (CDIP), UNCW's Coastal Ocean Research and Monitoring Program (CORMP) operates 13 real-time coastal offshore moorings in North and South Carolina that provide hourly reports of core meteorological and oceanographic parameters (www.cormp.org). CORMP also supports three coastal stations that provide weather, water level and/or water quality observations as well as one non-real time instrumented frame that measures water column currents, water depth, and near bottom temperature and salinity. 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. Real time data are made available as soon as they are received and processed and used by stakeholders such as USACE's Research and Development Center's Coastal and Hydraulics Laboratory (Wave Information Study, hurricane model validation), NOAA's National Weather Service (coastal waters & rip current forecasts, marine hazard warnings), SECOORA's Marine Weather Portal, Wrightsville Beach Ocean Rescue, harbor pilots, fishing websites (e.g. saltwatercentral.com) and the public. By providing observations in the Carolinas portion of the SECOORA footprint, CORMP fills what would otherwise be large observational gaps, 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.

A key accomplishment in Year 1 was deployment of two new buoys in partnership with the SC Ports Authority and Charleston Pilot Association. Both buoys are located 19 NM SE of the Charleston Harbor entrance. The first, CHR60, provides hourly updates of wind speed and direction, air temperature, atmospheric pressure, humidity, surface water temperature and salinity. The other, a Sofar Spotter buoy (CHR60WAVE), reports wave height, period, direction and water temperature every 30 minutes. These additions to SECOORA's observing network not only fill a long-standing data coverage gap, but also provide critical weather and sea state information for ships being moved into and out of the Charleston Harbor. In Year 2, CORMP will continue to enhance SECOORA's mooring array by upgrading CHR60WAVE to a Sofar Spotter Gen 2 Smart Buoy and

integrating water level to the real-time data feed; thereby providing ship operators with direct water depth measurements at the shipping channel entrance for the first time. CORMP also will enhance the value of SECOORA funded observations through development of a new Situational Awareness Support Tool (SAST) initially targeting weather forecasters and ocean rescue groups. The SAST allows users to specify stations and thresholds for parameters of interest to create a customized alert. When an alert is triggered, the user is automatically notified by email, social media, and/or text. Three NWS weather forecast offices are participating in the first phase of development.

West Florida Shelf Moorings and Modeling – University of South Florida

Coordinated Observing and Modeling for the West Florida Shelf and Applications in Matters of Societal Concern

Principal Investigators: R.H. Weisberg, Y. Liu, Y. Sun, J. Chen, J. Law, A. Nickerson, L. Sorinas; College of Marine Science, University of South Florida

The University of South Florida, Ocean Circulation Lab maintains a coordinated program of coastal ocean observations and models, with observations consisting of instrumented moorings for surface meteorology and in-water sensors and models consisting of coastal ocean models that downscale from the deep ocean, across the continental shelf and into the estuaries. The objectives continue to be to describe and understand the circulation of the West Florida Continental Shelf (WFS) and the role that the circulation plays in shelf ecology and other matters of societal concern.
The forcing of WFS circulation is a combination of local (winds, heat flux, river input) and deep-ocean (the Gulf of Mexico Loop Current system) influences. Our seasonal prediction of *Karenia brevis* major bloom on the WFS is manly based on the deep-ocean forcing, i.e., the interactions of the Gulf of Mexico Loop Current and the shelf. To better understand the Loop Current system, we analyzed satellite altimetry data for a new description of the Loop Current pattern evolution and found three canonical forms: Penetrative, Ring Shedding and Retracted States. This results also benefit the oil & gas and maritime commerce industries.

The termination of the 2018 Florida *K. brevis* red tide event was simulated with a passive tracer model independent of biological processes. The model results show that without offshore source of *K. brevis* cells, a nearshore bloom may quickly dissipate due to persistent upwelling circulation. Due to the coastline geometry, upwelling circulation may trap *K. brevis* cells in the coastline nook south of Sanibel Island.
Other funding resources (e.g., NASEM, NOAA ECOHAB, NOAA COMIT, FDEP) have been heavily leveraged for our observing and modeling work. Note that some of those resources are being lost (e.g., NASEM). Steady funding are required to sustain the critical SECOORA assets and to retain highly skilled and dedicated scientists that are difficult to recruit.

North Carolina High Frequency Radar – ECU Coastal Studies Institute and UNC Chapel Hill

Maintaining the North Carolina High Frequency Radar Network

Principal Investigators: Mike Muglia[1], Harvey Seim[2], Sara Haines[2], Trip Taylor[1], Spencer Wilkinson[1], and Tony Whipple[3] | ECU Coastal Studies Institute[1], UNC Chapel Hill[2], UNC Institute for Marine Sciences[3]

We continue to maintain four ~5MHz HFRs in North Carolina supported by IOOS/SECOORA at the Duck Field Research Facility (DUCK), Buxton-Group Cape Hatteras National Park Service (NPS) (HATY), Ocracoke airport (OCRA), and on the Core Banks at the NPS Great Island Campground (CORE). We have many accomplishments to report this year. First, we successfully brought a fourth site online in Ocracoke and it continues to maintain better than 85% operation time. All four sites have received their FCC licenses to operate. Harvey Seim and Mike Muglia are part of a project funded by NSF to optimize and re-analyze the HFR data since their installation in 2004 and compare them with other observations in the region, "Collaborative Research: North Atlantic Dynamics - Developing and Exploiting a Long-Term Cape Hatteras Gulf Stream Time Series". Several manuscripts that use the observations from our network or rely solely upon them were published or are currently in review:

Muglia, Michael, Harvey Seim, John Bane, and Patterson Taylor. "Gulf Stream Meander Kinematics Off Cape Hatteras, NC." *Frontiers in Marine Science.* Submitted January 2022. **Accepted May, 2022.**

Seim, H., Andres, M., Edwards, C., Gawarkiewicz, G., He, R., Muglia, M., Savidge, D., Todd, R., Zambon, J., Han, L. "Overview of the Processes driving Exchange At Cape Hatteras (PEACH) Project", *Journal of Oceanography.* Submitted December 2021. **In Press**

Muglia, M., Seim, H., & Taylor, P., "Gulf Stream Position, Width, and Orientation Estimated from HF Radar Radial Velocity Maps off Cape Hatteras, NC." *Journal of Atmospheric and Oceanic Technology* (2022). https://doi.org/10.1175/JTECH-D-21-0098.1

The NC HFR network compliments a suite of funded projects. The DUCK HFR is part of a DOE funded wind turbine mitigation experiment with Codar Ocean Sensors and several of our colleagues to the north. Muglia's team partnered with Codar Ocean Sensors and Oscilla Power to get a phase I DOE SBIR funded to begin the design of a wave powered offshore transmitter to complement existing HFR coverage off NC. The Phase 2 proposal is currently in review. We have had challenges with the low power site, CORE, overheating. Tony Whipple installed a new cooling system this year that has fixed the problem. DUCK has been plagued with bad coverage and a poor antenna beam pattern. We are working toward getting the proper state coastal zone management permits to consider moving the site to Jennette's Pier in Nags

Head. We are also exploring funding options to optimize the radar network to inform the coming NSF Pioneer Array move to the Outer Banks in 2024.

East Florida High Frequency Radar – Florida Institute of Technology

Treasure Shores and Hightower Beach Florida HFR

Principal Investigator: Dr. Steven Lazarus, Florida Institute of Technology

The Treasure Shores radar was fully installed (cabling, antennas, and tuning) in February 2022 by the PI with assistance from Florida Tech undergraduate and graduate students. Since then, the PI worked with FIT Information Technology personnel to create a virtual machine onto which the radar data will flow. We have established reliable remote comms with the supporting equipment (which is housed in a small utility room at the site) including the cooling system (via Tripp Lite Remote Control Cooling Management), and a UPS 2200VA (via a web portal). The comms are comprised of a Cradlepoint CBA850 LTE Adapter (with a 3-year NetCloud Essentials license) and an ASUS AX-1800 (RT-AX55) WiFi router (ASUSWRT). A Verizon unlimited account was set-up at a discounted rate through the university. A Synaccess remote power management system is also in place and functional. We have struggled with respect to establishing remote communication with the WERA user-interface PC (X11 tunneling issues); however, we have recently installed a trial version of TeamViewer and have had success with a remote login. The PI has asked the vendor to provide a quote for two sites and whether or not a second party can remote in for trouble shooting purposes. The radar data should be made available soon.

A second radar install, originally planned for a Patrick Air Force Base location, was relocated to Hightower Park (Satellite Beach, Florida) because the antenna placement was restricted to the west of the dune down-shore of a 15-foot sea grape canopy. This would have required elevating both the transmit and receive antenna which is problematic. The Hightower location was formally approved by the Satellite Beach City Council in January 2021. Since then, a group of citizens has raised various concerns regarding the radar installation on the property. Hightower Park was established with both local and state support – the latter through the Florida Communities Trust (FCT) which provides grant funds to local governments and nonprofits to acquire conservation lands. FCT asked for a land appraisal and a “Linear Facilities Request” – both of which were delivered in time for the 20 April 202022 meeting agenda in Tallahassee. The PI attended the meeting remotely while SECOORA Deputy Director Jennifer Dorton attended in person. Both of us spoke to a range of questions and issues involving environmental impacts (especially sea turtle nesting which is significant in our region), physical appearance, etc. The FCT board also heard from the group of concerned

citizens that travelled to Tallahassee for the meeting. With the additional support of the City of Satellite Beach, the FCT unanimously approved the radar. Pending the environmental assessment, the installation is scheduled for early November at the end of the official turtle nesting season.

Georgia and Florida High Frequency Radar – Skidaway Institute of Oceanography

Maintaining the Georgia and Florida High Frequency Radar Network

Principal Investigators: Catherine R. Edwards, Kris Maedke-Russell, Karen Dreger, Dana Savidge; Skidaway Institute of Oceanography, University of Georgia

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 along shelf 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. After rebuilding both systems and converting frequency to 5.5 MHz (CAT) and 13.5 MHz (JEK) during Year 1, both systems are functional, but have required significant hands-on troubleshooting of multiple hardware failures due to the age of the instruments.

Over the past year, we have been working steadily on installation of a new pair of 13.5 MHz radars north of Cape Canaveral. Siting, permitting, and legal agreements of the Canaveral National Seashore (CNS) system were finalized in spring/early summer 2021; installation, testing, and full calibration were completed in December 2021. Tuning in February 2021 improved return signal, but several of the coils repurposed from operations in North Carolina were unable to be tuned. The most favorable combination of equipment was chosen to maximize range and performance until the issues can be addressed in the long term. After a multi-year process due to the complexities of federal-federal agreements, COVID, and other unforeseen delays, the land use agreement for a radar site at Kennedy Space Center was finalized in early spring 2022 and planning is underway for installation to begin during summer 2022, with regular coordination with NASA KSC site managers to begin infrastructure work (electrical, plumbing, shed tie down) in June/July and hardware installation in August/September, pending scheduling and approval from KSC site manager partners.

FCC licenses for all four sites were issued in spring 2021, but construction permits for new installations stipulate that they must be operational within one year. Given the lengthy delays in the land use agreement process, IOOS Program manager Dr. Brian

Zelenke and contractors from Freedom Technologies provided some guidance on the need for an extension, the application for which was submitted in December 2021 and granted in March 2022. Other operational challenges include maintaining uptime with the ongoing issues troubleshooting and repairing the aging GA systems and balancing the financial burden (time, hardware/repair costs, and travel) of operating aging equipment with a limited budget.

South Florida High Frequency Radar Network – University of Miami RSMAS

Maintaining South Florida High Frequency Radar Network

Principal Investigators: L. K. (Nick) Shay, J. Martinez Pedraja and B. Jaimes de la Cruz
Department of Ocean Sciences, Rosenstiel School, University of Miami

As part of the US IOOS/SECOORA priority Wellen Radar (WERA), we continue to operate and maintain to the extent possible high frequency (HF) radar sites at Crandon Park, Virginia Key, Dania Beach, and North Key Largo. Hourly (subsampled to 2.2 km) data from these sites are sent to SECOORA and the IOOS National High Frequency Radar Network at Scripps Institution of Oceanography for integration, display and dissemination. These data are also on the UM's Rosenstiel School web site. Our targeted "up time" is 85% for these sites, however there have challenges to maintain this up time given that we do have to comply with requests from the county, state and federal government to turn the radars off at certain times on a not-to-interfere basis. Over the past year (and during COVID), we re-deployed radars at Virginia Key and Crandon Park given that those sites suffered damage due to Irma in 2017. More recently, Virginia Key transmit antenna array was significantly damaged by a higher-than-normal King Tide in November 2021 (~1.6 feet higher than Mean High Higher Water observed at the Rosenstiel School Pier). The transmit array was subsequently redesigned and approved by Miami Dade Sewage and Water and Virginia Key Park officials as part of our signed agreement. Subsequently, the site had been working up until 16 May, when beach maintenance ripped up cable and damaged the splitter. As of 24 May, the site was repaired and is undergoing tests prior to restarting data acquisition.

Over the past year we received our licensing agreement with the FCC working with IOOS Program manager Dr. Brian Zelenke, Dr. George Voulgaris (USC) and Dr. Cliff Merz (USF) as well as Freedom Technologies contractors. Additionally, we just received refurbished coils for the 13.5 MHz systems to be installed in Dania Beach and North Key Largo. We intend to complete that transition this year at these two sites once we get the filters from Helzel. Notwithstanding COVID related problems, fiscal challenges remain with respect to our day-to-day HF radar operations given rising fuel and

electricity costs (North Key Largo tripled during COVID), increases in the rent for the beach hut at Virginia Key, beach maintenance around the sites damaging equipment as well as cost-of-living salary increases for technical personnel.

South High Frequency Radar Network – University of South Carolina

Maintaining the South Carolina High Frequency Radar Network

Principal Investigators: G. Voulgaris, D. Cahl, and W. Jefferson

The University of South Carolina (UofSC) has been operating two HF radar systems, located at Georgetown, SC (GTN), and Fort Caswell, NC (CSW) that together cover Long Bay, off the coast of South Carolina. In 2021 UofSC completed the installation of a third HF radar site at Myrtle Beach State Park (MBSP). This site fills a coverage gap between GTN and CSW in the nearshore of Long Bay; therefore, providing a more robust vector current data for the entire Long Bay including the societally important nearshore region.

The new MBSP site consists of a 4-antenna Tx and an 8-antenna Rx array operating at the ITU approved frequency of 13.5 MHz. Sites GTN and CSW, originally operating experimentally at 8.3 MHz, were upgraded to transmit at the new ITU band of 5.25 MHz. These frequency modifications were accompanied by several site renovations. Specifically, new Rx and Tx cables were laid, Tx arrays were rebuilt, and new active Rx antennas were installed. The latter do not require guide wires and as such are more suitable to environments with turtle nesting activities. Radio station authorization was obtained from the FCC for all three sites in April 2022 (Call Sign: WRML590) and soon after firmware upgrades were conducted to allow for all sites to transmit their Call Sign as required by the FCC. The GTN site infrastructure is consistently under the threat of coastal erosion with critical damages occurring yearly because of King Tides and/or storm surges. In order to fortify the system against future damage the receive antennas were all moved back from the front of the dunes but the threat remains.
Currently all UofSC sites are FCC compliant and operate satisfactorily with GTN and MBSP being close to 100% uptime while CSW is 80-90% due to spurious issues with the electronics. At MBSP radar range is ~75km during at night but during daytime, it is reduced to 30-40km due to radio interference, the source of which is yet to be determined. Range coverage at GTN and CSW ranges from 100 km to 300 km. It has been our experience that the 5.25 MHz band is noisier than the previously used experimental frequency of 8.3 MHz.

In order to optimize the surface current estimates from the three beamforming HF radar sites we operate, we examined the feasibility of using a direction-finding methodology

(Beamscan). Our analysis revealed that the traditional beamforming method performs best near the radar boresight, whilst at locations far from the radar boresight directions (>50°) the performance deteriorates. Beamscan's performance is slightly lower near the radar boresight direction but outperforms beamforming at high angles (>50°). Operationally, a hybrid beamforming / Beamscan method might provide consistency in data quality / accuracy, and this is something that will be investigated in more detail in year 2. In addition, in year 2 we will continue operation and maintenance of all three stations and try to identify sources of noise and mitigation methods in order to provide a more consistent range.

West Florida High Frequency Radar Network – University of South Florida

Maintaining West Florida High Frequency Radar Network

Principal Investigator: Clifford R. Merz, and R.H. Weisberg, University of South Florida, College of Marine Science (USF/CMS)

- Operate and maintained three (3) US IOOS/SECOORA identified priority CODAR SeaSonde system HFR sites (Naples, Venice and Redington Shores), as well as two (2) WERA HFR sites (Venice and Ft. DeSoto Park), along the West Florida Shelf (WFS). Real-time data are provided to SECOORA, NOAA NDBC, and the IOOS National HFR CORDC Network (HFRNet) for integration, display and dissemination. Data plots are also displayed on the USF/CMS Coastal Ocean Monitoring and Prediction System (COMPS) (http://comps.marine.usf.edu) web site. All sites exceeded the 85% HFR performance goal over the period June 01, 2022 to May 31, 2022 with the exception of the Redington Shores CODAR site. As discussed in prior progress reports and journal articles, Redington Shore often exhibits reduced data return levels in the spring and summer when low offshore energy conditions exist even though actual site operation was nearly 100%. Investigative work continues at Redington Shores.
- Participated as SECOORA's HFR Settings Coordinator interfacing between the IOOS Surface Currents Program Manager and SECOORA member HFR operators regarding FCC ITU Band ULS licensing.
- CODAR HFR FCC ITU ULS 5.25 – 5.275 MHz license application prepared but awaiting required FAA site approval followed by FCC antenna registration. After which the ULS license application will be submitted. WERA HFR FCC ITU ULS 13.45 – 13.55 MHz license completed. Site hardware modifications completed with both sites operational with transmitted call sign.
- Participated as part of an initial a 3-person writing team, who along with SECOORA Deputy Director Dorton, updated the SECOORA HFR build out plan (BOP).
- Leveraged HFR work continues on a related NASEM-GRP award aimed at obtaining a better understanding of the Gulf of Mexico Loop Current outflow region via installation of 3 new CODAR SeaSonde HFR systems within the lower Florida Keys (Marathon and Key West) and Dry Tortugas (Fort Jefferson National Park). As part of this grant, a new HFR was installed near Marathon, Florida in late 2019

to study the Gulf of Mexico Loop Current System through the Florida Straits outflow region. Plans continue to install the remaining 2 HFR sites in late 2022. All 3 of these new HFR sites are at locations identified as gaps in the original HFR BOP. 4 publications issued.

- Updated all USF CODAR SeaSonde systems to the latest Radial Suite software version, Release 21 (R21). This included all 3 SECOORA priority sites as well as the existing NASEM funded Marathon site and soon to be deployed Key West Site. During the update, the NAPL computer hard drive failed and a spare was reconfigured and deployed.
- Additional correspondence and on-site meetings continue with Elgin AFB personnel regarding potential shore side infrastructure and facility building changes at the Venice US Coast Guard Auxiliary Station where the USF CODAR and WERA HFR systems are located.

Coastal Hazards and Climate Variability

Water Level Team – American Shore & Beach Preservation Association and Hohonu, Inc.

Water Level Network Team Update

Principal Investigators: Nicole Elko and Brian Glazer, ASBPA (American Shore & Beach Preservation Association) and Hohonu, Inc.

Year 1 Accomplishments

- 23 of 40 sensors installed in North and South Carolina and Florida (e.g., Figure 1)
- 23 sensors surveyed to NAVD88 using RTK GPS and established a MLLW datum, reporting real-time water levels to SECOORA data portal relative to MLLW
- Co-developed installation plans, data needs, and flooding thresholds with 23 coastal communities who install sensors, serve as key partners, and utilize water level data for decision support; hosted quarterly partner meetings, both in-person and virtual

Challenges

- Controlling costs/resource investment – Sensors are relatively cheap and easy to build/replace, but other project elements require significant time/cost investments such as survey, data management, quality control, and partner engagement.

Year 2 Objectives

- Install remaining 17 sensors in North and South Carolina and Florida

Water Level Team – Coastal Carolina University

Expanded Real-time Water Level Sensing in South Carolina and South Florida: Observations and Applications

Principal Investigators: Paul Gayes[1], Jason O. Hallstrom[2], Len Pietrafesa[1], Shaowu Bao[1] and Tom Mullikin[1] | 1 Burroughs and Chapin Center for Marine and Wetland Studies, Coastal Carolina University, 2 Institute for Sensing and Embedded Network Systems Engineering, Florida Atlantic University

The Coastal Carolina and Florida Atlantic University component of the SECOORA water level sensor team is focused on expanding near real-time water level sensors across sections of northeastern South Carolina and southeastern Florida. The team is partnering with a broad range of stakeholders toward: 1) integrated observing systems; 2) supporting modeling systems; and 3) diverse applications, which help define and refine continued technology development. The integrated observing effort is called the *SEA (South East Atlantic) Econet*.

The water level sensing package being deployed was initially developed through a series of NSF and other agency awards associated with enabling landscape-scale environmental sensing across a broad array of parameters, with diverse data access pathways, including public-facing data portals and APIs. Various parameters are accessed and assimilated into modeling systems at NOAA and CCU and support a range of public and private uses across a range of federal, state, local, and private partners.

In South Carolina, Year 1 activities of the SECOORA-funded effort are focused on expanding 10 water level sensing stations within the Waccamaw – Pee Dee basin, an area that has sustained a series of historic flooding events in the last decade. Initial emphasis is on the interface and propagation of marine influence (blocking) within the lower watershed. The emphasis will expand over the next few years (eight more stations in Year 2), filling gaps in real-time stations up the basin, responding directly to local stakeholder interests and overall integrated sensing and modeling efforts.
In South Florida, the focus has similarly derived from diverse partnerships, including municipal, state, community, and other interests in the region. Year 1 SECOORA-funded efforts are focused on installing 10 sensors with long-term partners and stakeholders along the east coast of South Florida. Year 2 efforts will continue to expand across Atlantic Southeast Florida. The efforts will be greatly enhanced through $750K of weather, water level, and water quality instrumentation invested in SEA Econet through Florida Atlantic University.

The overall effort benefits from continued technology advancements in low-cost sensing and telemetry platforms, data management infrastructure, and the team's public-facing data portal, www.sensestream.org. Most recently, the team has designed a reduced form-factor installation kit, simplifying 5G/4G-based water level installations. A new generation telemetry platform has been completed and will be deployed in the coming year, decreasing costs and improving reliability.

The first year of the project experienced relatively limited challenges or issues. Public and stakeholder engagement has been active, evolving, and supportive in refining initial and subsequent years' deployment sites, optimizing for broad interest and utility. Building off of existing team experience installing and managing diverse observing platforms greatly facilitated project objectives and progress. Primary challenges were related to standard scheduling, weather, and logistical issues. Supply chain issues were largely mitigated by momentum in the network. A primary remaining need is the adoption of common, consistent surveying in sensor elevations to report in consistently (relative to NGVD 88) across all partners in the SECOORA network.

Water Level Team Update – Florida International University

Integrated coastal flood observation network for citizen engagement and improved data, modeling and projections

Project Team: Tiffany Troxler, Jayantha Obeysekera, Michael Sukop, Emily Standen, and Rachel Stovall, Florida International University; Amy Clement, University of Miami; Greg Dusek, NOAA/National Ocean Service; Carlos Genatios Sequera, Miami-Dade College; Alexander Nunez, Digital E Consulting

Overview: The goals of our project are to develop a multi-sensor network of integrated coastal flood observation sites that combine approaches of crowd-sourced, citizen flood measurements, in-situ measurements of depth and salinity, web cam monitoring and drone surveys, and coordinate with SECOORA partners to develop a regional scale enterprise. The information from the network is highly responsive to stakeholder challenges and societal needs, and fundamentally supports SECOORA's priorities for contributing to our improved understanding, management, and stewardship of valued coastal ocean resources. Value-added products and services include improved flood modeling and projections, flood warning systems with location specific thresholds, and improve flood metrics to support decision-making. In particular, we seek to integrate and leverage: 1) relevant existing observing assets, data management and communications, modeling, products and education and outreach activities and 2) identified SECOORA investment opportunities to support end-users and broader group of stakeholders charged with coastal flood risk preparedness.

Our objectives are to: 1) establish nine integrated coastal flood observation stations in Florida, with a subset including extreme high tide citizen science flood reporting and drone flights, real-time water and salinity gauges, and web cam monitoring; 2) coordinate with other SECOORA water level network project teams to extend integrated observation stations and data; and 3) coordinate transfer of citizen science flood reporting programming and tools.

Year 1 accomplishments: This year, we've installed 4 new in-situ water level sensors, conducted 2 king tide citizen science flood monitoring sampling events, and gained permission to install 2 flood monitoring web cams. Over the 5-year project, our SE FL network will include up to 10 water level sensors, and web cam and drone monitoring at up to 8 sites in addition to the annual citizen science flood event monitoring. We have also leveraged the developing network to expand our research capacity through a new NOAA Adaptation Science Program grant to support the Resilient305 Collaborative. The collaborative works to develop resilience metrics from flood and other hyperlocal data to achieve the overarching goal of enhancing quality of life through a comprehensive approach to building community resilience across in Miami-Dade.

Challenges: Identifying locations for web cam deployment has been challenging, but our regular meetings with our expanding local partners and PIs from other teams in the network helps to bring new ideas for overcoming these kinds of challenges.

Year 2 objectives: We'll plan to finish our water level gauge installs, deploy web cams and conduct drone surveys for at least 3 sites in both dry and flood seasons.

Water Level Team Update – Georgia Institute of Technology

Smart Sensor Networks for Coastal Flooding in Georgia

Principal Investigators: Kim Cobb, Emanuele Di Lorenzo, Russell Clark; Georgia Institute of Technology

The goal of this work is to “partner with stakeholders, decision-makers, and residents to co-design and co-deploy a network of internet-enabled smart flooding sensors along the Georgia coast at the scales required for the decision-support tools of coastal communities.”

Leveraging existing collaborations with a diverse stakeholder and outreach network in Georgia’s coastal counties, this project is providing real-time high-resolution and high-frequency flood data that coastal communities can use to (1) plan for and respond to flood emergencies (e.g. flooding, hurricanes, storms) and (2) design resilience and

adaptation strategies for the long-term effects of sea level rise and the projected increase in flooding. The data produced in this project is being integrated in ongoing high-resolution modeling efforts to advance our understanding of coastal system dynamics and prediction capabilities at 10-meter spatial resolution.

Specific goals include (1a) map the current environmental and flooding dynamics in coastal Georgia at the scale where people live and make decisions, (2b) serve the data streams to the SECOORA portal, and (3b) work with stakeholders and decision-makers to incorporate the data into their decision-support tools.

The project team deployed six new sensors in Chatham and Camden counties and upgraded ten additional sensors in Chatham to meet the operational goals of the SECOORA data portal. In addition, two sensors were installed at the Fernandina Beach testing site. The team worked with Axiom to document and support the integration of the live sensor data feed into the SECOORA portal.

Community engagement continued in with notable participation from students at Jenkins High School, in Savannah, Georgia, where engineering students again worked on sensor assembly and testing. A successful new partnership with the city of St Marys has led to the installation of new communication gateways and three new sensors to date.

In the second year, the team will continue new deployments with eight additional sites identified. The hardware supply chain issues will continue to be a challenge that may require adjustments to target locations.

Glider Operations – Georgia Tech

SECOORA Glider Observatory: Georgia Tech Operations

Principal Investigators: Fumin Zhang, Georgia Tech

Year 1 accomplishments
Completed:

- We use GENIoS software to automatically control two Angus deployments. Angus was under GENIoS control during Nov. 18 - Nov. 25, 2021, and Apr. 10 – Apr. 18, 2022, 17 days in total.
- We applied the adaptive learning method to detect anomaly conditions in Angus 2021 and 2022 deployment. We are able to identify anomalous conditions in the deployments that are consistent with pilots' expectation.
- We developed a neural-network based belief abstraction algorithm for state estimation in glider navigation task.

On track:

- We are developing a new python-based GENIoS software.

Year 2 objectives

- We aim to continue piloting gliders using GENIoS.
- We are expecting the new python-based GENIoS to be tested and completed this year.
- We plan to incorporate the state estimation from the anomaly detection algorithm into GENIoS, so that GENIoS generated waypoints can adapt to variation in vehicle states and environmental states.

We aim to incorporate glider deployment data into the belief abstraction algorithm, and design uncertainty-aware decision-making algorithms for glider deployments.

Glider Operations – Skidaway Institute of Oceanography

SECOORA Glider Observatory: SkIO Operations

Principal Investigators: Catherine R. Edwards, Karen Dreger, Kris Maedke-Russell, Frank McQuarrie, Garrison Hefner, Drew Vincent, Ben Hefner; Skidaway Institute of Oceanography, University of Georgia

The SECOORA regional glider observatory is a collective effort among the glider groups at SkIO, UNC, USF, and GT. Project PIs cooperate to support shelf-wide glider surveys through at least 4 glider deployments in the South Atlantic Bight (SAB), with joint deployments/recoveries, piloting, and data management, pooling resources to take advantage of complementary assets (instruments, personnel, and ship access).

During year 1, SkIO participated in 7 observatory-funded missions in the SAB for a total of 134 glider-days, leading/hosting 4 of those missions and providing data visualization, logistics, deployment/recovery, piloting, and/or coordination support for 3 missions led by USF. This tight coordination of resources and operations is further facilitated by a glider coordinator who serves on both teams, as well as cross-training of lab personnel for glider preparation and piloting. In addition to these directly supported missions, the observatory provided data submission and observatory structural resources to one additional NSF-funded mission at Gray's Reef National Marine Sanctuary. As the regional lead, PI Edwards coordinates observatory operations, resources, and planning through monthly all-hands calls, and developed a monthly "Tech Talk" series for deep dives into technical and/or scientific topics of interest.

The glider observatory has been awarded significant external funding to supplement baseline operations, including $110k to fund additional missions during hurricane season 2021 and a pending proposal for $675k to purchase a new glider and fund 3 deployments per year in the 2022 and 2023 seasons. During year 1, data from 6 deployments during hurricane season were assimilated into Navy and NOAA models, including RTOFS, the operational ocean model used by NOAA coupled with meteorological models for tropical storm predictions. SkIO also supported deployment, piloting, and recovery of 4 Navy gliders made available through a Navy/NOAA partnership and OMAO funding. While one shallow glider was lost in the Gulf Stream, SkIO deployed and led recovery for two deep Navy gliders that sampled for over 6 months in the Sargasso Sea before crossing the Gulf Stream for recovery off Cape Hatteras. PI Edwards co-led a piloting team for a 4th Navy glider deployed off Louisiana that criss-crossed the Loop Current before transiting the Florida Straits and Gulf Stream edge to recovery out of Charleston, SC; Edwards also facilitated and advised the use of the Navy's GHOST automated piloting system for this glider in its first application of a non-Navy mission.

PI Edwards also participated in a new collaboration with NOAA AOML/PMEL scientists to coordinate gliders with 5 Saildrones during hurricane season, including 2 Saildrones in the South Atlantic Bight. Edwards assisted with design and implementation of the Saildrone sampling in shallow (SD-1040) and deep (SD-1031) water, including coordination of Saildrones with gliders, multiple NDBC and CDIP buoys, and one NOAA OMAO cruise at GRNMS. This work received significant press (one of the 5 Saildrones captured conditions from within the eye of Hurricane Sam) and has thus far resulted in 2 publications (EOS, BAMS) and 12 presentations at national meetings (AMS Tropical, AMS annual meeting, Ocean Sciences, and an upcoming CLIVAR workshop). Efforts are underway for 2022 operations, which will include coordinated glider and saildrone sampling near the edge of the Gulf Stream, where air-sea interaction can be significant.

Glider Operations – University of South Florida

SECOORA Glider Observatory: USF Operations

Principal Investigator: Chad Lembke, University of South Florida, College of Marine Science.

Over the past year USF glider deployments have continued in support of numerous research endeavors. Efforts funded by SECOORA have provided specific operations in the South Atlantic Bight (SAB) and Gulf of Mexico (GoM) as well as augmented additional efforts funded by GCOOS and the State of Florida. Over the 12 months USF

gliders have conducted over 250 glider days. Data accepted by the IOOS Glider DAC has been supplied with assistance from SECOORA or GCOOS.

SECOORA glider work in the SAB has been conducted in collaboration with other SECOORA Glider Observatory members. This includes collaborative planning, piloting, and field operations resulting in a more efficient effort by utilizing shared resources, knowledge, and regional proximity.

SECOORA and collaborative research in the GoM has been in collaboration with the Florida Wildlife Research Institute and USF researchers to guide operational activities. The standard deployment objective typically is focused on across shelf transects in the same general vicinity to develop a near sustained presence. These efforts are expected to continue.

CNAPS Model – North Carolina State University & Fathom Science

Principal Investigators: Ruoying He, North Carolina State University & Fathom Science

Coming soon!

RENCI Model – University of North Carolina at Chapel Hill

Multi-decadal reanalysis of coastal water level to support NOAA sea level and flood risk products

Principal Investigators: Brian Blanton, Rick Luettich, Jeffrey Tilson, Taylor Asher, UNC-Chapel Hill

The University of North Carolina at Chapel Hill is computing a 43-year reanalysis (1979-2021) of coastal storm surge with the ADCIRC storm surge and tide model (http://adcirc.org, http://adcircprediction.org). Using best available atmospheric reanalyses, NOAA observed water levels, and a new data assimilation system for ADCIRC (Asher et al. 2019), the results will provide detailed datasets of long-term coastal water levels for use in a variety of applications, including computation of local extreme water level probability distributions over monthly to 100-yr return intervals that will be compared with the existing set of 1-degree gridded extreme water level probability distributions currently being produced from a tide gauge-based regional frequency analysis (RFA) for the U.S. coastline (Sweet et al (2020), Hall et al (2016)). We anticipate that the project's reanalysis will produce a more accurate and precise local solution (lower root mean squared error) as compared to currently available information. This reanalysis will also permit testing of the RFA approach to hazard

estimation between observation locations, since the spatial coverage of the reanalysis is coast-wide and includes the bays and estuaries.

The overall reanalysis process is as follows. For a specific geographical area, we will compute the 43-yr simulation using astronomical tides and meteorology from the ECMWF ERA5 Reanalysis project (10-m winds and atmospheric pressure and mean sea level), using the NOAA HSOFS ADCIRC grid, which includes the entire eastern and Gulf of Mexico coastal regions at a reasonable and consistent spatial resolution. The predicted water levels will be compared to NOAA NWLON tide gauge observations to quantify the time-dependent prediction error. We will use that error as input into a data assimilation scheme for ADCIRC that corrects for unmodeled, low frequency contributions to the total coastal water level. These errors will be assimilated into the posterior simulations, substantially improving upon the prior error throughout the coastal area.

To date, we have computed the reanalysis on a test grid for Chesapeake and Delaware Bays as the larger simulation suite proceeds. The primary challenges are related to water level observations in early years of the period. Nonetheless, preliminary results indicate that the posterior solution is substantially better than the prior, which impacts results derived from the reanalysis, such as the 1% water level exceedance values and other coastal flooding metrics.

Southeast and Caribbean Disaster Resilience Partnership

Update on the Southeast and Caribbean Disaster Resilience Partnership

Principal Investigator: Meredith Hovis, North Carolina State University

The Southeast and Caribbean Disaster Resilience Partnership (SCDRP) is a coalition of public and private organizations that collectively seeks to strengthen the resilience of communities to mitigate and adapt to the impacts of natural hazards and climate change. SCDRP is the broadest regional collaborative network for professionals in emergency management, climate adaptation, disaster preparedness, recovery, and resilience in the U.S. Southeast and the Caribbean. SCDRP recognizes that the scale of disasters and climate-related impacts faced in the U.S. Southeast and Caribbean require vested interests to protect and transform high-risk communities. Our efforts reflect a deep commitment to collaboration across sectors to strengthen the region's capacity to address common issues resulting from disasters and climate impacts.

Over the past decade, our network has evolved into a cross-sector regional

forum for resilience professionals from the public, private, and non-governmental sectors to build relationships and deepen communities' resilience capacity through targeted regional coordination events; outreach to and engage with government officials, and businesses; support public policy research; host an annual regional convening.

This year we have expanded the reach of these efforts to organizations and communities in the greater Caribbean nations and territories. With this effort, we have increased the translation of our presentations and website in Spanish. We also hired a part-time Executive Director and part-time Program Coordinator to help facilitate sharing of information and resources; recruit more diverse partners and retain current partners; increase awareness of the Partnership, its mission, and membership; and raise funding for the Partnership's sustainability. At the beginning of 2022, we held our Annual Meeting, hosting over 100 attendees and raising approximately $11,000 from registration fees and sponsorship donations.

Next year, we will continue to expand our work in the greater Caribbean by featuring Caribbean organizations and speakers in disaster resilience and recovery disciplines at our monthly Partnership meetings and hosting our Annual Meeting in January 2023 in Puerto Rico.

Ecosystem: Water Quality & Living Marine Resources

The FACT Network

Just the FACTs: acoustic telemetry data aggregation and collaboration in the southeast United States

Principal Investigator: Joy Young, Fisheries Data Solutions, LLC (FACT Network)

The FACT Network began as a grass roots collaboration of scientists in 2007 and has since grown to over 280 members in the Southeast United States, Bahamas, and US Caribbean. We are dedicated to improving the conservation and management of aquatic animals by facilitating data management amongst researchers using acoustic telemetry, providing a community for scientists, and building stakeholder partnerships. In 2018, FACT, in partnership with SECOORA, instituted a cloud-based data processing system nicknamed 'the node.' The common structure allows tag/detection matching across all OTN-structured nodes. Most pertinent to this region, it allows for researchers to continuously track their animals from Canada to western Florida.

Accomplishments Year 1: Created an online data visualization, the DaViT, for resource managers and the public. Completed four data processing events. The node grew an average of 10% every six months. Increased data types accepted to include mobile receiver arrays (e.g. gliders). Continued to publish environmental data from receivers with integrated sensors to the SECOORA data portal. Initiated an equipment loaner program where receivers are loaned for a period of one year. Continued our Moorings of Opportunity (MOO) program where receivers are provided to mooring operators and are downloaded during regular service. One new receiver was deployed off North Carolina as part of MOO. Initiated a student travel award. Added content to the FACT website (www.secoora.org/FACT). Hosted our first in-person meeting in over two years. Challenges Year 1: Continued growth of the network and number of projects has increased the workload during data processing events. Cross matching across many networks has highlighted the need for species-level quality control rules implemented during data processing. Acceptance of the DaViT by scientists has been very positive, although some concerns remain regarding information about endangered species and proprietary rights to data.

Objectives Year 2: Continue our programs listed under accomplishments. Expand the role of the FACT Network to support diversity and inclusion in the acoustic telemetry community. Grow our online communications including revamping the FACT project pages on the website and increase our social media presence. Synthesize data held in the node in one or more manuscripts addressing regional movement patterns of fishes and aquatic reptiles. Support our community by hosting online and in-person data analysis workshops.

BioTracks – University of Miami

Towards a MBON-ATN acoustic telemetry data project to map and monitor marine biodiversity hotspots

Principal Investigators: Neil Hammerschlag and Thiago B. A. Couto; Rosenstiel School of Marine and Atmospheric Science, University of Miami

Acoustic telemetry is a widely used tool to understand the distribution of multiple coastal and pelagic species, their movement patterns, and habitat use. Several independent regional networks operate along the Western North Atlantic, Gulf of Mexico, and Caribbean Sea and work to facilitate data-sharing among researchers using acoustic telemetry both nationally and internationally (e.g., FACT, ACT). These networks provide an expedient opportunity to harness data sharing and collaboration for evaluating multi-species spatial hotspots This information is important to understand interactions between human uses of ocean spaces and identify potential gaps in marine protected

area coverage. Using historical and newly acquired acoustic telemetry data, the overall goal of this project is to integrate historical and newly acquired acoustic animal tracking data into biodiversity monitoring, and ultimately generate data visualizations of marine biodiversity hotspots based on acoustically tracked animals that will be useful for conservation and natural resource management. seeks to identify shared biodiversity hotspots of coastal marine species. These multi-species hotspots will be analyzed with respect to essential ocean variables to identify the key environmental and biological drivers behind them. Current and projected hotspots and migration corridors will be overlayed with place-based management zones to highlight areas vulnerable to exploitation. This is focused on the Gulf of Mexico, Caribbean and Western North Atlantic. This collaborative A-BioTrack project, is a joint initiative of the Animal Telemetry Network (ATN) and of the Marine Biodiversity Observation Network (MBON). Year 1 was challenged by hiring a suitable postdoctoral researcher to lead the effort. Year 1 accomplishments to date have included: (1) identifying and hiring a postdoctoral researcher (Dr. Thiago Couto), (2) development of a data management plan with the ATN, (3) development of data contribution for coauthors; (4) beginning solicitating data sharing contributions from the acoustic tracking community, and (5) selection of a spatial analysis methodology for special distribution modeling using acoustic tracking data. Expanding on these successes, Year 2 objectives will include: (1) create and map shared multi-species hot spots as a metric of biodiversity from species distribution modeling of tracking locations and covarying remotely sensed variables; (2) overlay these aggregated biodiversity hotspots with place-based management zones to highlight and map areas protected from and vulnerable to exploitation; (3) create and disseminate map visualizations of these protected and vulnerable biodiversity hotspots; and (4) preparation of a peer-reviewed scientific paper for submission.

South Carolina Soundscape Observatory – University of South Carolina Beaufort

The Estuarine Soundscape Observatory Network in the Southeast (ESONS)

Principal Investigators: Eric W. Montie[1, 2] and Alyssa Marian[1]; 1 Department of Natural Sciences, University of South Carolina, 2 Graduate Program in Marine Biology, College of Charleston

The Estuarine Soundscape Observatory Network in the Southeast (ESONS) monitors underwater sounds and noise using passive acoustic recorders in four estuaries of South Carolina including the May River (n=3 stations), Port Royal Sound (n=2), Charleston Harbor (n=3), and North Inlet-Winyah Bay (NI-WB) NERRS (n=1). Soundscape data are used to monitor animal behavior at multiple levels of biological complexity (i.e., from snapping shrimp to fish to marine mammals) and at time scales ranging from minutes to years. The soundscape approach allows the ability to

‘eavesdrop’ on key behaviors of marine animals that can change rapidly or gradually in response to environmental changes and human impacts, thus providing a measure of resilience or shifting baselines for economically important or protected species. Passive acoustic platforms provide sound files at a high temporal resolution of two minutes every hour. Acoustic records from this network assist in tracking: (1) received root mean square (rms) sound pressure levels (SPLs) over various bandwidths; (2) snapping shrimp acoustic behavior; (3) courtship sounds and spawning potential of soniferous fish; (4) vocalizations of marine mammals; and (5) anthropogenic noise detections.

During Year 1, we serviced all nine recorders successfully. Our longest time series (~10 years) occurs in the May River estuary, where we have soundscape data from 2013 to present. In June 2017, we expanded ESONS to Charleston Harbor. In November 2019, we added two stations in the Port Royal Sound Area (one in Colleton River and one in Chechessee Creek). In September 2020, we added an experimental station in the North Inlet-Winyah Bay NERRS. In addition, during Year 1, we reviewed and created standardized, long-term datasets of soundscape endpoints of the nine stations up to spring 2021. Datasets for each station include received rms SPLs (broadband 1 Hz-40 kHz, low 50-1200 Hz, and high frequency 7-40 kHz); fish calling intensity scores for oyster toadfish, black drum, silver perch, spotted seatrout, and red drum; counts of bottlenose dolphin echolocation bouts, burst pulses, and whistles; anthropogenic noise detections; water temperature; and water depth. The biggest challenge in this project is manually reviewing acoustic files, which is time consuming and labor intensive. In addition, the NI-WB NERRS station contains minimal biological sounds, so we are considering moving this station to Port Royal Sound or the ACE Basin NERRS.

During year two of this project, our objectives are to (1) continue servicing ESONS recorders, (2) complete soundscape endpoints through 2022, (3) perform a thorough analysis of the Charleston Harbor Soundscape, and (4) understand bottlenose dolphin vocalizations and relationships to dolphin sightings and prey in Charleston Harbor.

Water Quality Decision Support Tools – University of South Carolina

SECOORA - Integrated Decision Support and Management Tools for Adaptive Public Health Practices: An Early Advisement and Reporting System for Recreational and Shellfish Harvesting Waters of the Southeast

Principal Investigators: D.E. Porter, D. Ramage and Z. Hart – University of South Carolina; H. Kelsey and N. Miller – University of Maryland Center for Environmental Science; N. Nelson – North Carolina State University; A. Cook, L. Longstreet and K. Claridge – Mote Marine Laboratory & Aquarium

Under the SECOORA umbrella, the overall goal of our five-year project is to build upon,

integrate, enhance, and expand our respective How's the Beach (HTB; SECOORA / UofSC; howsthebeach.org), ShellCast (NCSU; https://ncsu-shellcast.appspot.com/) and Beach Conditions Reporting System (BCRS; Mote Marine Laboratory and Aquarium; https://visitbeaches.org/map) initiatives. Working with state and local public health officials, resource managers, local municipalities, tourism and chamber of commerce officials, tourism and eco-tourism industries, the public and other identified end users and stakeholders, we are:

- providing access to relevant data and information on water quality and safety to support improved decision making;
- geographically expanding the HTB and ShellCast nowcasting / forecasting efforts in recreational waters and shellfish harvesting waters;
- supporting the integration of the BCRS to allow for citizen reporting of conditions throughout the SECOORA footprint;

Year 1 accomplishments include development of technical plans (data sharing, web design, user interface) for integration of data and information exchange across HTB, ShellCast and BCRS; engaged state and local water quality data providers to support expansion of HTB and ShellCast modeling; BCRS reporting was expanded into SC with the additions of Hunting Island State Park and Folly Beach Pier, the latter of which is operating as a pilot location with the potential for two additional locations on Folly Beach in the future; and engaged stakeholders' review of modeling and decision-support tools.

Year 2 objectives include implementation of technical plan developed in Year 1, including API build-out for sharing of HTB, BCRS and ShellCast data and information between programs; complete ShellCast expansion to cover all shellfish waters in SC and continue laying the groundwork for expansion into FL; continue expansion of BCRS sites in SC and NC; push HTB nowcasts and ShellCast forecasts to SECOORA data portal; and develop education and outreach materials (e.g., infographic, press release, rack card) to provide broader exposure to the SECOORA-supported tools and applications.

Sargassum Forecasting – University of South Florida

Monitoring and forecasting pelagic Sargassum in the South Atlantic Bight: Initial results from PlanetScope/Dove observations

Principal Investigators: Chuanmin Hu[1], Shuai Zhang[1], Brian B. Barnes[1] and Tanya N. Harrison[2]; [1]College of Marine Science, University of South Florida, [2]Planet Labs, Inc.*

Sargassum beaching has been a significant problem in the Florida Keys and along the east coast of southeast United States. A satellite-based system, namely the *Sargassum* Watch System (SaWS) has been established to monitor and track floating *Sargassum*, yet the system suffers from lack of accurate data in coastal waters. The project seeks to

fill the data gap using high-resolution satellite data, with a long-term goal to forecast *Sargassum* transport in coastal waters of selected sites. During this initial effort, we have developed a machine learning algorithm to extract *Sargassum* features from high-resolution PlanetScope/Dove satellite imagery. The constellation of the small satellites can provide near daily-coverage of beaches at 3-4 m ground resolution, thus suitable for monitoring of *Sargassum* beaching. Our initial results show success in extracting *Sargassum* features and estimating *Sargassum* amount on Miami beach and Cancun beach as well as in their nearshore waters. Although the general applicability of the algorithm still needs to be tested over other sites, the results show potentials of using the high-resolution satellite images to monitor the beach environments on a routine basis.

Gray's Reef Mooring – University of Georgia

Ocean acidification time-series mooring at Gray's Reef National Marine Sanctuary

Principal Investigator: Scott Noakes, Ph.D., 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 offshore Georgia, USA and within the boundaries of Gray's Reef National Marine Sanctuary. 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 also plays a major role in the partial pressure of carbon dioxide (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.

As with any research station located approximately 20 nautical miles offshore, biofouling, sea state, marine life and yes, humans have often made it difficult to keep the Gray's Reef monitoring station operational. It is not uncommon to find fishing hooks and line tangled in the data cables and tubing associated with the CO2 monitoring system. Hungry fish often bite the submerged cables and floating debris slam into the sensors mounted under the buoy. However, given all these challenges, the system has managed to operate with little down time.

In addition to the monitoring effort offshore and a direct response to the challenges just mentioned, a new buoy design is currently being investigated that will allow for the submerged sensors to be deployed from the surface rather than diver deployed. This design will protect the sensors and the associated cables from being damaged while mounted under the buoy. Once divers are no longer required to work under the buoy, servicing operations on the CO_2 system can be conducted in slightly rougher seas making it a little easier to schedule offshore work.

Research planned for the sanctuary utilizing the CO_2 data will be aimed at determining how the organisms currently residing at Gray's Reef cope with the seasonal changes and how they will adapt to rising seawater CO_2 over time. Without the CO_2 data generated by this monitoring station, these studies would not be possible.

Southeast Ocean and Coastal Acidification Network

Update on the Southeast Ocean and Coastal Acidification Network

Principal Investigators: Janet Reimer, University of Delaware and Emily Hall, Mote Marine Laboratory & Aquarium

The Southeast Ocean and Coastal Acidification Network (SOCAN) was established in February of 2015 through a partnership with the Southeast Coastal Ocean Observing Regional Association (SECOORA) and NOAA's Ocean Acidification Program (OAP). The Coastal Acidification Networks are charged with catalyzing partnerships and leveraging resources to move regional acidification network efforts forward. SOCAN has significantly increased NOAA OAP's regional capacity building efforts by tailoring messaging to the unique societal climate of the U.S. Southeast and working with stakeholders to build awareness and prioritize monitoring efforts for understanding acidification in this region. SOCAN has taken a leadership role in synthesizing and applying available science in addition to serving in funding proposal coordination roles throughout the Southeast since its inception. SOCAN continues its core commitments to advance acidification knowledge and communicate research findings to stakeholders and decision makers, as well as work to assess research and monitoring gaps, societal, economic, and vulnerability needs in the Southeast.

SOCAN is working with the Interagency Working Group on Ocean Acidification (IWGOA) as outlined in the Coordinated Ocean Observations and Research Act of 2020 to identify social, economic, and environmental vulnerabilities. SOCAN stakeholders in the aquaculture, tourism, and subsistence fishing sectors will likely face challenges due to acidification. SOCAN already has established relationships with various research institutions, the Gullah/Geechee Sea Island Coalition, Sapelo SeaFarms, National Estuary Program sites, and other community partners that will provide economic and scientific data to help determine priority monitoring sites and data needs based on the Coastal Communities Vulnerability Assessment draft. SOCAN hosted a virtual workshop in line with the IWGOA request for information from each region of the USA and will also host another virtual meeting this calendar year in line with the timeline for the upcoming Monitoring Prioritization Plan to update the monitoring priorities in the Southeast. This workshop will address what type of information our stakeholders need to make informed management decisions and where monitoring is needed.

SOCAN communicates with its stakeholders through various virtual media outlets, including Twitter, Facebook, Instagram, the Ocean Acidification Information Exchange, and email updates to members. This June SOCAN will launch its new website, which will

be updated and streamlined. A new highlight of the website is the Affiliated Research page, which highlights research programs funded through grants awarded to SOCAN and projects that are associated with SOCAN or SECOORA. The new website will also feature links to data (where available) and monitoring sites, links to virtual Townhalls an workshops, reports and other related media, and recent research papers by members. The state-of-the-science and ongoing state research pages will also be updated to reflect the most recent advances.

Data Management and Data Visualization

Artificial Intelligence: Annotation, Data Standards, and Applications – Florida Fish and Wildlife Conservation Commission

Augmenting Ocean Observing through Artificial Intelligence: Annotation, Data Standards, and Applications

Principal Investigators: Lucas McEachron, David Kochan, Florida Fish and Wildlife Conservation Commission; Jesse Lopez, Lauren Showalter, Axiom Data Science; Enrique Montes, University of Miami; Frank Muller-Karger, Dan Otis, University of South Florida

Our goal is to support regional AI marine applications by building an interactive SECOORA AI Annotation Data Portal (AI Portal) based on existing SECOORA data management and communications infrastructure. The AI Portal will be a resource for documented standards, annotation and labels, storage and access solutions, and documented ocean observing workflows to make the process of completing an AI project efficient, accessible, and transparent. In the first year, we focused on identifying different tools, standards, workflows, and resources for imagery, video, and acoustic applications in a draft instructional document that will serve as the basis for content in the AI portal. Additionally, we scoped technical requirements and common AI challenges in an initial workshop with research teams conducting machine learning projects across a range of applications: maritime, water quality, harmful algal bloom, passive acoustics, coral spawning, and reef fish identification.

A key component of the AI portal is demonstrating marine use cases that are easily reproducible. This year, we focused on developing and expanding a coral spawning detection workflow with the Florida Aquarium. The workflow alerts users to coral spawning from live streaming video of corals held in aquaria and summarizes spawning statistics in a dashboard. However, we are experiencing temporary IT security issues between institutional partners that would otherwise enable a complete product. Additionally, we received 16,000 annotated reef fish videos from 1.6 TB of data to train a similar model and expand the Florida Aquarium workflow to include streaming

underwater video from a coral reef; we intend to connect the additional camera to a dashboard via a buoy with a cell signal.

We will continue to develop the AI portal while making progress on demonstrative use cases. In the coming year, we expect to reach out to the broader SECOORA membership to understand how we can fill the gaps between the resources available in the AI landscape, technical portal requirements, and the broader research community's needs. Additionally, we intend to engage with related marine annotation portals and global biological data aggregation efforts to understand how the AI Portal can contribute to global data libraries in mutually beneficial exchanges.

Fisheries Data Access – South Carolina Department of Natural Resources

Enhancing the Capabilities of the SEAMAP-SA Biological Surveys Integrated into the SECOORA Data Portal

Principal Investigators: Tracey L. Smart and C. Michelle Willis, South Carolina Department of Natural Resources

The Southeast Area Monitoring and Assessment Program, South Atlantic (SEAMAP-SA) fully or partially supports a variety of long-term living marine resource surveys in waters of the Atlantic coast off the Southeast United States conducted by North Carolina Department of Environmental and Natural Resources, South Carolina Department of Natural Resources, and the Georgia Department of Natural Resources. These biological surveys provide essential data for a variety of state and federally managed species in this region, including finfish, sharks, turtles, and invertebrates. SEAMAP-SA has begun the process of migrating its online database into the SECOORA data portal. To complete this migration, the current 5-year SECOORA grant is supporting finalizing the migration, increasing the number of data and code tables, and increasing the ability of data users to visualize and summarize data in the SECOORA portal, capabilities not available in the current SEAMAP-SA system. In the first year of the project, Axiom continued to develop code to accept the SEAMAP-SA data and provide accurate summaries and visualization products and conducted load testing for these large, long-term biological data sets. SCDNR personnel continued to convert SEAMAP-SA data into DarwinCore and develop metadata for data users, as well as updated data sets. In year 2, the objectives are to incorporate tagging and sea turtle data and code tables and new years' of data into the system and to conduct thorough testing of data access products.

Data Management and Communications – Axiom Data Science

SECOORA Data Management and Communications Services
Principal Investigators: Lauren Showalter and 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, understandable, discoverable, electronically accessible, and well organized to allow researchers, policy makers, industry, and the public to make well-informed decisions. To satisfy this mandate, SECOORA supports a web-based data portal for the region providing ocean, coastal, and 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 data using IOOS-approved metadata standards, iii) provide data to users via standard services and data products, and iv) archive data in 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 is to be recognized in the ocean observation community as a trusted leader in FAIR data.

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 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 FY21 include:

- Support and data ingestion for the water level team
- Transition to SECOORA ERDDAP pipeline to NDBC
- Shell Base data support and archival
- Glider team support
- Updates and additions of NPS data in the Everglades
- Developed ML detector for Grouper based on acoustic data
- Support and tool development for WebCOOS and CETACEAN
- Support and tool development for the Estuarine Soundscape Observatory Network and FACT programs, and the glider team

DMAC objectives FY22 include:

- Portal release Version 2.14 and 2.15
- Transition from V1 to V2 sensor system
- Data ingestion and tool development for all SECOORA projects and PIs