Funding Opportunity Number: NOAA-NOS-IOOS-2021-2006475

Southeast Coastal Ocean Observing Regional Association (SECOORA): Delivering actionable coastal and ocean information from high-quality science and observations for the Southeast

TOPIC AREA 1:
AWARD TYPE: Cooperative Agreement
PROJECT DURATION: July 1, 2021 – June 30, 2026
TOTAL FUNDING REQUEST: $30,000,000

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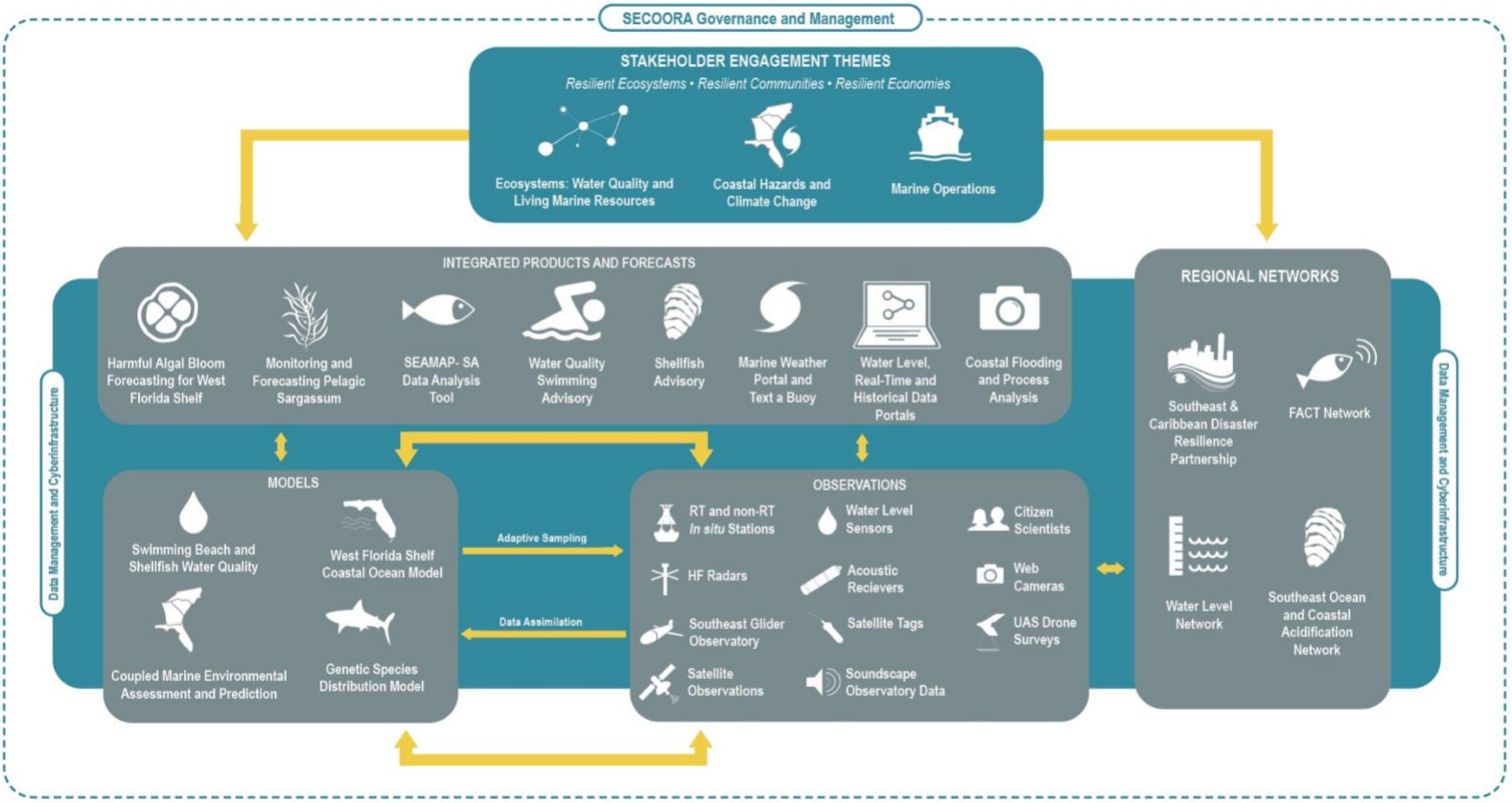

Figure 1. SECOORA Regional Coastal Ocean Observing System (click for a larger image)

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Project Summary

As 2020 concludes as arguably the most challenging year in modern American – and global – history, the value of objective, reliable information to inform decision making has never been clearer. Societal upheavals and disasters are increasingly linked to changes in global climate and disparities in community resilience. SECOORA's primary mission is to provide credible coastal and ocean information for the Southeast US in partnership with local, state, regional, national and international organizations and individuals. SECOORA's footprint covers the eastern Gulf of Mexico and the South Atlantic Bight, which are connected by the Loop Current–Florida Current–Gulf Stream continuum. Over the next five years, 2021-2026, SECOORA will focus on the coastal ocean while expanding its observing system to include new coastal observing capabilities not only along the coastline but also into the rivers and estuaries. With coastal communities facing the compound threat of storm surge, extreme rainfall, and rising sea level, additional high-density observing networks are necessary to meet these communities needs and provide decision-making support that protects public health, saves lives, and supports economic vitality.

Accomplishing this mission is possible through effective engagement of diverse communities partnered with scientists and supported by a transparently governed regional enterprise that can effectively set priorities and sustain investments. Letters of support as listed in Table 1 from coastal communities, NGOs, private companies, federal and state agency representatives, as well as academic stakeholders across the region highlight the value that SECOORA- funded observing systems provide to the southeast region. The breadth of users and stakeholders demonstrates SECOORA's reach, with harbor pilots, recreational fisherman, technology developers, weather forecasters, habitat and public health practioners and community officials using – sometimes the same, sometimes different – data required for decisions that are critical every day. It is the embodiment of the model and mantra of IOOS: "Collect once, use multiple times."

Elected officials	
Congressman Joe Cunningham SC-1 (D)	Congressman Bill Posey FL-8 (R)
Academic	
Scripps Coastal Data Information Program (CDIP)	Mississippi State University
University of NC Wilmington MarineQuest	University of FL IFAS Extension, Monroe County
Federal	NOAA National Weather Service (NWS) Charleston - SC
FL Keys National Marine Sanctuary	NOAA NWS Melbourne - FL
NOAA's Office of National Marine Sanctuaries	NOAA NWS Miami - FL
NOAA Atlantic Oceanographic and Meteorological Lab	NOAA NWS Morehead City - NC
NOAA Florida Keys National Marine Sanctuary	NOAA NWS Wilmington - NC
NOAA Grays Reef National Marine Sanctuary - GA	U.S. Army Engineer Research and Development Center
NOAA National Marine Fisheries Service	USGS St. Petersburg Coastal & Marine Science Center - FL
State	
FL Fish and Wildlife Research Institute	North Inlet Winyah Bay Natl. Estuarine Research Reserve, SC
FL Department of Health	SC Department of Health and Environmental Control
GA Dept. Natural Resources Coastal Resources	SC Floodwater Commission
NC Department of Environmental Quality	SC Department of Natural Resources
SC Sea Grant Consortium	SC Ports Authority
Local government	
Brevard County - FL	Miami-Dade City - FL
Broward County - FL	Miami-Dade County Parks - FL
Camden County - GA	Palm Beach County - FL
City of Boca Raton - FL	Pinellas County - FL
City of Hollywood - FL	St. Johns River Water Management District - FL
City of Miami Beach - FL	Sunny Isles FL City - FL
City of Savannah - GA	Town of Bluffton - SC
Coral Gables - FL	Town of Edisto Beach - SC
Kiawah Island Community Association - SC	Town of Wrightsville Beach Ocean Rescue - NC
Miami Beach Ocean Rescue - FL	West Palm Beach - FL
Non-governmental organizations (NGOs)	
Catalyst Miami - FL	NC Coastal Federation
Centre for Ocean Research and Education - FL	NC Beach, Inlet and Waterway Association
Charleston Waterkeeper - SC	Ocean Conservancy (National)
Coastal & Heartland National Estuary Partnership - FL	Recreational Fishing Alliance (National)
Coastal Discovery Museum - FL	South Atlantic Fisheries Management Council (Regional)
FL Aquarium	SC Aquarium
Fripp Island Sea Rescue - SC	SC Beach Advocates
Indian River Lagoon National Estuary Program - FL	Surfrider Foundation Miami Chapter - FL
International Game Fish Association	The Billfish Foundation (International)
Interstate Shellfish Sanitation Conference (National)	The Nature Conservancy SC
Private sector	
Baron Advanced Meteorological Systems (International)	Norwegian Cruise Line Holdings Ltd.
Cape Fear Pilot Association - NC	Aquatic Obsessions Scuba - FL
Carolina Mariculture Company - NC	Palm Beach County Diving Association - FL
Charleston Branch Pilots Association - SC	SaltWaterCentral.com (National)
FL Skin Divers Association	WeatherFlow (National)
GEO Blue Planet Initiative (International)	Synoptic Data PBC (National)
Marine Industries Association of Palm Beach County FL	Weather Forecast Solutions - FL
Maverick Fishing Charters - FL	West Palm Beach Fishing Club - FL

Table 1. SECOORA partners and supporters

Priorities for SECOORA for the next five years are to sustain and expand critical observing activities, include biological data collection, enhance data management and modeling activities, incorporate new technologies and techniques, and deliver user co-designed products. Tier 1 activities are the highest priorities based on stakeholder input and competitive evaluation and include sustained observing subsystem activities as well as necessary expansions to address critical regional needs. Tier 2 activities will be undertaken as funding allows. SECOORA specifically seeks to:

- Continue governance and management of SECOORA as an IOOS-certified regional association, and effectively engage users and stakeholders to prioritize investments.
- As shown in Figure 2, continue operation of:
  - 13 near-real time and three non-real time stations along the coasts of the Carolinas / West Florida Shelf;
  - 20 high-frequency radar measuring ocean surface currents, distributed from Cape Hatteras to West Florida;
  - a glider observatory to collect temperature, salinity and other data available in near-real time to support ocean and atmospheric models; and,
  - passive acoustic arrays in estuaries of South Carolina to monitor soundscapes.
- Fill observing gaps by investing in new efforts to:
  - initiate a region-wide community co-designed water level observing network / smart system testbed;
  - expand glider operations to west Florida, including a west Florida/South Atlantic Bight connectivity mission;
  - install new met-ocean moorings off Charleston and Myrtle Beach, SC and the east coast of FL, and cost-efficient Sofar wave buoys in NC and east FL;
  - add ocean acidification sensors in the Indian River Lagoon and FL Keys; and,
  - support new marine biological assessment and observing projects.
- Sustain and expand modeling and product efforts, including,
  - Coupled Northwest Atlantic Prediction System, which provides daily nowcast/forecast for currents, waves, temperature, salinity sea surface height and primary production;
  - West Florida Shelf and Tampa Bay daily nowcast/forecast, a high-resolution circulation model system that links shelf seas with estuaries, and supports harmful algal bloom forecasts;
  - ensemble empirical shellfish harvesting and recreational waters models; and,
  - Sargassum arrival forecasts for south FL communities.
- Provide a regional data management and cyberinfrastructure capability, including technical expertise, and expand utilization of artificial intelligence/ machine learning algorithms to improve analysis and utility of big data (e.g. acoustic, imagery, video).

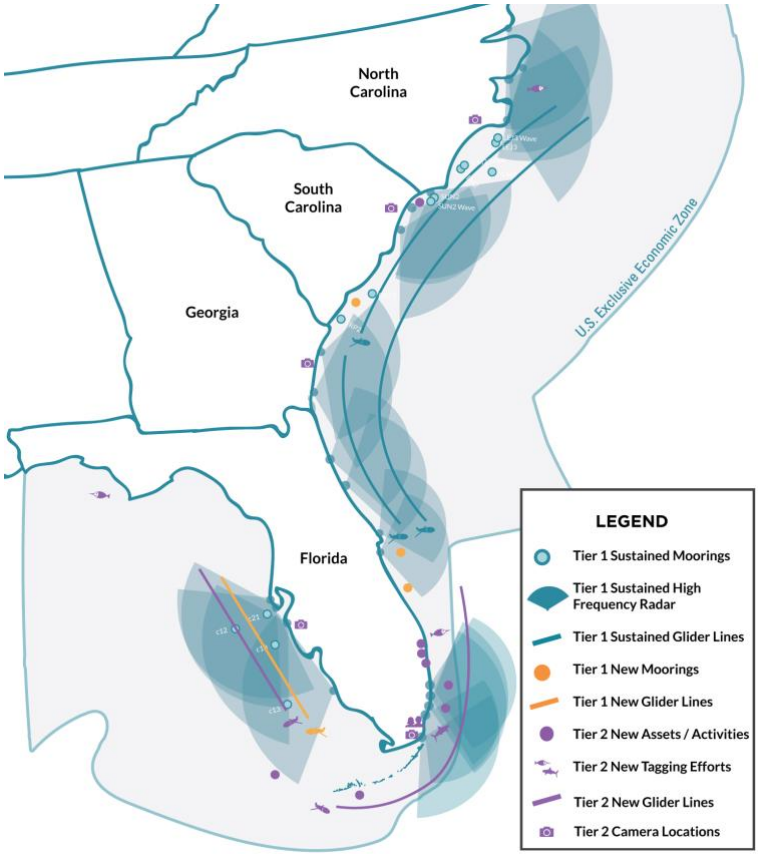

Figure 2. Existing and planned Tier 1 and Tier 2 activities (click here for larger image)

SECOORA works closely with partners to achieve our goals. In addition to the 36 academic partners on this proposal, other partners include the organizations identified in Table 1 that have written letters of support.

Background

Importance of the ocean to the Southeast

The ocean and coastal waters of the southeastern United States (SE) help drive local and regional weather climate conditions, support ecologically and economically significant ecosystems (which include important fisheries), and provide tourism, boating, and other recreational opportunities. In 2017, the marine economy contributed $2.3 trillion to the SE region's gross domestic product and provide over 19.1 million jobs with over $940.9 billion in wages (NOAA 2020).

SECOORA Mission and Goals

The SE Coastal Ocean Observing Regional Association (SECOORA) is one of 11 US Integrated Ocean Observing System (IOOS) regional associations (RAs). SECOORA was incorporated in 2007. It is a mature 501(c)3 organization with a history of sustaining long-term observations critical for the coastal SE. Our members include a cross-section of regional interests from private industry, academia, non-governmental organizations (NGOs), and state and federal government. The results of our most recent comprehensive stakeholder engagement effort are reflected in our Regional Coastal Ocean Observing System Strategic Operational Plan (RCOOS Plan), adopted by the SECOORA Board December 18, 2019. The RCOOS Plan covers the period 2020-2025 and presents stakeholder identified priorities for all of the RCOOS subsystems, excluding governance and management.

SECOORA integrates observations, models, data and information management, and outreach to sustain and advance a RCOOS responsive to societal needs. Our data management and cyberinfrastructure (DMAC) component transforms and delivers data and value-added products and services consistent with priorities identified through stakeholder needs assessments. SECOORA is a certified Regional Information Coordination Entity (RICE). This certification acknowledges SECOORA as meeting National Oceanic and Atmospheric Administration (NOAA) standards for DMAC and RA management. In simple terms, this means that users can have confidence that ocean and coastal data and information from SECOORA meets rigorous quality control and assurance standards.

SECOORA will continue efforts to ensure a strong and sustained IOOS. In partnership with the NOAA, the IOOS Program Office, and other federal programs and offices, SECOORA addresses critical national priorities through projects supporting the Animal Telemetry Network (ATN), Marine Biodiversity Observation Network (MBON), Coastal Ocean and Modeling Testbed (COMT), and Ocean Technology Transition (OTT) program.

SECOORA is a member of the IOOS Association, working with 10 other RAs to assure the needs and positions of on-the-ground users in the regions are adequately reflected in national policy and priority setting. SECOORA is actively engaged with other RAs, especially the neighboring RAs in the Gulf of Mexico (GOM), Caribbean, and on the East Coast. These collaborations across regions help ensure efficient integration of expertise and resources, limit redundancy, and improve effective transfer of knowledge.

Proposal Approach

Our criteria for selecting activities to include in this proposal were guided by two key planns: SECOORA's Strategic Plan and our RCOOS Plan. The process included a request for Letters of Intent (LOI) for activities that aligned with our RCOOS Plan. Through a competitive, two-stage evaluation process, all LOIs were reviewed by subject matter experts. LOIs were then comprehensively evaluated and ranked by a panel of five non-conflicted experts. Tier 1 activities were the highest ranked; other successful but lower ranked activities are in Tier 2. Final recommendations were approved by the SECOORA Board. Details of the process are available the website.

SECOORA's proposal includes 1) goals and objectives that implement the RCOOS subsystems, with activities that address each of three focus areas: coastal hazards and climate, ecosystems, and marine transportation; 2) our partnering and user engagement activities; 3) a workplan for achieving our goals and objectives; 4) milestones; and 5) summary budget information. Activities are proposed in two tiers based on priority. Tier 1 activities will be funded if SECOORA receives $3.5M per year; Tier 2 includes those that will be undertaken with $6M annually. The $3.5M level includes new critically important activities that must be undertaken to address regional priorities. Note that current SECOORA IOOS core funding is $3.03M, so by proposing Tier 1 for $3.5M the highest priority new activities are clearly identified.

Connection to Users/Stakeholders and Benefits for Key Focus Areas

Our approach to engaging users is dictated by their priorities, which shaped the three primary focus areas of our RCOOS Plan. The following are highlights of user connections and benefits by these three focus areas.

Coastal Hazards and Climate Change

The SE experiences severe weather- and climate-related events that cause significant hardships for the economic, environmental, public health and social well-being of residents and visitors. Recent major storm events such as Hurricanes Irma, Florence, and Michael caused damage across the SE from heavy rain, winds and storm surge. The collection of environmental data by in situ and mobile assets is required to establish situational awareness and baseline scenarios of coastal system functions. Long-term data are needed to assess changing ecosystem conditions, regime shifts, and the impacts of severe weather events. This assessment of short-term variability and long-term change will enable better understanding of climate change and improve the ability to forecast, adapt to, and mitigate changes. The region is also increasingly impacted by sea level rise and frequent "sunny-day" coastal flooding (Sweet et al., 2019). The NOAA National Water Level Observing Network (NWLON) report A Network Gaps Analysis for the National Water Level Observation Network provides guidance on the where additional observations are needed to support improved decision-making to address floods.

Tracking storms and high tides and forecasting impacts (such as storm surge) are vital for the protection of life and property. NOAA's National Hurricane Center and National Weather Service (NWS) provide the storm tracking, forecasts, and hazard alerts for tropical storm systems and other weather events. Data from SECOORA buoys are used by the NWS to meet their mission objectives. NOAA's Atlantic Oceanographic and Meteorological Laboratory is working with the US Navy, IOOS, and RAs to improve global ocean forecasts with observations from underwater profiling gliders. SECOORA's glider fleet provides valuable data from the South Atlantic Bight (SAB) and West Florida Shelf (WFS) for this effort. The US Army Corps of Engineers Wave Information Study (USACE WIS) collects directional wave data from SECOORA funded WaveRider buoys to support nearshore wave transformation models, perform research and development on existing wave modeling technologies, perform climate trend analyses, monitor coastal projects, and evaluate satellite-based remote sensing systems. SECOORA wave data are also used by the USACE WIS to investigate storm movement and spatial variations in wave climate. Recent examples include Hurricanes Irma, Jose, and Maria, and Mathew (Behrens et al., 2018, and Behrens et al., 2018). Finally, coastal communities and insurance companies are increasingly requesting parcel-level flooding information and forecasts to more effectively protect lives and property, as well as to make infrastructure planning decisions. Collectively, these partners and stakeholders engage with SECOORA through our planning efforts to prioritize SECOORA activities related to coastal hazards and climate change. Specifically, SECOORA's investments will provide improved observation and understanding of marine weather and oceanographic conditions, storm tracking and forecasting, and coastal flooding and sea level rise.

Ecosystems: Living Marine Resources and Water Quality

Marine ecosystems are dynamic and function through complex physical, chemical, geological, and biological interactions that change over time and space. Coastal ocean ecosystems in the SE are dominated by the Loop Current, Florida Current, and Gulf Stream. Our estuaries, coral reefs, and coastal ocean support important fisheries that are impacted by upland watersheds, tidal rivers that transport nutrients into estuarine and coastal ocean environments, and by anthropogenic inputs (e.g., run-off, pollution). Eutrophic conditions from anthropogenic impacts and nutrient overload, can lead to harmful algal blooms (HABs). These blooms can cause fish kills and negative effects on human and animal health, detrimentally impacting local economies. Meteorological, real-time (RT) and non-RT in-situ physical and biogeochemical coastal and oceanographic observations, and mobile platforms including tagged marine life provide data required to create models and informational products to address management concerns. SECOORA's primary focus is on managed areas as defined by our partners with the South Atlantic Fishery Management Council, Gulf of Mexico Fisheries Management Council, and states. SECOORA engages with state, regional and federal natural resource and fisheries managers to focus activities on critical data and information gaps to address fisheries, ocean sound, public health, HABs, and ocean acidification (OA).

Marine Operations

Meteorological and in-situ physical oceanographic observations collected in RT are critical to a wide user community that includes federal, state, and local governments; ports; academic and industry partners; commercial and recreational boaters and anglers; and beachgoers. These observations enable users to: monitor, prepare for, and respond to weather events threatening coastal communities; support efficient and safe marine transportation; provide information for search and rescue response; and inform offshore resource use and siting. Data obtained from buoys and high-frequency radars (HFR) are accessed daily by stakeholders (e.g., boaters, mariners) across the SE. These RT observations support safe boating, shipping and commerce, as well as mitigation of man-made (e.g., oil spill) and natural (e.g., HABs) hazards. Marine safety at sea is dependent on marine weather and oceanographic conditions. SECOORA contributes data from RT moorings and HFR that assist the US Coast Guard with search and rescue efforts and NOAA's NWS with marine and coastal zone forecasts. Our priorities in this focus area are mariner safety and rip current prediction.

Enabling Advancement of Basic Science

In addition to the stakeholder benefits from SECOORA's work, science benefits also accrue. The observing and modeling activities enable the collection of IOOS core variables as well as the characterization of essential ocean features, which for the SE is primarily the Loop Current-Florida Current-Gulf Stream continuum. Further, the continued and expanded observing activities integrated with modeling activities improves our understanding of change in the coastal ocean and associated impacts on marine life. Adding biological data to the suite of variables collected broadens the capability of scientists to understand marine ecosystems, impacts on those systems, and changing ecological baselines linked to climate change.

Goals and Objectives

In order to address the stakeholder-driven focus areas, SECOORA continues to invest in its core RCOOS subsystems. In response to societal needs, SECOORA has designed an RCOOS system with a sound scientific approach that provides credible and relevant information and prioritizes which activities can most effectively meet needs. We place emphasis on coordinating a multidisciplinary suite of coastal ocean observations with simulation models so that important phenomena may be described, understood, and ultimately predicted via models or applications. Data sharing permits access to these resources by users and stakeholders, as well as the ability to provide guidance for decision-makers based on tools developed to use these data streams. These five major RCOOS subsystems are highlighted in Figure 3.

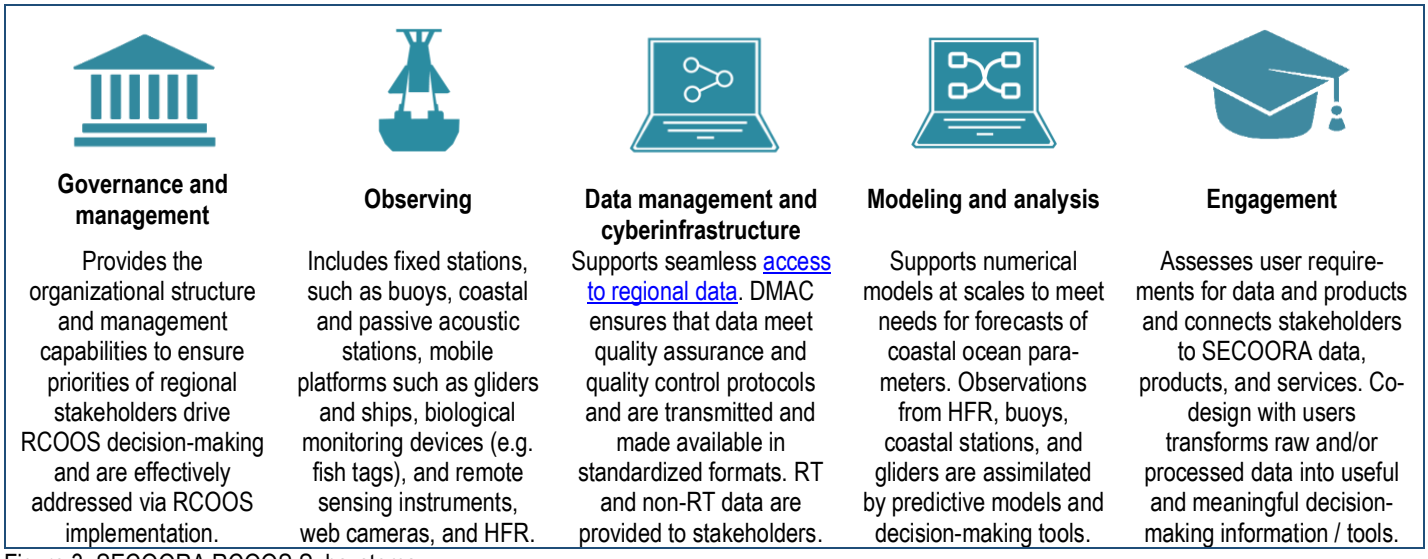

Figure 3. SECOORA RCOOS Subsystems

Goals

For this proposal, we have four goals that align with 1) SECOORA's Strategic Plan and RCOOS Plan, and 2) one or more of the **IOOS subsystem elements** identified in the notice of funding opportunity and the U.S. IOOS Enterprise Strategic Plan 2018-2022. These are indicated in bold below:

1. Continue successful operation of the SECOORA **governance and management subsystem**;
2. Maintain and augment the SECOORA **observing subsystem**;
3. Implement, integrate and expand the **data management and cyberinfrastructure**, and **modeling and analysis subsystems**;
4. Effectively implement the **engagement subsystem** to support co-design of products and delivery to users.

Details on objectives and technical approach are included for each goal in the Work Plan.

Work Plan

Goal 1: Continue successful operation of the SECOORA governance and management subsystem.

Objective 1.A Maintain the SECOORA governance and operational structure through implementation of SECOORA's Bylaws and Strategic Plan

SECOORA is a 501(c)3 not-for-profit organization incorporated under the laws of the State of South Carolina in 2007. SECOORA has a proven record of transparent operations, which are governed by the Board of Directors and implemented by the SECOORA Executive Director. The SECOORA by-laws govern SECOORA operations and can only be amended by the members. The by-laws also stipulate both geographic and sector (i.e., academic, private, public/nonprofit) representation. Members represent a broad range of stakeholders and experts with interests in the economic, social and ecological health of the coast and ocean. Per the by-laws SECOORA hosts annual members meetings and bi-annual meetings of the Board of the Directors.

SECOORA is currently updating our Strategic Plan, which with the by-laws, govern implementation of the governance and management subsystem. This Plan update will fine-tune the existing mission, vision and core values, while allowing the Board and membership to re-examine our strategic goals. A key priority is to advance our commitment to a diverse, equitable, and inclusive organization which will further enhance our role in the region as a coordinating entity. SECOORA will leverage successful diversity and workforce training initiatives undertaken by our members and partners. SECOORA is also committing to work with the IOOS Association, other IOOS regions, and the IOOS Program Office on workforce development initiatives to expand and diversify the ocean, coastal, and Great Lakes workforces and to improve our ability to provide relevant ocean and coastal data and information to underserved or underrepresented communities. The revised Strategic Plan will be reviewed by the Board and voted on during the May 2021 Annual Members meeting to take effect in July 2021. The strategic goals guide annual work plan development for SECOORA staff, thus assuring that annual priorities align with SECOORA goals and that work is on track to meet the goals. Progress is shared with the Board and members during annual meetings.

Objective 1.B Maintain SECOORA's certification as a Regional Information Coordination Entity.

SECOORA is certified by NOAA as a RICE, which means that we can prioritize, gather, manage, and distribute observation data for the SE, and have the data management architecture, policies and procedures to support these activities. Additionally, our operations align with the guiding principles included in the U.S. IOOS Enterprise Strategic Plan 2018-2022. SECOORA will work with IOOS to renew its RICE certification in Year 1 (2021-2022) and maintain certification throughout Years 2-5. SECOORA's Certification web page has extensive details on our operations and policies and the site will be maintained and documents updated as needed throughout the five-year period.

Objective 1.C. Annually update SECOORA's 2020-2025 RCOOS Strategic Operational Plan.

Implementation of the RCOOS Plan occurs through four subsystems of the RCOOS: observing, DMAC, modeling and analysis (MA), and engagement. Details of this implementation throughout the five-year period of this proposal are described in Goals 2 – 4. The SECOORA Deputy Director leads management of the RCOOS through

execution of subawards with our partners and supports SECOORA's Science Committee which reviews annual updates to the Plan.

Goal 2: Maintain and augment the SECOORA observing subsystem

Our strategy for managing and expanding the observing subsystem is: 1) maintain the long-term observing activities that are relied upon by users, 2) fill gaps based on scientific analysis and user input/assessment compiled as outlined in the RCOOS plan, 3) incorporate new, improved and/or more cost-effective technologies when feasible, and 4) broaden our observing activities to include water level and biological parameters. The assets that comprise the observing subsystem collect IOOS core variables as identified in the IOOS Strategic Plan. All SECOORA RT assets will meet or exceed 85% up-time. All non-RT station data will be downloaded, quality controlled, and transmitted to SECOORA quarterly. Table 2 provides a subset of Goal 2 activities. Appendix 3 provides a full listing of all goals and activities. Institutional operators of the systems are denoted in parentheses following the activity descriptions in the text. Appendix 2 provides a list of acronyms, institutions and lead Principal Investigators (PIs).

Table 2. Subset of Goal 2 Activities (find full table in Appendix 3).
(Legend: Teal – Tier 1 sustained activities, Gold – Tier 1 additions, Purple – Tier 2 activities)

Goal 2: Maintain and augment the SECOORA observing subsystem					
Obj.	**Project Title**	**RCOOS Subsystem**	**Funded Organizations**	**Tier 1 $3.5M**	**Tier 2 Greater than $3.5M**
A & B.1	Optimization & Enhancement of SECOORA Observing Elements in the Carolinas to Support Products and Applications	Observing	2 UNCW	9 met-ocean moorings, 1 non-RT mooring, 4 non-RT acoustic receivers, 1 new co-located met and wave buoys in SC, and 3 new wave buoys off NC	
A & B.2	A Coordinated Observing and Modeling Program for the West Florida Continental Shelf	Observing	3 USF CMS	4 met-ocean moorings, 2 non RT stations, and 1 non-RT acoustic receiver on WFS	Maintain C22 Pressure Point mooring
A	Operating and Maintaining High Frequency Radars in the SECOORA Footprint	Observing	4 UM 5 UNC CH 6 ECU CSI 7 UofSC 8 UGA SkIO 9 FIT 3 USF CMS	Provide NRT surface currents through operation of 20 high frequency radar stations in FL, GA, SC, and NC	Funding for spares
A & B	SECOORA Regional Glider Observatory	Observing	8 UGA SkIO 5 UNC CH 10 GA Tech 3 USF CMS	3 glider lines off the SAB, and 1 new glider line off the WFS for HAB monitoring	1 glider mission on the WFS to support storm tracking / forecasting and 1 glider mission to track WFS to SAB connectivity
A	Estuarine Soundscape Observatory Network	Observing	11 USCB	Maintain acoustic array in 5 SC locations	
B.1	Florida Coastal Ocean Observing System	Observing	12 RDSEA 9 FIT	2 new buoys off the east coast of FL	Additional sensors on moorings
B.1	Establish a regional low-cost water level network	Observing	10 GA Tech 13 FIU 14 ASBPA 15 CCU 16 FAU	188 internet-enabled smart flooding sensors in FL, GA, SC and NC	31 internet-enabled smart flooding sensors in FL, GA, SC and NC

Objective 2.A. Maintain existing long-term coastal and ocean observing operations

The following SECOORA observing activities will continue at the Tier 1 funding level:

- Collect core physical and biogeochemical variables via **13 buoys** offshore of NC, SC, and the WFS (Figure 2, and Tables 2 and 3). Table 3 specifies locations and parameters measured, as well as station installation year. Data are delivered in near RT to local servers, SECOORA's DMAC, and the National Data Buoy Center (NDBC). All data are reported hourly. Stations that telemeter data via cellular communications can increase their reporting frequency based on user requirements (e.g., NWS request for 15-minute data ahead of tropical systems). These assets provide data in locations and at time scales required to address needs identified in the National Strategy for a Sustained Network of Coastal Moorings and The National Operational Wave Observation Plan (UNCW, USF).
- Maintain the **OA sensor deployed on the C12 mooring** on the WFS. The station is a collaborative effort between SECOORA/USF and the US Geological Survey (USGS). The sensor was purchased and installed by USGS, who maintains the sensor every 3 months (clean lens, remove biofouling). Data are telemetered in near-RT to USF and SECOORA. Details are found in Appendix 4, Table A5.

Table 3: Locations of Offshore Buoys and Parameters Measured

Real Time Moorings	Operator	Deploy. Month/ Year	Wind Spd, Gust, Dir.	Air Temp	Baro. Press.	Rel. Humidity	SW/ LW Rad.	Water Temp	Cond/ Salinity	Current	Waves	Water Depth	Acoustic Rec.
LEJ3 – Outer Onslow Bay	UNCW	11/2015	X	X	X	X		X	X				X
LEJ3Wave	UNCW	11/2015						X			X		
ILM3 – Outer Onslow Bay	UNCW	06/2005	X	X	X	X		X	X				X
ILM2 – Inshore Onslow Bay	UNCW	07/2005	X	X	X	X		X	X				X
ILM2Wave	UNCW	05/2008						X			X		
SUN2 – Northern Long Bay	UNCW	02/2005	X	X	X	X		X	X				
SUN2Wave	UNCW	03/2012						X			X		
CAP2 – Inshore Capers Island	UNCW	02/2005	X	X	X	X		X	X				
FRP2 – Inshore Fripp Island	UNCW	02/2005	X	X	X	X		X	X				
CHS2 – Charleston Harbor	UNCW	Planned 2021	X	X	X	X		X	X				
CHS2 – Wave	UNCW	Planned 2021						X			X	X	
SOFAR 1 – SE NC	UNCW	Planned 2022						X			X		
SOFAR 2 – SE NC	UNCW	Planned 2022						X			X		

Real Time Moorings	Operator	Deploy. Month/ Year	Wind Spd, Gust, Dir.	Air Temp	Baro. Press.	Rel. Humidity	SW/ LW Rad.	Water Temp	Cond/ Salinity	Current	Waves	Water Depth	Acoustic Rec.
SOFAR 3 – SE NC	UNCW	Planned 2023						X			X		
C10 – WFS Central nearshore	USF	09/1998	X	X	X	X	X	X	X	X			
C12 – WFS Central offshore	USF	09/1998	X	X	X	X		X	X	X			X
C13 – WFS South	USF	09/1999	X	X	X	X		X	X	X			
C21 – Tower	USF	06/2018	X	X	X	X		X	X	X	X	X	
C22 – Pressure Point*	USF	06/2019	X	X	X	X		X	X	X			
East Coast FL #1	RDSea	Planned 2022	X	X	X	X	X	X	X	X	X		
East Coast FL #2	RDSea	Planned 2023	X	X	X	X	X	X	X	X	X		
SOFAR 4 – East Coast FL*	FIU	Planned 2022						X			X		
SOFAR 5 – East Coast FL*	FIU	Planned 2022						X			X		

*Only funded at $6M level

- Provide near-RT surface currents through operation of **20 HFR stations** to support search and rescue operations, fisheries management and oceanographic research. Data are delivered in near-RT to local servers, SECOORA DMAC and National High Frequency Radar Data Assembly Centers. Both CODAR and WERA systems are operated in the region. These HFR are operated and provide data in accordance with the National Surface Current Mapping Plan. Station specifics including operator, installation year, type, location and operating frequency are included in Table A1, Appendix 4 and Figure 2 (UNC, ECU CSI, UofSC, UGA SkIO, FIT, UM, USF).
- Fly **three glider shelf and event missions annually** in the SAB that collect conductivity, temperature, salinity, dissolved oxygen, chlorophyll a, colored dissolved organic matter and backscatter to characterize Gulf Stream shelf dynamics and improve forecasting of regional coastal ocean phenomena (e.g., hurricanes, HAB events). The glider team follow data collection and data sharing methods identified in the U.S. Underwater Glider Workshop Report. Each glider mission is 30-45 days and operations are conducted by four institutional partners in the SECOORA glider observatory. Mission data are disseminated to the international scientific community via the National Glider Data Assembly Center (DAC) where they are made available to the oceanographic modeling community. Glider owners, manufacture year, and sensor payload are detailed in Table A2, Appendix 4 (UGA SKIO, USF, GT, UNC).
- Maintain and download data from passive **acoustic telemetry receivers** deployed on four moorings in NC, one on the WFS, and on two SECOORA gliders that operate in the SAB. Receivers record the presence of tagged fish to inform fisheries research and management. Receivers deployed on moorings and mobile platforms offer a unique perspective on animal movements because they are located in areas logistically challenging for traditional receiver placements. Receivers are downloaded every 6-12 months and data are provided to the FACT Network for upload to the ATN network. See Table 3 and Appendix 4 for details.
- The Estuarine Soundscape Observatory Network in the Southeast uses **passive acoustic hydrophones** to monitor underwater sounds in five locations in four SC estuaries to monitor animal behavior at multiple levels of

biological complexity (from snapping shrimp to fish to marine mammals) and at time scales ranging from minutes to years (Monczak et al. 2020; Mueller et al. 2020, National Ocean Council 2016). See Appendix 4, Table A3. Additionally, two of the SECOORA gliders can be outfitted with hydrophones and are used in Greys Reef National Marine Sanctuary to record ambient noise. See Appendix 4, Table A2. The soundscape approach allows researchers 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 (USCB, UGA SkIO, USF). Data from these projects will be used by Wall et al. for the Topic 2 proposal, *Passive Acoustic Monitoring Access Network: Advancing Data Management and Cyberinfrastructure Solutions for a Big Data Problem,* submitted under this IOOS opportunity.

- Maintain **three non-RT moorings** in NC and FL that collect physical oceanographic data (primarily temperature, salinity, and currents). These stations are visited every 6-12 months, when deployed sensors are swapped with calibrated sensors. The recently deployed sensors are returned to the lab for cleaning and calibration. Data are downloaded, quality controlled, and shared with SECOORA (Table A4, Appendix 4).

A full list of assets can be found in Appendix 4, Existing SECOORA Supported Observing Assets.

Objective 2.B. Expand the observing subsystem to address the region's highest priority needs as identified in SECOORA's RCOOS plan.

Expansion of observing activities from 2016 to 2020 focused on gliders and HFR. SECOORA funded its first glider mission in 2016 and has leveraged that effort to partner with NOAA on the Hurricane Glider picket line initiative while continuing to fly 3-5 missions annually. In 2018, SECOORA received IOOS funding to add six new stations to our HFR network, resulting in a 40% net increase in the number of HFR in the SE. For this proposal period, Tier 1 expansion of observing activities will focus primarily on adding buoys and water level stations and adding glider missions in the GOM.

2.B1. For Tier 1, the following new assets/operations will be supported, enabling SECOORA to meet local and regional needs related to all three focus areas. The needs for these assets and locations are described in Section 3.2 of the RCOOS Plan (Observing Assets). These assets provide data in locations and at time scales required to address needs identified in the National Strategy for a Sustained Network of Coastal Moorings and The National Operational Wave Observation Plan.

- Add one buoy suite (one met buoy and one wave buoy) near the **Charleston Harbor SC** ship channel entrance. Year 1 activities include siting, permitting, and deployment; Years 2-5 are primarily maintenance with buoy turnarounds occurring once each year. Letters of support from the Port of Charleston and the Charleston Harbor Pilots in Appendix 1 highlight the need for this station (UNCW).
- Install and operate **three low-cost, real-time Sofar Spotter wave buoys** to be deployed off of southeastern NC near beaches with and without lifeguards in order to increase rip current forecast accuracy. Mariners in this area need wave data to improve decision-making for navigation, recreation, offshore operations, and marine safety. Two moorings will be deployed in 2022 and one in 2023, for a total of three. The buoys will be visited every 6 months to inspect the mooring line and anchor and remove bio-fouling (UNCW).
- Site and install two buoys off the **east coast of FL**. Based on stakeholder feedback, SECOORA has identified areas near Daytona Beach and Fort Pierce, FL as potential buoy locations. Year 1 activities entail siting and permitting for both buoys; Year 2 will see one buoy deployment, and in Year 3 the second buoy deployment and maintenance of the first buoy. During Years 4-5 maintenance of both buoys will continue. Buoys will collect core physical and biogeochemical variables (RDSea, FIT).
- Expand the spatial coverage of the glider observatory with **an annual 30-45 day WFS survey** to support modeling, fisheries science, and HAB monitoring (UGA SKIO, USF, GT, UNC).
- Establish a **RT regional cost-efficient, accurate water level network** to address needs for RT flooding information. The SE is plagued with high tide flooding, sometimes referred to as nuisance flooding, which leads to public inconveniences such as road closures, and it is becoming increasingly common as sea levels rise (Sweet et al., 2019). At present the four-state region does not have the density of water level data required to fully understand variations in water level at the appropriate spatial and temporal scales required for decision making (e.g.,

emergency management, habitat/environmental management, agriculture). Based on A Network Gaps Analysis for the National Water Level Observation Network, there are major spatial gaps in water level measurements from NC to the west coast of FL. SECOORA will invest in a new regional water level network to provide localized flooding alerts and the data required for longer-term sea level rise monitoring. The network will be developed in alignment with NOAA Center for Operational Oceanographic Products and Services (CO-OPS) Tiered Data Policy. Four PI teams are collaborating and partnering with stakeholders, decision-makers, and community residents to deploy a network of 188 cost-efficient fit-for-purpose water-level sensors. The network will provide near-RT water level and flooding data. In addition to installing water level stations, Year 1 activities will include establishing a network coordination structure; convening an advisory committee which includes representatives from CO-OPS; leveraging work by IOOS, CO-OPS, and the Alaska Ocean Observing System (AOOS) to establish a regional community water level user interface; and determining where to co-locate systems as a "testbed" to evaluate the lifecycle cost versus accuracy of data for the systems being installed. Provisional location and technical specification data including sensor accuracy are available in Table 4. Additional specifics include:

- Install 16 water level sensors in coastal GA in each of Years 1-3 and install 15 water level sensors in Years 4-5 for a total of 78 sensors by Year 5. Co-locate LoraWAN-equipped rain gauges at 42 locations (GA Tech).
- Install 14 water level sensing stations annually to be distributed across six SC counties and two FL counties for a total of 70 stations by Year 5 (CCU, FAU).
- Install eight integrated coastal flood observation sites in FL during Year 1 and maintain the sites in Years 2-5. This project also incorporates in-situ surface and shallow subsurface measurements of depth and salinity, webcam video, and drone surveillance (FIU).
- Install seven water level sensors in each of Years 1-2 and six water level sensors in Years 3-5, for a total of 32 sensors by Year 5. The 32 coastal communities in NC, SC, and FL will cost share the equipment and assist with maintenance for this effort (ASBPA, UH).

Table 4. Water Level Station Details at Tier 1 and Tier 2 Funding Levels

Station Location	PI Institution	# Water level sensors Tier 1	# Water level sensors Tier 2	Partner Affiliations
Georgetown County, SC	ASBPA	3	3	Town of Pawleys Island; Georgetown County
Beaufort County, SC	ASBPA	3	3	Town of Hilton Head, City of Beaufort, SC Sea Grant Consortium
Horry County, SC	ASBPA	3	3	City of Myrtle Beach; City of North Myrtle Beach; Horry County
Currituck County, NC	ASBPA	1	2	
Dare County, NC	ASBPA	2	2	Town of Duck, Town of Nags Head, Dare County
Hyde County, NC	ASBPA	2	2	Hyde County
Carteret County, NC	ASBPA	3	3	Town of Beaufort, Indian Beach, Carteret County
Brunswick County, NC	ASBPA	4	6	Town of Holden Beach, Town of St. James, Town of Sunset Beach, Ocean Isle Beach, Village of Bald Head, NC
Pender County, NC	ASBPA	2	2	Surf City and Topsail Beach
Nassau County, FL	ASBPA	2	2	TBD
Palm Beach County, FL	ASBPA	1	2	Town of Palm Beach
Lee County, FL	ASBPA	2	2	Captiva Island
Chatham County, GA	ASBPA	0	2	City of Tybee Island
Glynn County, GA	ASBPA	0	2	TBD
Charleston County, SC	ASBPA/FIU	4	4	City of Folly Beach, Town of Sullivan's Island, City of Charleston, NOAA, UNCW
Charleston County, SC	CCU-FAU	3	4	The Nature Conservancy, SC Floodwaters Commission, SC State Guard, SC DHEC
Dorchester County, SC	CCU-FAU	3	5	Dorchester County, SC Floodwaters Commission, SC State Guard, SC DHEC

Station Location	PI Institution	# Water level sensors Tier 1	# Water level sensors Tier 2	Partner Affiliations
Florence County, SC	CCU-FAU	4	5	Florence County, SC Floodwaters Commission, SC State Guard, Francis Marion University, SC DHEC
Georgetown County, SC	CCU-FAU	5	6	Georgetown County, The Nature Conservancy, SC Floodwaters Commission, SC State Guard, SC DHEC
Horry County, SC	CCU-FAU	15	15	Horry County, City of Conway, SC Floodwaters Commission, SC State Guard, SC DHEC
Marion County, SC	CCU-FAU	5	6	Marion County, SC Floodwaters Commission, SC State Guard, SC DHEC
Richland County, SC	CCU-FAU	3	6	Richland County, SC Floodwaters Commission, SC State Guard, SC DHEC
Palm Beach County, FL	CCU-FAU	24	24	Palm Beach County, City of Jupiter, Palm Beach County Business Development Board, City of West Palm Beach, City of Boca Raton
St Lucie County, FL	CCU-FAU	8	10	City of Fort Pierce, FL
Miami-Dade County, FL	FIU	5	5	Miami-Dade County, City of Coral Gables, Catalyst Miami, UNCW, NOAA
Broward County, FL	FIU	1	1	City of Ft. Lauderdale, Catalyst Miami, UNCW, NOAA
Monroe County, FL	FIU	1	1	Monroe County, Catalyst Miami, UNCW, NOAA
Brevard County, FL	FIU	1	1	Indian River Lagoon National Estuary Program, Catalyst Miami, UNCW, NOAA
Camden County, GA	GA Tech	30	30	Camden County, King's Bay Naval Base
Chatham County, GA	GA Tech	18	30	CEMA, City of Savannah
Glynn County, GA	GA Tech	30	30	TBD
TOTAL SENSORS		**188**	**219**	

NOTES: FIU using the In-Situ AquaTROLL 200 sensor (vented pressure transducer w/ coupled water temp/conductivity sensors) which have accuracy of 0.5% or better, <+/- 1cm. All other PIs are using the ultrasonic MaxBotix MB7388 temperature-compensated ultrasonic sensor which has an accuracy of 1% or better, typically +/- 1.5mm. Both sensors will sample at a frequency of 1Hz. All data telemetered via cellular communication except GA Tech which uses LoraWAN technology. All stations surveyed to NAVD88.

2.B2. For Tier 2, SECOORA will expand the observing network further to characterize coastal processes and ocean chemistry. The need for the assets and their locations are described in Section 3.2 of the RCOOS Plan.

- Install and operate one **new met-ocean mooring offshore of Myrtle Beach, SC**. Year 1 activities include siting, permitting, and deployment; Years 2-5 are primarily data collection and maintenance, with buoy turnarounds occurring once each year (CCU).
- Install and operate two Sofar Spotter **wave buoys offshore of Miami Beach** to improve nearshore wave characterization and rip current detection. Marine safety is a major concern in SE FL, which has a very dynamic oceanic environment and a history of numerous marine boating accidents. Miami Beach ranks #3 in the nation in rip current drownings (Paxton, 2014). Year 1 activities include siting, permitting, and deployment of both buoys. The buoys will be visited every 3-6 months to inspect the mooring line and anchor and remove bio-fouling (FIU).
- Maintain the **C22 met-ocean mooring** located on the WFS. This location provides critical data to understand shifts in the FL Loop Current which impacts major transport mechanisms along the WFS. This mooring was deployed in 2019 through funding from the National Academies of Sciences, Engineering, and Medicine, as part of the Florida Loop Current study. Mooring turnarounds are required annually. This station will not be maintained without additional funding (USF).
- Operate **OA sensors** at one seafloor station in the FL Keys and three estuarine stations in the Indian River Lagoon region, FL. The FL Keys mooring will establish a long-term seafloor OA time series in the lower Florida Keys and address needs as identified in the Interagency Working Group on Ocean Acidification Strategic Plan (IWGOA 2014). Stakeholders from across the SE have expressed their needs at meetings held by the regional acidification network (SOCAN) for actionable information about OA progression and identification of particularly vulnerable areas and species groups such as coral reefs. The seafloor station will be sited, permitted, and installed within the Florida Keys National Marine Sanctuary in Year 1. Maintenance will be required every 3-6 months,

depending on biofouling. This station will be non-RT. Sensors will be downloaded when swapped at 6-month intervals and data shared with SECOORA. The FAU HBOI stations will be part of the Indian River Lagoon Observatory Network (IRLON) and installed in the Indian River Lagoon (IRL) and St. Lucie estuaries. Currently, IRLON is being upgraded with improved data loggers and telemetry, website enhancements, and new technical capabilities to address two emerging threats to the IRL: HABs and coastal acidification. These threats have been identified as requiring monitoring and management in the IRL by the new Comprehensive Conservation and Management Plan of the Indian River Lagoon National Estuary Program (IRLNEP 2019). The OA sensors are integrated into the existing water quality monitoring stations and report in RT. Due to heavy biofouling in the estuary, the stations are visited every three to four weeks to clean instruments. All IRL data will be shared in RT with SECOORA. Details including monitored parameters are available in Table A5, Appendix 4 (Mote, FAU HBOI).

- Install and **operate webcams** to monitor urban, estuarine, and coastal flooding; shoreline change; visibility; and storm surge. Webcams will be deployed on existing structures (e.g., fishing piers, municipal buildings) at beach locations. The cameras will provide a RT feed of the area. Locations for camera deployments will be identified, sited, and permitted in Year 2. In Year 3, four webcams will be installed. In Years 4 and 5, three webcams will be installed for a total of 10 new webcams in the SECOORA region. Maintenance is required after storms (to assure cameras are still secure) and to clean lens on an as needed basis (UNCW).
- Fly two **additional 30-45 day glider missions.** One mission will support storm tracking and forecasting in either the GOM or SAB depending on storm location; and one WFS to SAB connectivity mission to track Loop Current to Gulf Stream transport (UGA SkIO, USF, UNC, Ga Tech).
- Install 31 **additional water level stations** throughout the SECOORA region. See Table 4 (GA Tech, CCU, FAU, FIT, ASBPA).
- Incorporate **high tide/flooding citizen science reporting** with FL community members (FIT). This project will leverage on-going citizen science activities led by Sea Level Solutions Center, Catalyst Miami, and local municipal/county agencies. Citizen scientists will be sent to specific locations where flooding is expected where they will take photos and make flood measurements. Data will be shared through http://miamistories.net/sea-level-rise/. The citizen science efforts will expand to SC by Year 3 in coordination with ASBPA (FIT, ASBPA).
- Support **Autonomous Surface Vehicle (ASV) missions** to address research and management data gaps within the region (SECOORA). SECOORA will work with regional PIs to conduct ASV missions for event-driven responses to HABs, to characterize water quality for post-storm assessments, to monitor conditions during fish kills, etc. The goal of these mobile platform missions is to provide critical data for decision support that augments and fills gaps in the current SECOORA observing subsystem. SECOORA will conduct ASV missions in Years 2 and 3.

2.B3. At the **Tier 2 level**, SECOORA will be able to conduct **biological habitat assessment and characterization projects** as defined in the SECOORA RCOOS Plan (Section 2.2).

- In partnership with MARACOOS, **apply 84 pop-up satellite archival tags (PSATs) on white marlin** to provide critical life history data including site fidelity, migration drivers, stock structure, and predictive habitat models to improve the assessment, conservation and management of this economically important species. The satellite tags act as biological gliders and will provide 12-month migration tracks that include millions of temperature-at-depth records throughout the SECOORA region and beyond. Tagging activities will be conducted in Years 2-5 in SE FL, northwest FL, NC, AL and NJ, with 21 fish tagged in each year. The tags remain attached to the fish for up to one year and then release. The data from these tags are transmitted to the Argos satellite network and then made directly available on the SECOORA portal. Recovered tag data will be downloaded and made available on the SECOORA portal. These observational data will be used to 1) improve and validate oceanographic and weather models, 2) couple animal telemetry networks with remote sensing and buoy observations, 3) assess coastal economic impacts associated with spatial and temporal shifts in distribution of the fishery due to climate change and 4) outreach results to end-users and the fishing and scientific communities on adaptation strategies for these anticipated changes (ROFFS™).
- Deploy 40 temperature-depth profiling satellite **tags on highly migratory sharks** for near-RT collection and transmission of data on a) shark movements, b) associated sea-surface temperatures, and c) associated

temperatures at depth. Twelve satellite tags will be deployed in Years 1-3 and four tags will be deployed in Year 4. The data will be telemetered back to a receiving station anytime the satellite tag is at or near the surface. The tags can remain on the sharks for multiple years. These data will be available to via SECOORA DMAC as the physical data can fill critical gaps needed for model development (UM).

Goal 3: Implement, integrate, and expand the Data Management and Cyberinfrastructure, and Modeling and Analysis subsystems

The DMAC subsystem is an integrating and foundational subsystem of the RCOOS, that when coupled with the MA subsystem enables the transformation of raw data into accessible and credible information for decision-makers. Over the last decade, SECOORA has worked with state, federal, and private partners to develop the technologies and capabilities necessary to address many of the common challenges to ocean data management, reuse, and visualization. In this capacity, SECOORA works with its DMAC contractor, Axiom Data Science, to provide advanced data management support, data systems architecture, software engineering, and cyberinfrastructure operational services to meet the US IOOS DMAC mandates. Axiom has worked with SECOORA and partners to support a regional DAC, operated and continuously improved its data center, and provided a regional web-based data portal (https://portal.secoora.org/) for access to ocean and coastal environmental data and information products across the US SE. This collection of data, technology, policies and procedures, human resources, intellectual property and physical infrastructure is SECOORA's DMAC subsystem.

Objective 3.A. Maintain and enhance the DMAC subsystem

For Tier 1, we will **operate and improve SECOORA's core DMAC subsystem**. The capabilities of the SECOORA DMAC subsystem provide the cyberinfrastructure and expertise to support an operational DMAC system, which was developed to meet the guidelines and specifications recommended by NOAA IOOS and endorsed by the federal Interagency Ocean Observation Committee (IOOC) and Global Earth Observation (GEO) Program. Axiom has developed advanced cyberinfrastructure to support observing systems and large-scale research programs composed of distributed science teams working across multiple domains. This cyber-infrastructure was first used operationally in 2009 as the core DMAC system for AOOS and today has expanded to support a spectrum of partners operating in oceanographic, atmospheric, ecological, and human use disciplines. Partners include IOOS, Central and Northern California Ocean Observing System (CeNCOOS), MBON, the Bureau of Ocean Energy Management, NOAA, the Department of Homeland Security, and the National Science Foundation's Long Term Ecological Research Network and Ocean Observatories Initiative.

The individual components that make up the SECOORA DMAC subsystem have been developed from open-source technologies and are designed to be scalable and to embrace IOOS community standards and best practices for data and management. More information on SECOORA data standards and requirements and adherence to the NOAA Environmental Data Management Framework can be found in Appendix 5 Data Management and Cyberinfrastructure Plan, which includes the Data Sharing Policy on page 4, and Appendix 6 SECOORA Methods to Address IOOS Core Capabilities.

Core components of the SECOORA DMAC subsystem include the following:

- High Performance Computing (HPC) — operation of provisionable compute and storage, including a mid-sized data center with 6,000 processing cores and 5 petabytes of disk storage. All nodes are interconnected over a low-latency InfiniBand fat-tree network topology. Managing our own infrastructure gives us the ability to quickly and cost-effectively provide computing services to small- and medium-sized projects and partners. The technology and API interfaces available through our data center have been are compatible with third party vendor cloud offerings, providing us the ability to scale to any size project by implementing a hybrid cloud model as needed.
- Data Assembly and Quality —software systems to interface with other devices or teams producing data. Axiom has developed automated systems to harvest data from sensor networks, mobile platforms, satellites, and modelling centers and transform those heterogeneous sources to common data and metadata representations. These systems also apply IOOS's Quality Assurance of Real-Time Oceanographic Data (QARTOD) tests to real-time in situ observations to generate, visualize, and distribute quality flags. The Research Workspace is an Axiom-developed platform designed to help research teams securely share datasets, author and execute server-side code,

generate metadata, and publish data products with Digital Object Identifiers (DOIs) to national repositories within the DataONE network and the NOAA National Center for Environmental Information (NCEI). Regional and national modeling products are downloaded and processed further by Axiom to allow for fast data exploration and visualization as well as for metadata enhancement, cataloging, and distribution through SECOORA data services.

- Implementation of Community Standards and Systems —building off the collective work of the community to ensure data discovery and reuse by enforcing data standards such as NetCDF simple feature specification, Climate Forecast conventions, Darwin Core, Ecological Metadata Language, and ISO 19115/19110 metadata formats. Following these standards enables other national cyberinfrastructures to discover and use the data resources through interoperable systems and protocols such as THREDDS, ERDDAP, and OPeNDAP. Serving data through these standard services allows other regional partners to ingest and use the SECOORA data in their work. For example, SECOORA modeling groups can use the SECOORA-provided data to assimilate or validate their models.
- Modern Big Data Analysis and Machine Learning Techniques — scalable computing executed in proximity to data storage. The capability is designed to store and provide access to petabytes of open-source historical and real-time data aggregated by Axiom in support of observing systems or research efforts. The technology stack supports running scalable analysis engines such as Apache Spark, Dask, and Pangeo on compute clusters. The benefit is that researchers can analyze extremely large datasets using HPC collocated with the data and download analysis products, rather than repetitively spending bandwidth and time downloading large datasets to analyze with limited local processing power. SECOORA has also identified audio and video data as important players in the future of understanding our coastal environments, so has dedicated resources to becoming a regional node for such data. SECOORA plans to organize and manage these datasets to allow researchers to run algorithms directly against the raw audio and video and also any labeled data products generated from such data. These datasets will drive SECOORA data products based on AI/ML analysis of audio and video data.
- Data Product Support— ontological database (OnDB) approach to drive end-user applications and analysis tools. Axiom applies an OnDB approach, a unified metadatabase that describes the provenance, context, and properties of all the datasets in the SECOORA DMAC subsystem and allows for the development of targeted applications. The data endpoints, catalogs, and interactive maps can also be made available through connected software such as cloud-hosted Jupyter Notebook to allow advanced users to generate value-added data products within the data system itself, using R, Octave (Matlab), and/or Python. Hosted notebooks that provide access to SECOORA model and sensor data managed within the OnDB can power customized analyses and products, thus allowing for an integrated approach to increase the accuracy, reliability and scope of operational ocean products and services for the SE.
- Integration with Other National Cyberinfrastructure — facilitating the research data lifecycle. The SECOORA DMAC subsystem covers all lifecycle steps, from initial observations, ingestion, and quality control, to data sharing via the SECOORA data portal or reuse of data for product or model development. The Axiom cyberinfrastructure stack integrates directly with DataOne, NOAA's National Data Buoy Center (NDBC) and NCEI, providing access to archiving and packaging tools for data analysis products.
- Human Expertise and Capacity — data management and analysis expertise. The Axiom team is comprised of 22 members, including data librarians, data coordinators, data analysts, data ingestion experts, full-stack software engineers, and system architects. Axiom staff are the key component to formatting data from diverse sources, making data available and accessible through SECOORA programs and interfaces, and providing support for providers and researchers. Axiom and SECOORA have allocated personnel and committed financial resources (see Appendix 8, Budget Justification) for staff to participate in the annual IOOS DMAC meeting and to participate in national activities that require regional expertise and input (e.g., Compilation of Environmental, Threats, and Animal Data for Cetacean Population Health Analyses (CETACEAN), MBON). Axiom staff are engaged in national DMAC activities through integrating new data assets and information products, implementing national DMAC standards (i.e., IOOS Metadata profile v1.2), advancing ioos_qc library and quality tests, and ultimately making data publicly accessible and re-useable thereby serving societal needs.

- Product Usage Statistics – SECOORA uses Google Analytics to track usage statistics for the data portal, webpage, and products. SECOORA will post monthly summaries of these statistics (number of sessions, page views, etc.) on the IOOS Proposal Documents web page.

Objective 3.B. Maintain and enhance the Modeling and Analysis (MA) subsystem

A central goal of SECOORA is to develop, in partnership with end users, modeling and analysis products that support decision making. SECOORA supports a numerical modeling framework (regional to sub-regional scale models) that enhances the observing subsystem through synthesis, interpretation, and prediction of ocean state variables. Coupled with the DMAC and observing subsystems they provide actionable information for decision-makers. (Wilkens et al., 2017)

3.B1. **Modeling**: Provide forecasts for select coastal ocean phenomena.
For Tier 1, continue to operate nowcast/forecast (N/F) MA products used by regional decision makers.

- Operate the Coupled North Atlantic Prediction System (CNAPS) numerical ocean modeling system to **deliver daily N/F of currents, temperature, salinity, and sea surface height fields**; generate a regional ocean climatology by performing a multi-decade hindcast; move the CNAPS system to the Amazon cloud; and implement the Ensemble Data Assimilation capability. Models and observations work together to provide the information needed by user communities. As stated in Baron Advanced Meteorological Systems Solutions Letter of Support (LOS) in Appendix 1, "…models provide more timely and reliable information for distribution to our marine customer base. In particular, advancements in the ability to more skillfully forecast the coupled impacts of storm-surge and river discharge/flooding are of vital significance." See Figure 4 (NCSU, Fathom Science).
- Maintain WFS and Tampa Bay (WFCOM and TBCOM) daily N/F of currents, temperature, salinity and sea surface height fields with a targeted 90% uptime. WFCOM downscales from the deep ocean, across the continental shelf and into the major estuaries by nesting the unstructured grid FVCOM in the GOM HYCOM, affording increasingly finer resolution upon approaching the coast. TBCOM achieves even higher resolution (down to 20 m) by nesting FVCOM in WFCOM. With such high resolution TBCOM includes Tampa Bay, Sarasota Bay, the Intra-Coastal Waterway and all of the inlets connecting these with the GOM. The latest version of WFCOM (soon to be transitioned to) includes the entire west FL Intra-coastal Waterway and inlets, a realistic representation of the entire FL Keys and inlets extending north to Biscayne Bay. Both WFCOM and TBCOM provide daily, 4.5 day trajectories for red tide and search and rescue operations, and provided realistic simulation of storm surges (USF).
- In partnership with Caribbean Coastal Ocean Observing System (COOS) and Gulf of Mexico COOS, develop and operate a high-resolution, web-based system to monitor and **forecast pelagic Sargassum** in several coastal zones of the FL Keys and SAB; this system would support all three RAs. The Sargassum explosion is causing significant impacts to coastal communities, both economically and environmentally, and is impacting areas throughout the Caribbean, Central America, and FL. This project will expand the capacity of an existing Sargassum Watch System (Hu et al., 2016) by including high-resolution data products that enable managers to more cost effectively address beach clean-up (USF).

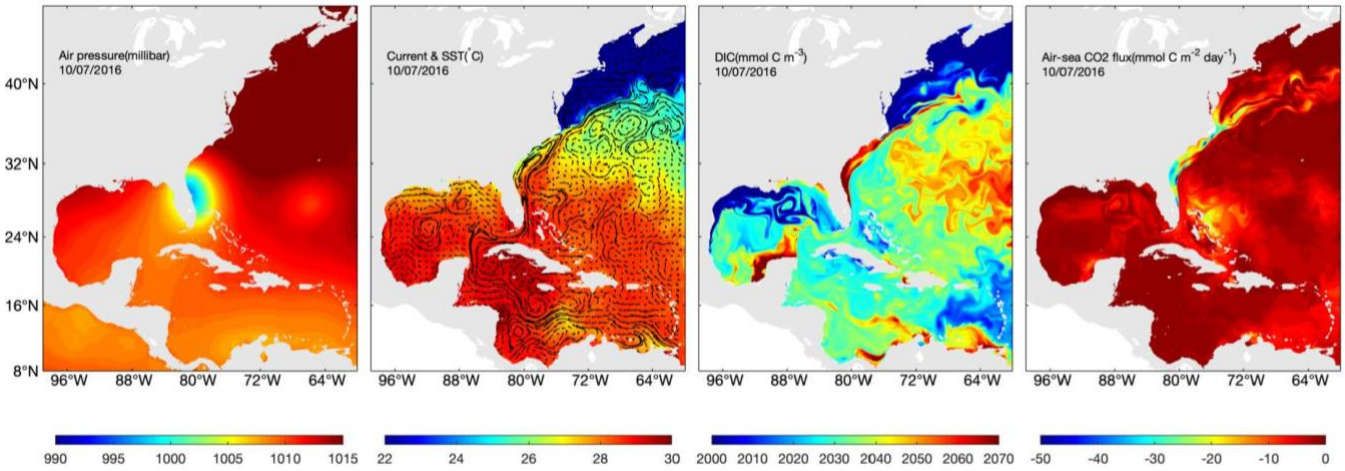

Figure 4. A snapshot of CNAPS biogeochemistry hindcast of surface ocean conditions on October 7, 2016 when Hurricane Matthew translated through the SE coastal waters. From left to right are surface air pressure, CNAPS-simulated surface ocean currents overlaid on simulated sea surface temperature, CNAPS-simulated surface dissolved inorganic carbon, and CNAPS-simulated air-sea CO_2 fluxes.

For Tier 2 increase or expand N/F MA products used by regional decision makers.

- Improve CNAPs model capabilities through grid refinement and model nesting technology to develop subregional, high-resolution, high-fidelity marine predictions for end-users (e.g., ports, river pilots, energy industry). Expand capabilities to include marine biogeochemistry N/F and conduct observing system simulation experiments to identify locations for optimal observing subsystem expansion (e.g., location and sensor combinations).
- Develop a series of **genetic Species Distribution Models (gSDM) for sharks** throughout the SECOORA region, to provide high-resolution data on animal distributions in the context of environmental parameters with 12-fold greater accuracy than SDM performed without genetics (Ikeda et al., 2017). Outputs will be used to 1) map reproductive dispersal patterns of animals in the FACT Network, 2) identify the physical features that define species-specific critical reproductive habitat, and 3) predictively model future distribution of critical habitat in response to climate change (FIT).

3.B2. Integrate improvements in the **analysis** components of the MA subsystem to speed transformation of data into information required by users.

In **Tier 1** SECOORA will:

- Improve and expand **biological data analysis tools** including integration of long-term living marine resource survey data types from Southeast Area Monitoring and Assessment Program South Atlantic into the SECOORA data portal and develop new data access, exploration, analysis and visualization tools (SCDNR).
- **Construct an interactive AI data webpage/site** to include a code repository, documentation of data standards for AI applications, and user requirements for analyzing imagery, video, and acoustic data (FWRI).

At the **Tier 2** funding level, SECOORA will:

- Continue to apply machine learning technology to speed-up and **automate the processing of large passive acoustic datasets** and create high-quality libraries of underwater sound types, specifically fish and marine mammals. This will support acoustic data analysis by PIs from USCB. This project provides collaboration opportunities with the proposal submitted by Wall et. al., *Passive Acoustic Monitoring Access Network: Advancing Data Management and Cyberinfrastructure Solutions for a Big Data Problem* to the IOOS Topic 2 opportunity (Mote).

Goal 4: Effectively implement the engagement subsystem to support product co-design and delivery

Objective 4.A. Engage with stakeholders to identify and respond to their needs

4.A1. Support **community-driven networks** focused on priority societal issues aligned with SECOORA's mission and Strategic Plan. SECOORA partners with other national and regional networks to leverage expertise and expand observing capacity. SECOORA will remain engaged with these groups throughout 2021-2026 at the **Tier 1 level**:

- IOOS Association is a national nonprofit organization established to advance U.S. IOOS and the nation's coastal observation information needs by working with the 11 Regional Associations, US IOOS, NOAA federal agencies, and other partners. SECOORA's Executive Director currently serves as Chair of the Association.
- NOAA Southeast and Caribbean Regional Collaboration Team (SECART): a means for NOAA and partners to engage at a regional scale (NC, SC, GA, FL, Puerto Rico, and the U.S. Virgin Islands).
- Regional Ocean Data Sharing efforts: SECOORA supports efforts aimed at meeting the nation's Ocean Policy, coordinating discussion to address gaps in regional data.
- A new SE regional community flooding water level network and smart sensor testbed initiated with this proposal. Additional details are provided in Goal 2.

With **Tier 2** funding SECOORA will also support the following:

- Southeast Ocean and Coastal Acidification Network (SOCAN) is dedicated to supporting and encouraging discussions on ocean and coastal acidification. SOCAN fills the gap in the "Strategic Plan for Federal Research and Monitoring of Ocean Acidification" by creating a regional interdisciplinary network of scientists, resource managers, industry, non-profit, and government representatives focused on ocean acidification research and monitoring (IWGOA, 2014). SECOORA will continue to lead SOCAN by organizing bi-monthly virtual Town Hall style webinars, recruiting and engaging stakeholders to participate in SOCAN virtual forums, and providing monthly newsletters.
- Southeast and Caribbean Disaster Resilience Partnership (SCDRP) is an affiliation of public, private, and nongovernment organizations (NGO) focused on disaster resilience. SECOORA will maintain this community of practice to share resources, catalogue existing activities, host meetings and monthly calls, maintain a website, and submit additional funding requests to ensure sustainability of efforts. In-person meetings will create opportunities for dialogue about capacity development in disaster resilience between scientists, high-level decision makers, local implementers, and other stakeholders (Ocean Obs'19, 2020).
- The FACT Network is a grassroots collaboration of marine scientists from the Bahamas to the Carolinas using acoustic telemetry and other technologies to better understand and conserve our region's important fish and sea turtle species (Young et al. 2020). It also houses one of the largest telemetry datasets in the world. Animal observations are critical to understanding the environmental processes that shape species distribution. According to the report "Toward a National Animal Telemetry Network for our Oceans, Coasts, and Great Lakes", the inclusion of biological resources will provide a science-based source of information critical to advancing most of the National Ocean Policy (2016) priority objectives, particularly Ecosystem-Based Management (Moustahfid, 2011). SECOORA will work with FACT to expand its capabilities in the areas of data stewardship, data product development, website hosting, and network support.

4.A2. Maintain and enhance the SECOORA outreach and engagement subsystem to address priority issues in the region. In Tier 1, this work will include continuing the Coastal Ocean Observing in Your Community webinar series, website maintenance with news stories and extreme event pages such as the Florida Red Tide Resources Page and the Hurricane Resources Page, quarterly newsletters, social media posts, and hosting and participating in workshops and meetings.

4.A3. Engage students in problem solving using ocean observing data. According to the OceanObs'19 Living Action Plan (2019), ocean science outreach and communication activities, including formal and informal education opportunities, are needed to increase ocean literacy (Ocean Obs'19, 2020). The SECOORA Education and Outreach Committee provides guidance on prioritizing educational and outreach needs. Annually SECOORA will support a NOAA Hollings Scholar and host two student awards: the Data Challenge and Vembu Subramanian

Ocean Scholars Award. While limited, these awards significantly impact individual student development as articulated by award winners (See #7 LOS in Appendix 1). SECOORA will continue providing opportunities for formal and informal educators to develop online coastal and ocean related curriculum. Additionally, SECOORA staff and PIs actively support students in the classroom through data workshops and hosting field trips to coastal monitoring stations throughout the region.

Objective 4B. Product Development

SECOORA is formalizing product development procedures that include iterative end user engagement so that products are co-designed with users based on their requirements. SECOORA will work with stakeholders to identify product development opportunities and evaluate existing products to determine ongoing support and potential for expanding geographic coverage. All proposed products fit within the identified SECOORA focus areas and provide environmental and/or economic benefit to our stakeholders. Current products include Text a Buoy, the Marine Weather Portal (MWP), (see Figure 5), the Hurricane Portal and How's the Beach. We anticipate future products will address water level data, acoustic data (i.e., soundscapes or summary habitat use and seasonality from fish tags), and HFR.

Figure 5. MWP is accessible by phone allowing for quick access to critical data.

At the **Tier 1 level,** the following product development projects will be executed:

- Improve provision of **advisories of public health risks in shellfish and recreational swimming** waters. PIs from three existing projects will collaborate with stakeholders to integrate, enhance and expand their respective How's the Beach (UofSC), ShellCast (NCSU) and Beach Condition Reporting System / Citizen Science Information Collaboration (BCRS / CSIC; Mote) efforts. N/F models will be developed for six stakeholder-identified beach areas and five shellfish water harvesting areas based on need and available data. Data include indicator bacteria concentration, radar-based precipitation, salinity, water temperature, and potentially other environmental data such as tributary river flow (where applicable), wind, current, and wave information (Dwight et al., 2012; Ragsdale et al., 2011; Kelsey et al., 2010; Dusek et al., 2019). Multiple Regression and Classification and Regression Tree (CART) analyses will be used to develop these relationships (Ragsdale et al., 2011; Kelsey et al., 2010) (UofSC).
- Development of a **Situational Awareness Support-tool for weather forecasters and ocean rescue groups** utilizing data from UNCW operated buoys. This nimble module will leverage the SECOORA DMAC subsystem to allow end users to register, administer, and view custom thresholds for any combination of in situ parameters. When user-identified thresholds are crossed, the user will receive a notice via email, text, and/or social media (UNCW).
- Leverage previously funded NOAA, AOOS, and Axiom work on the community water level initiative, and establish a **water level user interface** for the SE based on assessment of user needs (SECOORA).

At the Tier 2 funding level, SECOORA will expand products to include:

- Hire an "**extension agent**." This person will coordinate user engagement and bring user product ideas to a to-be-established Product Advisory Ad Hoc Committee and then to SECOORA staff, who will serve as the Product Managers. Additional funding will be utilized for development of products through contracts with TBD software developers. Appendix 7 provides additional details on the workflow for this process.
- Include more locations in the **advisories of public health risks in shellfish and recreational swimming** waters. N/F products will be developed for 12 beach reaches and up to 15 shellfish harvesting areas (UofSC).
- Expand the currently funded OTT project, **Webcams for Coastal Observations and Operational Support** (WebCOOS). In Years 3-5, add 10 webcams at SE beaches in order to further develop operational coastal hazard and beach usage algorithms, which can be shared with other IOOS regions. Develop additional image-based

products from webcams (e.g., visibility, surf zone conditions), and develop ML algorithms for the detection of urban/estuarine flooding and potential impacts to transportation from webcam imagery (UNCW).

Summary

The proposed Tier 1 activities will support our five core RCOOS subsystems that have been developed over the past decade plus necessary expansions, and include:

- Regional coverage over a geographically large and diverse section of the US coastal ocean;
- Observing subsystem components including buoy, tower, HFR, glider, and acoustic stations on which citizens, decision-makers and scientists have come to depend;
- A new regional scale water level observing network to address community needs for higher resolution flooding data;
- Expanded acoustic data collection and improved data analysis tools;
- Continuing engagement activities to maximize the impact and benefits of the RCOOS;
- Cross-state and intra-regional cooperation; and,
- Maintenance of critical in-water infrastructure, data flow from offshore to the internet, and proven technical capabilities and experience in operational coastal ocean observing and modeling.

Over the past 20 years, SECOORA has devoted significant effort to not only coordinate its legacy systems, but to also intentionally expand and enhance observational capacity, data accessibility, and product development. Our strategy has been informed by input provided by an extensive list of invested stakeholders and is articulated in the SECOORA RCOOS Plan. As a mature RA in a region with significant observing gaps and competing needs, SECOORA must balance maintenance, filling important gaps in observations and creating new connections to users through thoughtful expansion of products and services to build-out the RCOOS. SECOORA strives to support activities that have significant potential to maximize economies of scale, whether that be through effective leveraging of resources, integration of new or more efficient technologies, or prioritizing data and products that inform multiple SECOORA focus areas and identified stakeholder needs.

Over the next five years, SECOORA will use Tier 1 funding to sustain existing observing activities that address priorities in SECOORA's RCOOS Plan, support existing and proposed products, research, and applications, and enhance a growing archive of wave, climate, and oceanographic measurements that, for some stations, extend back 20 years. SECOORA also will expand and enhance observing activities, to include novel biological data collection approaches (e.g., soundscape ecology), integration of new low-cost and agile technology that can be easily repositioned to meet end user needs, enhanced data management and modeling activities (e.g., use of AI/ML techniques), and deliver user co-designed products (e.g., water level user interface). SECOORA seeks to exploit recent advancements in autonomous systems, AI/ML, and eDNA that are transforming ocean observing, and proposes to make strategic investments in each.

At the Tier 2 level, SECOORA will expand its observing subsystem elements to address additional national and regional imperatives. Additional funding will allow for the operation a higher resolution and more expansive forecasting system (e.g., CNAPS and How's the Beach), collection of basin-scale biological data, shark habitat assessment as well as the deployment of sensors needed to assess and respond to: 1) OA effects on key marine organisms, 2) offshore energy development, where the SE is the prime national battleground for new offshore energy exploration and which the seismic issue is very significant; 3) harbor/port expansion programs on the east coast; and 4) HABs on the WFS. With additional funding, SECOORA is poised to address these and other regionally significant issues in partnership with numerous stakeholders identified in this proposal.

The proposed activities will not only deliver stakeholders the ongoing observations and modeling products on which they already rely, but also enable innovative approaches that leverage existing SECOORA efforts (observations, models and DMAC) to create new and exciting collaborations. These efforts also provide the opportunity to strengthen existing collaborations and forge new partnerships that can be further leveraged by SECOORA and IOOS. For example, the proposed regional water level observing network will leverage partner funding and previous AOOS, NOAA and Axiom work. The biological data collection and novel data analysis investments will address priority needs of fisheries managers. The DMAC subsystem will enable users to advance the utility of observations and combine various components of the SECOORA network in novel ways. By creating

synergies, adding new capabilities in an intelligent way, and supporting core operations, SECOORA will contribute to a growing time-series of environmental/climatological observations in the SE. This will enable operational economies of scale for IOOS partners and regional end-users, advance the utility of new technologies, provide workforce training opportunities, and enhance user-driven products that support human populations, coastal economies and a healthy, sustainable environment. SECOORA looks forward to continuing its role the leader of ocean observing science partnership in the SE.

Milestones

Table 5 provides milestones for each goal and objective included in the proposal. In consultation with the PIs, SECOORA has developed measurable goals, objectives and outcomes meeting NOAA's SMART goal requirements. Due to space limitations, they are not included here, but are available if requested. Grey rows reflect Tier 2 activities.

Table 5. Milestones

Milestones	Y1	Y2	Y3	Y4	Y5
Goal 1: Continue successful operation of the SECOORA governance and management subsystem					
Maintain the SECOORA governance and operational structure	X	X	X	X	X
Maintain SECOORA's certification as a RICE	X	X	X	X	X
Update the SECOORA RCOOS Plan	X	X	X	X	X
Goal 2: Maintain and augment the SECOORA observing subsystem					
Operate and maintain 13 existing real-time moorings offshore of NC and FL	X	X	X	X	X
Operate and maintain 20 HFRs regionwide	X	X	X	X	X
Conduct SAB glider missions	X	X	X	X	X
Maintain acoustic telemetry receivers on 6 stations in NC and FL	X	X	X	X	X
Maintain the estuarine soundscape observatory using passive acoustic recorders	X	X	X	X	X
Operate and maintain 3 non-real time moorings offshore of NC and FL	X	X	X	X	X
Deploy and maintain Charleston Harbor, SC buoys (met and wave buoys)	X	X	X	X	X
Deploy and maintain 3 SoFar wave buoys off southeastern NC		X	X	X	X
Deploy and maintain 2 buoys off the FL east coast		X	X	X	X
Add 1 glider missions to the GoM in support of HAB monitoring	X	X	X	X	X
Establish and maintain a regional network of 188 water level sensors	X	X	X	X	X
Deploy and maintain Myrtle Beach, SC buoy		X	X	X	X
Deploy and maintain 2 SoFar wave buoys off FL east coast	X	X	X	X	X
Maintain OA sensors on C12 mooring on WFS	X	X	X	X	X
Maintain the C22 pressure point mooring on WFS	X	X	X	X	X
Deploy and maintain an OA station in the FL Keys	X	X	X	X	X
Deploy and maintain 3 OA sensors at stations in the Indian River Lagoon	X	X	X	X	X
Install and maintain an additional 31 water levels sensors	X	X	X	X	X
Install and maintain webcams on beaches within the region			X	X	X
Conduct water quality sampling during coastal tidal flooding events	X	X	X	X	X
Add 2 glider missions (WFS and WFS to SAB)	X	X	X	X	X
ASV missions for event driven response		X	X		
Tag 84 white marlin with satellite tags		X	X	X	X
Tag 40 sharks with satellite tags	X	X	X	X	X
Goal 3: Implement, Integrate, and expand the DMAC and MA subsystems					
Maintain and enhance the SECOORA DMAC subsystem	X	X	X	X	X
Maintain the CNAPS model, move system to Cloud	X	X	X	X	X
Maintain the WFCOM and TBCOM models	X	X	X	X	X
Develop and maintain the pelagic Sargassum tracking model	X	X	X	X	X
Improve CNAPs model through refinement, nesting, and biogeochemistry N/F	X	X	X	X	X
Develop Fisheries Species Distribution models	X	X	X	X	X
Develop biological data analysis tools through integrations of SEAMAP-SA fish survey data	X	X	X	X	X
Construct an interactive AI portal	X	X	X	X	X
Continue development of ML algorithms for fish species identification	X	X	X	X	X

Goal 4: Effectively implement the engagement subsystem to support product co-design and delivery					
Engage and support community networks (IOOS Association, SECART, regional data sharing, and community flooding network)	X	X	X	X	X
Support community driven networks (SOCAN, SCDRP, FACT)	X	X	X	X	X
Maintain and enhance the SECOORA outreach and engagement subsystem	X	X	X	X	X
Engage students through SECOORA scholarship and funding opportunities	X	X	X	X	X
Develop a situational awareness tool for weather forecasters and ocean rescue	X	X	X	X	X
Maintain & enhance products for shellfish & recreational swimming water advisories	X	X	X	X	X
Leverage Alaskan water level portal to create a water level portal for the SE	X	X	X	X	X
Hire an extension agent to coordinate product development	X	X	X	X	X
Expand locations for the shellfish & recreational swimming water advisories product	X	X	X	X	X
Expand WebCOOS product development	X	X	X	X	X

Project Budget

SECOORA is a **legal entity and fiscal agent** with final responsibility for acceptance and expenditure of funds according to the funding agency (NOAA) and has the ability to enter into enforceable contracts with funding organizations, our subawardees and contractors. SECOORA has successfully executed two previous IOOS five-year cooperative agreements, and numerous other grant awards and contracts, including but not limited to competitively awarded COMT and OTT three-year awards and Congressionally directed Hurricane Supplemental funding. Currently, we are managing **59 subawards and contracts totaling over $10.4M**. Our FY20 audit concluded with no negative findings and SECOORA is considered low risk.

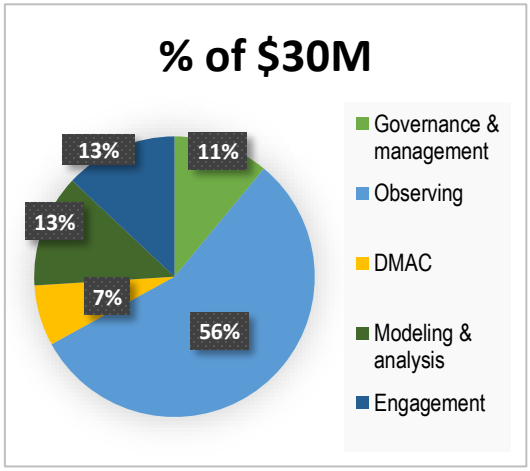

Figure 6. Cost by RCOOS Subsystem

Summarized costs by budget class for this five-year effort at the Tier 2 scenario are in Table 6. Extensive additional budget details are in Appendix 8. Figure 6 summarizes costs by RCOOS subsystem. Note that some DMAC cost are included in the Modeling and Analysis, and Engagement subsystems. Additionally, the DMAC subsystem is leveraged with AOOS and CeNCOOS providing economies of scale. Tier 1 funding will support Goal 1, Goals 2A through 2B1, and Goals 3A1, 3B1 and 3C1. Many components of this proposal are leveraged. **Nearly 60% of projects are providing leverage** in the form of donated equipment, salary match, volunteer time, tuition waivers, facility use, reduced indirect cost rate, in-kind services, donated services, other grants including kick-start funds and biological data collection, all **estimated at over $14M** over the five-year proposal life. Additional leveraging details are available on request.

Table 6. SECOORA Budget Summary by SF424A Budget Class

BUDGET ITEMS		YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	TOTAL
Total Salaries and Wages		$ 426,540	$ 426,540	$ 426,540	$ 426,540	$ 426,540	**$ 2,132,699**
Fringe Benefits (27%)		$ 115,166	$ 115,166	$ 115,166	$ 115,166	$ 115,166	**$ 575,829**
Total Salaries,Wages,Fringe Benefits		$ 541,705	$ 541,705	$ 541,705	$ 541,705	$ 541,705	**$ 2,708,527**
Travel		$ 90,879	$ 80,800	$ 57,668	$ 55,500	$ 86,640	**$ 371,487**
Equipment		$ 250,000	$ -	$ -	$ 250,000	$ -	**$ 500,000**
Supplies		$ 91,220	$ 73,620	$ 95,479	$ 112,752	$ 73,620	**$ 446,691**
Contractual		$ 582,660	$ 857,660	$ 848,735	$ 572,973	$ 582,660	**$ 3,444,688**
Construction		$ -	$ -	$ -	$ -	$ -	**$ -**
Other costs		$ 299,466	$ 253,865	$ 125,600	$ 135,600	$ 348,815	**$ 1,163,346**
Other costs: Subawards All combined		$ 3,945,254	$ 4,089,628	$ 4,239,068	$ 4,237,214	$ 4,147,594	**$ 20,658,758**
TOTAL DIRECT COSTS		$ 5,801,184	$ 5,897,278	$ 5,908,255	$ 5,905,744	$ 5,781,034	**$ 29,293,497**
Indirect Costs	10% de minimis	$ 198,816	$ 102,722	$ 91,745	$ 94,256	$ 218,965	**$ 706,504**
TOTAL		**$ 6,000,000**	**$ 6,000,000**	**$ 6,000,000**	**$ 6,000,000**	**$ 6,000,000**	**$ 30,000,000**

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