Southeast Coastal Ocean Observing Regional Association (SECOORA) Build Out Plan

Submitted to NOAA IOOS

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A Unique Region

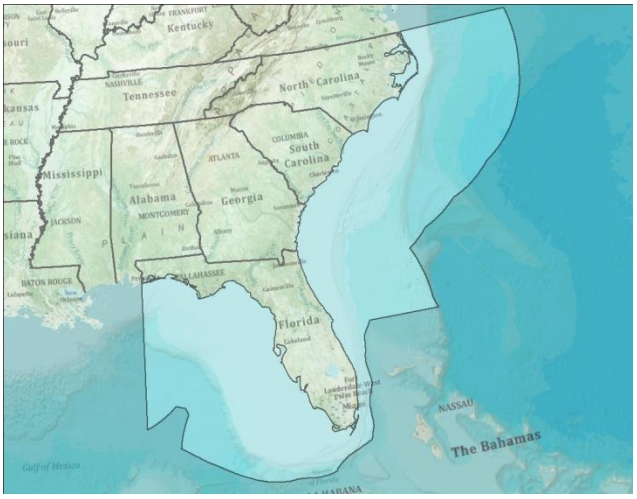

Figure 1 The SECOORA Footprint

The SECOORA region encompasses 4 states, over 42 million people and spans the coastal ocean from North Carolina to the west Coast of Florida. The region is vulnerable to hurricane hazards, potential impacts from oil drilling off Cuba and neighboring regions, and climate change because of low-lying coastal land and corals and other habitats that will be the first indicators of significant ecological impact. A regional observing system is critical to understanding risks and reducing impacts, as well as supporting the economy of the SE. SECOORA is creating customized products to address these thematic areas: Marine Operations; Coastal Hazards; Ecosystems, Water Quality, and Living Marine Resources; and Climate Change.

The SECOORA region is linked through large-scale circulation patterns. The western boundary current (WBC) of the North Atlantic, comprised of the Loop Current/Florida Current/Gulf Stream system, interacts strongly with coastal waters, intimately coupling the SECOORA region to the global circulation. Changes in shelf width across the region and changes in circulation with time modulate the degree to which the deep ocean interacts with the nearshore environment but throughout the region shelf water properties reflect the WBC influence.

Numerous estuaries in the SECOORA footprint connect the watersheds of the southern Appalachian mountains to the coastal waters. These varied estuarine systems, from broad lagoons to denditric marsh systems with large tidal ranges, also are influenced by shelf processes and establish a strong connectivity between the land and the sea. Better documenting and understanding the nature of the connections between the watersheds and coastal environments will support informed management and growth in the four states.

The transition from the WBC in deep water to varied nearshore and estuarine environments can be complex and leads to a requirement that observations be collected from all these environments. The cross-shelf structure can be captured by measurements made within the WBC, on the outer, middle and inner continental shelf, and nearshore and within the estuaries.

A second aspect of this connectivity is in the atmosphere where strong frontal passages impact ocean circulation in the Gulf and along the eastern seaboard. Strong surface winds such as those produced by tropical storms can induce upwelling/downwelling regimes in the SECOORA footprint that affect the ecosystem in profound ways. Wintertime cyclogenesis also occurs over the Gulf Stream creating severe weather such as extratropical cyclones that impact both the SE and mid-Atlantic. Like tropical storms, these severe weather events (e.g. nor'easters), may result in loss of life and property in addition to profound economic consequences. Strong land/sea contrasts can produce localized weather patterns like the sea breeze/land breeze. Thus, implementing a robust strategy to acquire marine atmosphere and oceanographic observations in SECOORA that are linked to robust

predictive models and decision making tools is essential to improving forecasting of severe weather events and marine conditions.

Background

During the period of July - September 2011, SECOORA undertook the process of developing this Build Out Plan to describe our observing system needs for the next 10 years. This plan will be coordinated with the other 10 RAs to present a comprehensive national picture of the regional needs for observing assets. These plans not only help fulfill the ICOOS Act requirements of an independent cost estimate and annual regional gaps analyses, but will provide important information for the National Ocean Policy goal "Strengthen and integrate Federal and non-Federal ocean observing systems, sensors, data collection platforms, data management, and mapping capabilities into a national system and integrate that system into international observation efforts." Moreover, the plans will provide the detailed information and rationale to support budget requests and to enumerate the impacts of budget decisions.

This plan is also an extension of a document completed by SECOORA in 2010 titled "*Changing Ecosystems, Economies, and Climate: Strategic Priorities for the Southeast Coastal Ocean Observing Regional Association*" which outlines priorities for contributing to the understanding, management, and sustainment of ocean and coastal resources and integrates identified stakeholder needs.

Components

This build out plan consists of the following components:

- **Resources.** Identifies supporting documentation.
- **Assumptions and Limitations.** The three-month timeframe for developing this plan constrained our ability to complete all the work necessary for a robust plan. We also made assumptions that impact the information in this plan.
- **Rationale.** This portion of the plan is a textual description of the subcomponents and the background for why specific assets have been included.
- **Product and Services Matrix.** This multi-page table defines priority products in the thematic areas of interest, and details the requirements to develop the products including variables collected, model types, temporal and spatial resolution, and operational requirements.
- **Subsystem Matrices.** Each subsystem (observing, modeling and analysis, DMAC, Product Development, Education and Training, Research and Development, and Governance and Management) is described in these spreadsheets with specific details on what assets and resources would fulfill the needs for the documented products and services.
- **Map.** The map is a big picture overview of preliminary placement of assets based on the products and services defined, which will be submitted by Oct. 15, 2011.

Resources

The SECOORA region has a rich history of ocean observing and has many scientists who have worked with stakeholders in the past to conduct similar analyses of needs for the region. This planning process built greatly on those efforts, as well as national plans. Links to these background materials are provided here.

- Journal of Marine Systems 77 (2009) 261–277: Towards a Regional Coastal Ocean Observing System: An Initial Design for the Southeast Coastal Ocean Observing Regional Association
- National Operational Wave Observation Plan

- High Frequency Radar Observing Systems: SECOORA Gap Analysis
- A Plan to Meet the Nation's Needs for Surface Current Mapping

Limitations and Assumptions

Limitations:

- We relied on previous stakeholder assessments, contacted a limited number of stakeholders, met with the South Atlantic Alliance and mined information from our Board and members. However, more work is needed to refine the products to assure they meet user needs.
- Observing assets exist that are not yet documented in this plan. We continue to work to find and map all existing observing/monitoring stations.
- We were not able to fully specify the configuration and costs of observing assets and sensors for all system elements. We have presented the basic requirements, such as variables to be measured and geographic locations.
- We know there are not enough vessels available in the region to meet the deployment, operation and maintenance needs of the proposed RCOOS system. We can provide a list of vessels home-ported in our region. This current draft of the plan does not include costs or recommendations regarding new vessels to meet system requirements, which will be a significant additional cost.
- We did not have the time to robustly analyze and optimize our asset deployment. There may be redundancies that should be eliminated.
- Deployment requirements for acoustic arrays and an underwater cable are to be determined.

Assumptions:

- In the geographic areas that overlap with GCOOS (on the west coast of Florida) and MARACOOS (NC coast north of Hatteras), the intent is for our plans to have the same observational assets. However, there may be SECOORA plan elements not included in the other RA plans, and vice versa. These unique elements complement, but do not duplicate, any deployments or activities included in the other RA plans. SECOORA coordinated with both GCOOS and MARACOOS, but has not made detailed comparisons between plans.
- We assumed that existing federal assets would remain, and we have no knowledge of plans for increasing federal assets so have also assumed there will not be new ones.

Rationale

It is not possible to instrument the ocean at a high enough density to capture all the structure and variability that is needed to support the products envisioned. A cost-effective approach is to use observationally-constrained models to provide the high spatial and temporal resolution depictions and predictions of coastal, ocean and marine conditions. This approach is the same as that used in meteorology, with the added complication that the ecosystem must also be observed and modeled. While the physical circulation of the ocean and atmosphere has a considerable history of modeling supported by automated observing, ecosystem modeling and observing is still in its infancy. The approach taken is therefore to firmly establish the modeling and observations necessary to represent the physical systems and to utilize these platforms to make major advancements in observing the ecosystem and developing ecosystem models.

The modeling system rationale is described first, followed by the suite of observational assets that will be used to constrain and validate the models. An emphasis is placed on developing assimilative models that utilize the observation assets to the greatest possible extent to ensure the model depictions accurately represent the environment. Data management and communications enable the unfettered flow of modeled and observed

data and support product development and outreach and education. The governance and management of the enterprise is described last.

Modeling

SECOORA will support a numerical modeling framework (sub-regional to regional scale models) to provide validated modeling products for managers and other users. It is assumed that national and basin-scale models which provide a coarse representation of the region will be operated and maintained by federal agencies and will provide initialization and boundary conditions for the regional-scale models. SECOORA plans to advance modeling/prediction sub-systems that would include: regional-scale models of the atmosphere, ocean circulation, and surface waves nested within nationally-provided models; nesting of very high-resolution inner shelf and estuarine models; the coupling of dynamical models (coastal mesoscale meteorological, coastal circulation, coastal hydrological, and coastal wave models); the coupling of application models (e.g., ecosystem and sediment transport); and the utilization of advanced numerical modeling methods (e.g., data assimilation schemes, non-hydrostatic models, and unstructured and adaptive grids). The modeling framework will encompass both comprehensive baroclinic operational circulation models (essential for adjective and turbulent transport estimates, water quality and ecosystem models) and integrated barotropic operational tide, storm surge, and wave models (essential for coastal inundation estimates, sediment transport models).

Observing

No one measurement system or technique can meet the requirements encompassed in the products to be supported by the build-out plan. Needed are observations that capture the temporal variations over extended periods of time as well as the spatial variability of the ocean, at the surface and throughout the water column to the ocean bottom. Remote sensing, either shore-based or from satellites, deliver a wealth of information on the spatial structure and its variability over time of certain ocean surface properties but can not measure the ocean interior, nor can they observe all the relevant ocean variables. Fixed stations, be they coastal stations, bottom-moored buoys, or fixed offshore platforms, can support measurement of a broad range of variables from the surface to the bottom and provide continuous in-situ observations of changing conditions over time. Mobile assets, such as gliders, profiling floats, surface drifters or ships, can measure the detailed spatial structure of ocean properties or provide unique measures of transport. Together these systems meet the resolution requirements to validate models and for assimilation. Each is discussed briefly below.

Remote sensing: Satellite remote sensed imagery is assumed to continue to be available from national governments. Most passive imagery is available at fairly high resolution and valid in the nearshore and inshore, whereas much of the active system imagery (e.g. altimetry or scatterometer winds) are only valid a considerable distance from shore. Regional downlink and processing is critical to timely delivery and tailoring of the information. Coastal ocean surface current mapping radar provide highly resolved surface currents (and possibly waves and winds) and full coverage out to 150 km offshore is envisioned to support many of the products. Nesting of higher frequency systems is an important method for enhancing resolution in critical areas, e.g. major ports.

Fixed stations: There are two main components, coastal stations and moored offshore buoys. Coastal stations directly address the need to document variability in the nearshore and inshore. Many systems exist, and the emphasis is placed on filling gaps in spatial coverage and missing observed variables. Few offshore buoys exist, and a significant number of them measure only surface properties. A consistent array of buoys is proposed that sample in each of the major dynamical regions mentioned (inshore to the WBC) and with an approximate along-shelf spacing of 100km, a typical alongshore decorrelation scale for the coastal ocean.

Mobile assets: in general, these platforms collect high-density data in both the horizontal and vertical planes, augmenting the moored array. Most are easy to deploy and all are flexible in terms of mission objectives and

event response, the only such observing resource. Data collected with these assets support weather, search and rescue, event response, ecosystem and climate modeling programs. Glider observations characterize the subsurface distributions of temperature, salinity, chlorophyll-a, particles and other properties, and are used to improve, validate and constrain regional circulation and ecosystem ocean models. Modeling products constrained by assimilation of three-dimensional temperature and salinity fields provide powerful tools for stakeholders involved in management efforts. Observations will also provide surface layer heat content for atmospheric forecasts.

DMAC

SECOORA Data Management and Communications (DMAC) subsystem is the "Middle Ground" for most of the SECOORA activities, and its products and services depend on observations, modeling, and outreach subsystems. Growing the technological infrastructure and the team of expert personnel in our region will enable DMAC standards development that promotes interoperability, aggregation, access, visualization, utilization, archival and dissemination of coastal ocean data and information products in a timely manner via a SECOORA data and information portal. SECOORA will coordinate with the sub-regional observing systems and other entities (State and Federal agencies) within the SE region to implement a coordinated robust DMAC subsystem to help advance IOOS DMAC.

Education and Outreach

The primary focus of the E&O subsystem is to engage formal and informal education audiences and stakeholders regarding observing technologies, data, products, and services. SECOORA is focused on transitioning from opportunistic stakeholder engagement to a deliberate E&O engagement program designed to increase our understanding of stakeholder needs and requirements, and showcase results from investments in observations and product development. An E&O Coordinator will manage projects, provide leadership and vision for the program, conduct annual assessments, and make changes as necessary to improve performance. The Coordinator will also continue collaboration with other RAs as well as E&O specialists from programs such as Sea Grant, National Estuarine Research Reserve System, National Marine Sanctuaries, and COSEE to leverage resources and eliminate potential duplication.

Governance

SECOORA Governance includes four major parts:

1. Administrative: SECOORA provides human resource management for its staff; prepares all programmatic reporting on NOAA and other funding awards; develops and manages contracts; oversees accounting; and efficiently and cost-effectively manages operations.
2. Board, Member, NFRA and IOOS Support: SECOORA plans and facilitates Board and Member meetings, staffs SECOORA committees, and recruits new members. SECOORA is also actively involved in NFRA and with the IOOS program office. SECOORA engages with national DMAC, E&O, modeling and other NFRA and IOOS supported committees and groups.
3. RCOOS Management: The Regional Coastal Ocean Observing System (RCOOS) manager coordinates and facilitates Principal Investigators (PIs) and other stakeholders to implement a cohesive RCOOS.
4. Communications and Stakeholder Engagement: SECOORA plans stakeholder workshops and serves as an ambassador for ocean observing, SECOORA, and IOOS with regional stakeholders, including serving on the Executive Planning Team for the South Atlantic Alliance. SECOORA has a strong focus on communications and produces a range of communication products including outreach material, press releases, a bi-weekly newsletter, a media outreach network, and content for SECOORA's website.

Products and Services Guidance								
A.	**Category:**							
B.	**Products:** Can be classified in LEVELS							
C.	Level 1: Raw data – delivery of minimally processed data or model output to "super" users. (e.g., HFR data for SAR; data sent to NDBC; data used by agencies for model input for fisheries, etc).	Level 2: Processed information or data - display of real-time data, posting of information with minimal processing (e.g., posting of real-time data from buoys).	Level 3: Data Visualizations (charts, graphs, graphic displays, phone apps, etc.)	Level 4: Decision-support tools (DST)-information tools developed to fulfill specific decision-making needs (e.g., alerts, Huron/Erie modeling output of public health officials, harbor warning systems)				
D.	**Identify Primary Users/Stakeholders**							
E.	**Geographic Coverage:**							
	1. Deep water/open ocean	2. Slope	3. Shelf (includes the subcomponents of the outer shelf, mid-shelf, inner shelf)	4. Coastal (nearshore environments, beaches, coastal waters)	5. Inland (estuaries, riverine waters)			
F.	**Variables** (*indicates variable identified in the Blueprint Assessment as one of the 26 IOOS core)							
	Physical: temperature*, salinity*, pressure, surface currents*, currents at depth, surface waves*, sea surface height, water levels* (this includes lake level and sea levels), freshwater flows, ice distribution*, optical properties*, heat flux*, ocean color/optical properties*	Meteorological: wind speed and direction*, air temperature, barometric pressure, precipitation, humidity, visibility	Chemical: nutrients (organic and inorganic, dissolved* and particulate), dissolved oxygen*, contaminants*, partial pressure of carbon dioxide (pCO2)*, acidity (pH)*	Biological: dissolved organic matter; phytoplankton species and abundance*, zooplankton species and abundance*, fish species and abundance*, sea turtles and marine mammals; extent and condition of benthic habitats; pathogens*	Geological: bathymetry*, bottom character*, suspended sediments (total suspended matter*), turbidity, stream flow*			
G.	**Modeling Type**							
	Dynamical:	1. Atmospheric	2. Circulation	3. Inundation	4. Wave	5. Hydrologic	6. Sediment Transport	7. Water quality/ ecosystem	8. Fisheries
	Statistical:	9. Surface current	10. Water quality	11. Rip current					
H.	**Resolution:**	High <10m	Medium ~100m	Low >500m					
I.	**Operational Requirements:** Timeframe for information delivery, i.e. is 24/7 operations support required								
J.	**Timeframe:** During which years of the plan will the product be developed and/or supported?								

	Marine Operations: Product or Service	Product Level	Primary Users/Stakeholders	Geographic Coverage (plus any subregional descriptors)		Model Type	Temporal Resolution	Spatial Resolution	Operational requirements	Timeframe, i.e. year of plan
1.1	**Safe and efficient commercial shipping and recreational boating products and services**									
1	Augment the national backbone with regional observations for marine environment. (Applies to All Marine Operations Subareas)	1,2	NOAA NOS, OAR, NWS, NMFS; Coast Guard (Homeland Security) Recreational Boaters, Marine Transportation Industry, Port Authorities, Fishing Industry, Marine Weather Consultants, Pilot Associations, Academic Researchers, Students, Environmental Consultants	1,2,3,4,5	Physical: add directional waves, current profiles and bottom temperature; Meteorological		Hourly; Sea State: 1 to 3 hours; and monthly glider data		Weather and Ocean Conditions: 1 - 3 hr reporting delay; available 24/7	All
2	Visualization and alert tools for marine weather observations	3,4	NOAA NOS, OAR, NWS, NMFS; SAFMC, Recreational Boaters, Marine Industry, Port Authorities, Fishing Industry, Marine Weather Consultants	1,2,3,4,5	Physical: add directional waves, current profiles and bottom temperature; Meteorological		Hourly	As defined by model or observations	24/7	All
3	Nowcast/forecasts of weather and ocean conditions integrated with Automatic Identification Systems data	4	NOAA NOS, OAR, NWS, NMFS; Recreational Boaters, Marine Industry, Port Authorities, Fishing Industry, Marine Weather Consultants	1, 2, 3, 4	Physical: add directional waves, current profiles and bottom temperature; Meteorological	1,2,4,9		Weather: 3Km Ocean Forecasting Low res: 3KM offshore (outershelf and beyond), 1 km mid-shelf; Nearshore waters (inner shelf)- 100m-1km depending on the coastline configuration and bathymetry		all
4	Aggregation of bathymetry data, including nearshore bathymetry for shoreline, from National databases, research projects	1,2,3	Recreational Boaters, Marine Transportation Industry, Academic Researchers, Coastal Managers, NOAA charts, modelers, marine spatial planners	4,5 (priority areas where bathymetry shifts due to coastal storms)	Geological, Geodetic parameters		Level 0 (Raw) - Whenever data becomes available and Level 1 and 2 (Processed) - 3 - 5 years	As defined by data collectors and producers	Available service 24/7 for access by user communities	outyears
5	Water level and currents observing system in major Ports	1,2	Marine Transportation Industry, Port Authorities, National Weather Service, Homeland Security, Pilot Associations	4,5, with a focus on the 11 major Ports in the SE: Brunswick, JAX, Port of Miami-Dade, Moorhead City, NC; Port Canaveral, FL; Port of Palm Beach, FL; SAV, CHS, Tampa, Port Everglades, Wilmington, NC	Physical: Specifically, Water Level, Tides, Currents (Profile) Meteorological: wind speed and direction, air temp, humidity, visibility, air pressure		Hourly	4 stations /Port	24/7	

	Marine Operations: Product or Service	Product Level	Primary Users/Stakeholders	Geographic Coverage (plus any subregional descriptors)		Model Type	Temporal Resolution	Spatial Resolution	Operational requirements	Timeframe, i.e. year of plan
6	Estuarine Circulation Models in major ports and other selected sites.	3,4	Recreational boaters, Ecosystem Scientists, Fisheries Managers, Marine Transportation Industry, Port Authorities, National Weather Service, Homeland Security, Pilot Associations	4,5	Physical: add directional waves, current profiles and bottom temperature; Meteorological	2,6	Hourly; Sea State: 30 minutes to 3 hours	sea state conditions: Coastal Ocean 30 - 300 m; Open Ocean 3 - 4 km		
1.2	**Search and Rescue (SAR)**									
1	Regional High Frequency Radar (HF Radar) delivered to National HF Radar Portal for display and dissemination to end users	1,2	Coast Guard, State Emergency response, Recreational Boaters, Commercial Fishermen, National Weather Service, Beach Safety Managers	Entire region, Nested Radar systems for increased spatial resolution in the nearshore, ports	Physical: Surface Currents, and potentially Winds, Waves in out-years		WERA: 30 min - 1 hour; CODAR - 3 hours =	Frequency and Bandwidth dependent (E.g. 42 Mhz/1Mhz - 150 m; 8MHz/250Hz - 3 Km)	24/7 during a search and rescue event and archived data online	Timeframe dependent on funding. SECOORA region needs a lot of HF Radar investment to achieve full coverage.
2	See 1.1.1. These in situ data are critical for SAR.								24/7 during a search and rescue event and archived data online	
3	Hindcast/nowcast/forecast Regional and Sub-Regional ocean circulation and oil spill trajectory models based on combined data from moorings, HF Radar, & drifters to create a model and visualization tools.	3,4	Coast Guard, Port Authorities, Marine Transportation Industries, Recreational Boaters, Marine Domain Awareness Systems, , Emergency Managers, Oil Spill Responders	1,2,3,4,5	Physical: add directional waves, current profiles and bottom temperature; Meteorological	2	Hourly	Nested models with high resolution near coasts	24/7 during a search and rescue event and archived data online	
1.3	**Spill Response**									
1	See 1.1.1. These in situ data are critical for Spill Response. Add chemical and biological data				Physical: add directional waves, current profiles and bottom temperature; Meteorological; Chemical , biological				24/7 during a spill event and archived data online	
2	Targeted sampling of vertical distribution of temperature, salinity, currents, chlorophyll, fluorescence, and dissolved oxygen with mobile assets	1,2,3	USCG, Oil and Gas sector, Port Authorities	1,2,3	Physical: specifically, water temperature, salinity, pressure, chlorophyll fluorescence, acoustic backscatter, velocity, CTD , Optical back scatter; Chemical, specifically DO and CDOM		Hourly; Sea State: 1 to 3 hours	As defined by the vertical resolution of the observations	24/7 during a spill and rescue event and archived data online	

	Marine Operations: Product or Service	Product Level	Primary Users/Stakeholders	Geographic Coverage (plus any subregional descriptors)		Model Type	Temporal Resolution	Spatial Resolution	Operational requirements	Timeframe, i.e. year of plan
3	Hindcast/nowcast/forecast Regional and Sub-Regional ocean circulation and oil spill trajectory models based on combined data from moorings, mobile assets (gliders, auvs, ships, etc.) HF Radar, & drifters to create a model and visualization tools. *Same as product 1.2.3* with addition of mobile asset data	2,3,4	Port Authorities, Marine Transportation Industries, Recreational Boaters, Marine Domain Awareness Systems, Coast Guard, Emergency Managers, Oil Spill Responders	1,2,3,4,5	Physical: add directional waves, current profiles and bottom temperature; Meteorological; Chemical , biological	Dynamical and Statistical (Circulation)	Hourly; Sea State: 30 minutes to 3 hours	sea state conditions: Coastal Ocean 30 - 300 m; Open Ocean 3 - 4 km	24/7 during a spill and rescue event and archived data online	
4	Tool for user-defined data streams (i.e., location, data type, data format etc.) from the SECOORA data portal for use in their in-house applications/models.	4	NOAA, SAFMC, Port Authorities, Marine Transportation Industries, Recreational Boaters, Marine Domain Awareness Systems, Coast Guard, Emergency Managers, Oil Spill Responders	1,2,3,4,5	Physical: add directional waves, current profiles and bottom temperature; Meteorological; Chemical , Biological		Hourly	As high as the instrument specifications	24/7 during a spill event and continue until the end of the event. Make available near	
5	Delivery of high resolution satellite imagery products (Altimetry, SST and Ocean Color) and validation to help with event, i.e. spill, resolution	1, 2, 3, 4	Coastal Communities, Utility Companies, Emergency Managers, Stormwater Managers, NOAA, and FEMA	1,2,3,4,5	SST, SSH, Color, Synthetic Aperture Radar and Chlorophyll		Coastal 3 hours and Open Ocean 6 hours	Coastal Ocean - < 1 Km and Open Ocean (5-10 km)	near real time	
6	Inventory of expertise and additional rapid response resources including the identification of sampling and analysis capabilities	1,2,3		1,2,3,4,5	All					
7	Baseline hydrocarbon footprint in estuaries	1, 2, 3	Emergency managers, oil spill responders	5	Hydrocarbons					
1.4	**Offshore Energy**									
1	***See 1.1.1. These in situ data (including acoustic background noise) are critical to support environmental assessment and operational efficiency.***	1, 2, 3	USCG, Oil and Gas sector, Port Authorities, BOEMRE, alternative energy developers	1, 2, 3	Add hydrocarbon concentrations/profiles, passive acoustics and archived data; turbine height winds					
2	Climatological data (oceanographic and atmospheric) for alternative ocean energy marine siting	3,4	Oil and Gas sector, Private Sectors involved in offshore energy	1,2,3,4,5	turbine height winds					

	Climate Variability and Change: Product or Service	Product Level	Primary Users/Stakeholders	Geographic Coverage (plus any subregional descriptors)	Variables	Model Type	Temporal Resolution	Spatial Resolution	Operational requirements	Timeframe, i.e. year of plan
2.1.	**Changes in Ocean Conditions Over Time Products and Services**									Comments
1	Deliver baseline long term observations to support climate change assessment, understanding and impact analyses	1,2,3	Federal scientists, Academic Researchers, Modelers, Land Use Planners	1,2,3,4,5	Physical; Meteorology; Chemical, specifically hydrocarbon concentrations/profiles; Biological, specifically passive acoustics		Variable depending on data type	Randomized in the various geographic domains, no coarser than 100 km alongshore		
2	Geological and biological data layers for Coastal Resources Atlas' and other uses	3	NODC/NCDDC, Federal scientists, State natural resource managers, Land Use Planners, Coastal Communities	4,5, state specific	Geological; Biological, specifically fish species and abundance, sea turtles and marine mammals; extent and condition of benthic habitats; bathymetry, bottom character		At least seasonal; monthly is better. Updated bi-annually			
3	Visualization and analyses tools for use by fisheries and ecosystem managers of historical circulation and climate data, including maps of mean fields and seasonal variation of surface and subsurface temperature *Same as 3.1.3 Ecosystems*	3,4	Climate and Ecosystem Scientists, Fisheries Managers, Academic Researchers , Natural Resource Managers	2,3, 4,5	Same as 3.1.1	2, 8	hourly collected data is optimal but real-time data is not required for this product	Low: 30 km		
4	Detailed characterization of salinity changes and circulation in estuaries and impacts on estuarine habitat	4, 5	Climate and Ecosystem Scientists, Fisheries Managers, Academic Researchers , Natural Resource Managers	3, 4, 5	Physical (incl. current profiles), meteorological, chemical, geological		depends on the state level need (NC, SC, FL, GA)	depends on the state level need (NC, SC, FL, GA)		
2.2	**Ocean Acidification Products and Services**									
1	*See 2.1.1,* with focus on delivery of data concerning inorganic carbon system from in-situ sensors to establish baseline and help modeling community engaged in predicting changes in the ocean carbon cycle	1,2	Federal scientists, Academic Researchers, Modelers, National Weather Service, NOAA	1,2,3,4,5	partial pressure of carbon dioxide (pCO2), acidity (pH))		Near real time not required			
2	Clearinghouse for maps of sensitive areas including species distribution, habitats, esp. Coral Reef areas (analogous to bathymetry product)	3	Coastal Managers, Land Use Planners, Coastal Communities, Ecosystem Scientists, Fisheries Managers	2,3	fish species and abundance, sea turtles and marine mammals; extent and condition of benthic habitats;			Variable depending on data type		
2.3	**Sea Level Change Products and Services**									
1	*See 2.1.1.* This data is needed to observe and model sea level change.									

SECOORA Products: Climate Variability and Change

	Climate Variability and Change: Product or Service	Product Level	Primary Users/Stakeholders	Geographic Coverage (plus any subregional descriptors)	Variables	Model Type	Temporal Resolution	Spatial Resolution	Operational requirements	Timeframe, i.e. year of plan
2	Local bathymetric and geodetic,(in combination with 2.1.1 data) to support sub-regional forecasts for sea level rise and land subsidence	1,2	Academic Researchers, Modelers, National Weather Service, NOAA, Coastal Managers, Land Use Planners	1,2,3,4,5	Geological, especially bathymetry, geodetic data		10m	Variable depending on data type		
3	GIS based index and links (like a bibliography) of regionally-relevant sea level change studies, models and estimates of change	5	State and local managers and planners	4, 5	Research studies, models			Updated annually		

	Ecosystems, Fish, and Water Quality: Product or Service	Product Level	Primary Users/Stakeholders	Geographic Coverage (plus any subregional descriptors)	Variables	Model Type	Temporal Resolution	Spatial Resolution	Operational requirements	Timeframe, i.e. year of plan
3.1	**Healthy and Productive Ecosystems**									
1	Comprehensive, multidisciplinary dataset to assess ecosystems workings, incl. physical, chemical, and biological (primary productivity to fish larvae)	1,2	Federal and state Ecosystem Scientists and managers, Fisheries Managers, Academic Researchers, Natural Resource Managers	1,2,3,4,5	Meteorological, specifically winds, air temp, precip; Physical, specifically currents, temp, sal, waves, WL; Chemical, specifically macronutrients - nitrate, phosphate, ammonia, micronutrients, dissolved oxygen, primary productivity, phyto biomass - chlorophyll - and species; Biological, specifically zoo biomass and species, other secondary producers (jellies), higher tropic levels (fish, mammals, turtles)		temporal - at least seasonal, automated - daily to hourly	Spatial - research needed - enough to capture major provinces in footprint, finer nearshore (10s km), coarser offshore (100+km);		
2	Visualization, analysis and alert tools for ecosystem observations	3, 4	Federal and state Ecosystem Scientists and managers, Fisheries Managers, commercial and recreational fishers, Academic Researchers, Natural Resource Managers	1,2,3,4,5	Same 3.1.1					
3	Visualization and analyses tools for use by fisheries and ecosystem managers of historical circulation and climate data, including maps of mean fields and seasonal variation of surface and subsurface temperature. *Same as 2.1.3*	3,4	Ecosystem Scientists, Fisheries Managers, Academic Researchers , Natural Resource Managers	2,3, 4,5	Same as 3.1.1	2, 8	hourly collected data is optimal but real-time data is not required for this product	Low: 30 km		
4	Delivery of high resolution satellite imagery products (Altimetry, SST and Ocean Color) and validation to help with even resolution, i.e. HABs, upwelling, hypoxia,	1, 2, 3, 4	Coastal Communities, Utility Companies, Emergency Managers, Stormwater Managers, NOAA, and FEMA	1,2,3,4,5	SST, Chlorophyll and Ocean Color		Coastal 3 hours and Open Ocean 6 hours	Coastal Ocean - < 1 Km and Open Ocean (5-10 km)	near real time	
5	Environmental Surveillance Network to collect data that managers would need to make decisions for public health	1, 2, 3	Coastal Managers, Public Health Officials, Stormwater Managers, Coastal Communities	4, 5	physical, meteorological, chemical, biological (Fish species and abundance), geological	7	24/7 preferred - data collected can be non real-time	Low		

	Ecosystems, Fish, and Water Quality: Product or Service	Product Level	Primary Users/Stakeholders	Geographic Coverage (plus any subregional descriptors)	Variables	Model Type	Temporal Resolution	Spatial Resolution	Operational requirements	Timeframe, i.e. year of plan
3.2	**Sustainable Fisheries**									
1	Same as 3.1.1. These data are critical to addressing sustainable fisheries issues	1, 2								
2	Comprehensive ocean circulation model to predict fish larvae transport advance development of comprehensive ecosystem model by life cycle.	4	Ecosystem Scientists, Fisheries Managers, Academic Researchers, Natural Resource Managers	1, 2, 3, 4, 5 GOM/WFS, Florida Straits, SAB	physical, meteorological, chemical, biological (Fish species and abundance), geological	2, 5, 7, 8	Data can be collected in non real-time and/or real-time (e.g. collect ADCP and CTD data in non real-time and MET data in real time). Need to collect data anywhere from hourly to every 3 hours.	Med: 100 m to High <10m (not everywhere, too fine)	24/7 NOT req'd	
3	Linked biological and physical stock assessment models	4		1, 2, 3, 4, 5 GOM/WFS, Florida Straits, SAB	Same as 3.1.1	1, 2, 8	3 hours; 24/7 not req'd	10km		
4	Integrate passive acoustics into existing assets to augment BOEMRE tagging programs, provide data on fish migration,	1, 2, 3	Fisheries and Ecosystem Managers, Fishing Industry, shipping industry	1, 2, 3, 4	Biological		Near real time	Low	24/7 NOT req'd	
5	Fishable days model. Apply wind, wave and fishing effort data to develop fishable days models	4	Fisheries Managers, Fishing Industry, Commercial Fishermen	1,2,3,4	Same as 3.1.1 plus fishing effort observations, fuel cost and related socio-economic data	1, 2, 4, 8				
3.3/3.4	**Harmful Algal Blooms/Hypoxia**									
1	*Same as 3.1.3: Environmental Surveliance Network* . Collect ongoing observations and response mode observations when event is detected	2, 3	Water Quality Organizations, Public Health Officials, Ecosystem Scientists, Fisheries Managers, Academic Researchers, Natural Resource Managers							
2	Hypoxia/HAB Prediction Model	3, 4	Water Quality Organizations, Public Health Officials, Ecosystem Scientists, Fisheries Managers, Academic Researchers, Natural Resource Managers	3, 4, 5 regional scale and sub regional, i.e. WFS, FS, and SAB, Long Bay, SC, Neuse River estuary, NC, Pamlico and Albemarle sounds to start	physical, meteorological, chemical, geological	2, 7, 8, 9, 10	Hourly; 24/7 preferred	Med: 100 m to High <10m		

	Ecosystems, Fish, and Water Quality: Product or Service	Product Level	Primary Users/Stakeholders	Geographic Coverage (plus any subregional descriptors)	Variables	Model Type	Temporal Resolution	Spatial Resolution	Operational requirements	Timeframe, i.e. year of plan
3	Evaluation of past HABs, anoxia/hypoxia or similar events to determine triggers and appropriate alerts for potential events	2, 3; Other: Research paper/whitepaper; possibly model output	Water Quality Organizations, Public Health Officials, Ecosystem Scientists, Fisheries Managers, Academic Researchers, Natural Resource Managers	3, 4, 5 regional scale and sub regional, i.e. WFS, FS, and SAB, Long Bay, SC, Neuse River estuary, NC, Pamlico and Albemarle sounds to start	historical and NRT data; physical, met., chemical, bio., geological (Phytoplankton species, Chlorophyll, primary production)	1, 2, 5, 7, 8		Med: 100 m		
3.5	**Minimizing the Impact from Polluted Waters**									
1	Shellfish Harvesting Advisory Model	4	Public Health Officials, Natural Resource Managers	5 - Inland: Shellfish growing areas in each state	Met (incl. wind speed, direction and duration; precipitation from gauges and NEXRAD); Physical; Chemical; Pathogens, Geological. Modeled salinity and circulation. Land use (watershed area, etc.)	2, 10	Variable; Near RT	Med: 100 m		
2	Beach water quality advisory model(s)	4	Public Health Officials, Coastal Managers	4, 5 at select heavily utilized beaches in each state	Met (incl. wind speed, direction and duration; precipitation from gauges and NEXRAD); physical, chemical, pathogens, geological. Modeled salinity and circulation. Land use (watershed area, etc.)	10	Variable; Near RT	High		

	Coastal Hazards: Product or Service	Product Level	Primary Users/Stakeholders	Geographic Coverage (plus any subregional descriptors)	Variables	Model Type	Temporal Resolution	Spatial Resolution	Operational requirements	Timeframe, i.e. year of plan
4.1	**Improved hazard forecast models for coastal communities**									
1	Delivery of near real-time hydrological, sea level, winds, currents and waves in-situ observations needed for storm surge / inundation models and HAZMAT	1, 2, 3	Coastal Communities, Utility Companies, Emergency Managers, Stormwater Managers, NOAA, and FEMA	1,2,3,4,5	Physical (incl. surface currents, currents at depth, directional waves, sea surface height, water levels); Meteorological				near real time	
2	Regional maps and time series of coastal wave forecast model output (Significant Wave Height, Tides/flooding and wave direction etc.)	3, 4	Coastal Communities, Utility Companies, Emergency Managers, Stormwater Managers, NOAA, and FEMA	2,3,4,5	Swell, Significant wave height, Direction, tides	2, 3, 4, 5	5-7 days	model grid (SE region or sub regions within SE)	Available 24/7	
3	Assemble and make available the wind forcing required for modeling efforts	1, 2, 3, 4	Scientists/modelers, Coastal Communities, Utility Companies, Emergency Managers, Stormwater Managers, NOAA, and FEMA	4,5 (esp. highly populated)	Winds (in situ and remotely sensed)	1, 2		Higher resolution is better (need more in 'complicated' nearshore areas)	As soon as new data becomes available	
4	Assemble and make available high quality elevation data (shoreline and bathymetry) for use in storm surge models	1,2, 3, 4	Coastal and inland communities, Utility companies, local and state emergency and stormwater managers, NOAA, and FEMA	2,3,4,5	Geological (Latitude, Longitude and water depth, Datum)	Coordinate transformation Tool such as Vdatum	high (10m)			
5	Archive and deliver HF Radar data for data assimilation into models	1,2, 3, 4	Coastal Communities, Utility Companies, Emergency Managers, Stormwater Managers, NOAA, and FEMA	2,3,4,5	surface currents and waves		hourly	12 Km (North American Mesoscale)	near real time	
6	Storm Surge (water/wind) and/or wave models	1, 2, 3, 4	Coastal and inland communities, Utility companies, local and state emergency and stormwater managers, NOAA, and FEMA	4,5	surface currents, currents at depth, surface waves, sea surface height, water levels, bathymetry	2-Circulation, Storm IC/BC (wind, bp, track, etc)	high (10m)		24/7; near real time and non real-time	
4.2	**High Resolution Sea Level Predictions**									
1	Covered under climate change section									

	Coastal Hazards: Product or Service	Product Level	Primary Users/Stakeholders	Geographic Coverage (plus any subregional descriptors)	Variables	Model Type	Temporal Resolution	Spatial Resolution	Operational requirements	Timeframe, i.e. year of plan
4.3	**Rip Current Prediction using Coupled Circulation and Wave Models**									
1	*Same as 4.1.1 with addition of Bathymetry and bottom type*	1, 2	NOAA NWS, Coastal Communities, Beach Safety Managers	3,4	Physical (incl. surface currents, currents at depth, directional waves, sea surface height, water levels); Meteorological; Geological, specifically bathymetry, bottom type	1,2,4,9,11		high		
2	Maps of surface currents and waves measured using very high resolution HF Radar	2, 3, 4	Coastal Communities, Utility Companies, Emergency Managers, Stormwater Managers, NOAA, and FEMA	4,5; priority is high-use swimming beaches	surface currents and waves		hourly	coast to 200 KM	near real time	
3	Improved models to predict the occurrence of rip currents	3,4	Coastal Communities, Beach Safety Managers, National Weather Service	3,4	water level, winds, waves, currents, bathymetry, bottom type	1,2,4,9,11		high	Daily and hourly	
4.4	**Other Products and Services**									
1	Contributing data, observations and models to support mapping of erosional hotspots and beach renourishment design and modeling. *Same as 4.1.1 with addition of geological data.*	1,2, 3	USACE, Coastal Communities, Coastal Managers, coastal engineers	4	Physical (incl. surface currents, currents at depth, directional waves, sea surface height, water levels); Meteorological; Geological	2,4		high	Shoreline Maps made available with partners (State and Federal agencies)	

Governance and Management subsystem rationale:
SECOORA Governance includes four major parts:
1. Administrative: SECOORA provides payroll and human resource management for its staff; prepares all programmatic reporting on both the RA and RCOOS awards; develops and manages contracts; oversees accounting; and efficiently and cost-effectively manages operations.
2. Board, Member, NFRA and IOOS Support: SECOORA plans and facilitates Board and Member meetings, staffs SECOORA committees, and recruits new members. SECOORA is also actively involved in NFRA and with the IOOS program office. SECOORA engages with national DMAC, E&O, modeling and other NFRA and IOOS supported committees and groups.
3. RCOOS Management: The Regional Coastal Ocean Observing System (RCOOS) manager coordinates and facilitates Principal Investigators (PIs) and other stakeholders to implement a cohesive RCOOS.
4. Communications, Education, and Stakeholder Engagement: SECOORA plans stakeholder workshops and serves as an ambassador for ocean observing, SECOORA, and IOOS with regional stakeholders, including serving on the Executive Planning Team for the South Atlantic Alliance. SECOORA has a strong focus on communications and produces a range of communication products including outreach material, press releases, a bi-weekly newsletter, a media outreach network, and content for SECOORA's website.

TOTAL Number of FTEs	6 TOTAL 1.0 FTE Executive Director 1.0 FTE Program Manager 1.0 FTE Administrative Support 1.0 FTE Finance & Contracts Specialist 1.0 FTE RCOOS Manager Graduate Fellow on rotating basis (potentially housed in a member institution)
Office Rental	6 total offices plus conference room for 12
Office Equipment and Supplies	Initial setup (desk, chairs, file cabinets, etc.) for non-computer: $1,500 per FTE; Initial computer and related accessories $2,500 per FTE; Conference room set-up: $5k for table, 12 chairs, dry erase board Total supplies annually: $10k (includes software licenses, regular computer replacements, normal office supplies, etc.)
Operational costs	Electricity, water, phone, internet, trash: $700/month; Cleaning: $100/month; Cell phones: $600/month; Taxes, business license, etc: $500 annually Directors Discretionary Fund to support issue-based or time sensitive observing needs: $50k annually Travel to support Member and Board meetings, Board travel and Staff Travel to various meetings: $100k annually Business management: Email server, file sharing, network support and Web servers: $10K annually

Synthesis Table for Cost Estimation

	Office Space*	**Office Equipment and Supplies**	**FTEs (Personnel Costs should include allowance for 25% fringe)**
Administrative	2 Office: 60 sf	Accountant/auditor: $35k annually; Tort liability & fraud insurance: $2k annually; Legal & other expert advice: $5k annually	1.0 FTE Finance & Contracts Specialist 1.0 FTE Administrative Support
Board, Member, NFRA and IOOS Support	1 Offices: 150 sf 1 Meeting Room: 150 sf	Dues: $6k annually	1.0 FTE Executive Director 1.0 FTE Program Manager
Observing System Management (RCOOS Management)	2 Offices: 180 sf		1.0 FTE RCOOS Manager
Communications, Education, and Stakeholder Engagement	1 Office: 60 sf		1.0 FTE Education and Outreach Coordinator addressed in E&O Subsystem Template

One rule of thumb is: 90 square feet per Executive; 60 sf for administrative and 15 sf per person for meeting room.

SECOORA TRAINING AND EDUCATION SUBSYSTEM TEMPLATE

E&O Subsystem Template Rationale: The primary focus of the E&O subsystem is to engage formal and informal education audiences and stakeholders regarding observing technologies, data, products, and services. An E&O Coordinator will manage projects, provide leadership and vision for the program, conduct annual assessments, and make changes as necessary to improve performance. The Coordinator will also continue collaboration with other RAs as well as E&O specialists from programs such as Sea Grant, National Estuarine Research Reserve System, National Marine Sanctuaries, and COSEE to leverage resources and eliminate potential duplication. Time from the Program Manager and Executive Director noted here are accounted for in the Governance Subsystem Template.

Synthesis Table for Cost Estimation *assume most products are yearly

Target audience	Product or Service	Development Costs	Distribution Costs	FTEs
Train formal educators and Ocean Education Partners (COSEE, Sea Grant, Ocean Observatories Initiative)	Training on existing and new observing technologies (e.g. Basic Observation Buoy workshops).	$10k for supplies (sensors, PVC, materials) per workshop	$15k per workshop	1 month E&O Coordinator
	Training on how to access and use real time data in curricula/lesson plans (e.g. Global Positioning Systems workshops, EARTH workshops).	$5k for supplies	$20-25k per workshop	1 month E&O Coordinator plus travel
	Develop products and training materials including: • data visualization tools • online tutorials • webinars	$40k per year for lesson plan development and online integration		2 months E&O Coordinator and 1 month Web Developer
Develop programs in coordination with informal education centers to highlight observing data and where possible connect with watersheds (museums, aquaria, science centers)	Develop exhibits for science learning centers or adding an observing component to partner Web site (i.e., graphics of parameters outside of the location).	$5k for weather instruments, $15k for water quality instruments $20k for development of customized software for centers	$5k for kiosk and hardware, $2k for training workshop, travel and supplies	2 months E&O Coordinator and 1 month Web Developer
	Provide professional development opportunities for staff and docents, work with them to create a community of Citizen Scientists or engage them in monitoring efforts.	$10k for individualized development of materials for center		1 month E&O Coordinator
Stakeholder groups (marine resource managers, public health officials, energy industry, fishermen, boaters, tourism industry, emergency responders, maritime operations, real-estate and insurance industry)	Develop working groups to ensure our resources are focused on delivering information and products that will be immediately useful and meet priority needs of stakeholders.			1 month Program Manager
	Facilitate "think tank" meetings for data providers and product developers to foster the development of novel products and to focus efforts on Web site development to direct different types of uses to content desired.		$15k per year for in person meetings focused on a specific thematic need, unless meeting can be piggybacked on already planned meetings.	1 month E&O Coordinator 1 month Web Developer, 2 months Program Manager
	Stakeholder-specific displays or presentations to share at appropriate venues and training on specific products of interest.	Presentations and training materials	Travel for staff and/or relevant Principal Investigators	1 month E&O Coordinator, 1 month Program Manager, 1 month Executive Director
Internal-Professional development for RA staff/council and committee members	Create an IOOS tool box that will enable all IOOS educators to communicate consistent messages.	Work done in coordination with IOOS and NFRA.		1 month E&O Coordinator
	Facilitate dialogue among councils and committees through professional development opportunities.	Coordination of meeting agendas to include time for professional development.		1 month E&O Coordinator, 1 month Program Manager
General Public	Add a current regional event piece such as oil spill, hurricane, algae bloom, hypoxia, etc.	$10k for individualized development of materials for center		1 month Web developer plus Graduate Fellow
	Focus on getting observation data as part of the daily news forecasts, and have public radio messages include IOOS information.			1 month E&O Coordinator, 1 month Program Manager
Material Production	Product posters, reports, and promotional material	$10k for printing	$2k for shipping	

Synthesis Table for Cost Estimation

Overview E&O Needs	Computing Resources Required	FTE	Other	
	1 Personal computer, 1 Printer	1 FTE E&O Coordinator	$10k staff travel	

SECOORA DMAC SUBSYSTEM TEMPLATE

DMAC Subsystem Rationale: SECOORA Data Management and Communications (DMAC) subsystem is fundamental to most of the SECOORA activities and its other sub systems. Growing the technological infrastructure and the team of expert personnel in our region will enable DMAC standards development that promotes interoperability, aggregation, access, visualization, utilization, archival and dissemination of coastal ocean data and information products in a timely manner via a SECOORA data and information portal. SECOORA will coordinate with the sub-regional observing systems and other entities (State and Federal agencies) within the SE region to implement a coordinated robust DMAC subsystem to help advance IOOS DMAC. All data provided will be accompanied with metadata, including QA/QC flags determined in coordination with the data providers. The data management cost for data providers is addressed in observing subsystem template. Time from the RCOOS Manager noted here is accounted for in the Governance Subsystem Template.

SECOORA DMAC System Components	Metadata	Data Aggregation/Assembly	Data Catalog / Discovery	QA/QC	Data Access/Transport	Data Storage/Archive
General description of DMAC Operations to be compliant with IOOS Standards (as described in Whitepaper and includes discovery, QA/QC, archives)	Metadata describes the organization and structure of the observational and model data sets. Metadata provides the necessary information about how and when the data were gathered. Metadata standards that are available include both general-purpose standards for representing metadata (e.g., FGDC CSDGM, Dublin Core, ISO 19115/19139) or OGC Sensor Model Language.	Data Aggregation/Assembly combines observational data collected by multiple data providers within the SECOORA region and provides a single data set to the end users as one-stop shopping for their needs.	SECOORA will provide catalogs that allow an end user to search for data (observations and model) in a variety of ways. Using the catalog, an end user can search for a desired parameter and can narrow that search by location of the sensor, time and date of the observation, level of quality control, and metadata offered. Catalog searches allow customers to identify a source for the data they need. SECOORA will also produce service metadata and dataset metadata that can be harvested by commercial search engines such as Google etc.	SECOORA will provide best practices and guidance to sub-regional data providers within the SECOORA Region to implement the IOOS Recommended QARTOD/QARTOD to OGC (Q2O) QA/QC tests and assist the data providers, if needed. SECOORA will work with the data providers to ensure the data integrity.	These services allow customers to "pull" data on request from data assembly centers. Different data types may require different services, and a variety of services may be offered to satisfy different customers, but all data access services are expected to enable the customer to (1) make an explicit request at the moment of need and (2) specify the desired subset of the data based on the location of interest, the time of interest, or other criteria.	Establishing mechanisms and infrastructure for secure, short-term and long-term data storage. Provide guidance to data providers and provide assistance to store/archive their data. Work with NODC to archive the aggregated data either directly or via National Data Buoy Center (NDBC)
SECOORA DMAC System (Existing State) on sub-components based on IOOS DMAC white paper	SECOORA currently aggregates and delivers closer to 10,000 in-situ observations every hour from various sub-regional observing system data providers that are acquired and made available by academic, state and federal data sources. For in-situ observations, SECOORA currently uses the SEACOOS developed netCDF standard with Climate and Forecast (CF) Metadata netCDF convenetions. SECOORA is also making available the model output, remotely sensed (land based and satellite) images via its data portal. SECOORA has established a RA Asset Inventory that provides information about observation platforms, sensor equipment and cost, and environmental variables measure within SECOORA Region. SECOORA vocabulary was completed and registered with Marine Metadata Initiative (MMI). The SECOORA Vocabulary is the next iteration of the work on terms that improves the accessibility and understanding of data and observations of winds, tides, currents, water quality, and chemistry of our coastal waters and oceans. The SECOORA Vocabulary, now expanded to nearly 200 terms is based on the IOOS Parameter Vocabulary (130 terms). All terms were given unique definitions. All term names and definitions were reviewed and references and units provided in most cases. In addition, terms were associated with many of the IOOS Core Variables in U.S. Integrated Ocean Observing System: A Blueprint for Full Capability. The SECOORA Vocabulary is now registered with MMI's Ontology Registry and Repository (http://mmisw.org/ont/secoora/parameter).	SECOORA is revising the SEACOOS created technical document describing our data aggregation process and will be run through the DMAC to post the same on SECOORA web site. The data providers are recommended to provide data (push or pull) in netCDF or any other format to SECOORA with metadata about the data. The data gets aggregated and distributed with other sub-regional systems observatsions and made available to end users.	SECOORA will be participating in the IOOS Catalog development and will make sure the entire region's data are registered in the IOOS Catalog. SECOORA has also built a Model Inventory Catalog and participates in getting our sub-regional THREDDS services registered with IOOS Catalog.	Implementation of QA/QC tests for aggregated near real-time in-situ observations based on QARTOD recommendations is in progress. Quality control and alerts to assure data ingest and aggregation is operational has been implemented.	SECOORA has currently implemented variety of periodically exported output formats and dynamic web services. They are: Google Maps/Earth, Latest ObsKML, Styled KML, Open Geospatial Consortium(OGC) web services such as WMS (Web Mapping Service), WFS(Web Feature Service) and SOS (Sensor Observing Service),Time-series graphs – individual sensor/observation graphs, SQL for same schema Xenia databases, CSV for Excel or general import, Shapefile for GIS style applications, GeoRSS – platform-specific GeoRSS feeds which provide hourly updates for RSS type readers, GeoJSON – platform-specific GeoJSON feeds which provide hourly updates for Javascript oriented browser functionality, Quality-control and event notification – the archival collection of data allows for self-referential quality-control and trending of data and also event notification when observations exceed known historical parameters. SECOORA also pushes data to NDBC to further get distributed to Global Telecommunications System (GTS) for use in atmospheric and ocean forecast models.	SECOORA is currently archiving near real-time in-situ data, however more work must be done to determine long-term data archive maintenance. Carolinas RCOOS is submitting data presently to NODC. SECOORA is currently archiving USF remote sensing data. **SECOORA will be working to submit data to NODC and will encourage and work with sub-regional data providers to either direct to NDBC to NODC or via SECOORA.**

Regional Data Management Enhancements Describe regional data management requirements not covered by the IOOS DMAC Whitepaper (regional data portals)	SECOORA has funded DMAC projects and activities that have helped sub-regional members in advancing their data management capabilities and infrastructure. These include: Xenia Relational Database Schema The NWS Marine Weather Portal which provides 24/7 access to critical marine information for commercial & recreational communities, access to NOAA & observing system data on one site, and represents a transfer technology developed within SECOORA to NWS. Various partners are engaged in this effort including the NOAA NWS: E & S Region HQs, NWS WFOs in NC, SC, FL, AL, MS, LA, TX, USC, USF, UNC-W; Second Creek Consulting. The Biological-Habitat GIS integrates biological & habitat data through an online mapping application. Data included are SECOORA in situ observations, important marine habitats, Environmental Sensitivity Index datasets, bathymetry, etc; This product provides support for innovative problem solving and Marine Spatial Planning, delivers complex biological and physical data, Near real time & updated databases and provides Information of value to decision-makers, scientists, educators, public; The Model Inventory Explorer exposes near real-time modeling activity within SECOORA region.
Maintenance Actions (outline specific maintenance actions required to maintain DMAC operations)	Daily monitoring of the data management system to ensure appropriate aggregation and delivery of data to stake holders and end users; Daily monitoring of the data feeds from sub-regional data providers (in-situ, model and remote sensing); Alerting and working with sub-regional data providers to fix any data posting issues; SECOORA web site/data portal upkeep; Event driven (Oil Spill, Hurricane) data display needs; Archival; System Administration duties (upkeep of the servers, installing updates etc.)
Development Needs (If necessary, describe development efforts required for advancing, operationalizing or refining each of the identified issues)	Establish a SECOORA regional DMAC Center that will provide coordination, guidance, development, and centralized data aggregation, delivery, and storage capacity; Redundancy (Failover, Reliability and availability, response); Redundancy of Systems and Data; Training of sub-regional data providers (IOOS DMAC standards and procedures); Train Personnel to advance their technical expertise (attending courses and conferences on data management); Upgrade to 24X7 quasi manned/automatic operations (Consistency, reliability and accuracy); QA/QC algorithm development and implementation for existing and new data types that may become available; Server Capacity Requirements (Needs of new servers to meet the growing demands), Need to upgrade to provide 24/7 operations; Establish backup capacity (sites) to provide redundancy to ensure continuous operations in case of infrastructure failure at central hub; Work with NOAA (NODC, NCDDC, NDBC and Co-Ops) on the archival of observations and model data; Provide redundancy to sub-regional coastal ocean observing systems (Data Telemetry and Processing, storage and delivery); Explore Cloud Computing; OGC SensorML; Providing access to historical data to support end users needs; Support the development of products for all theme areas; Registering the data services with IOOS; Upgrade performance measures and data portal usage statistics; Work toward IOOS DMAC Data Certification; Develop best practices for new data providers to provide data to SECOORA; Provide data providers with tools to convert their data into one or more file formats for data aggregation; Work with NDBC to determine their best practices for more in-depth quality control, such as Nearest Neighbors or other checks we have yet to implement; Develop dedicated, responsive in-situ recent and archival database servers; Test operations in Cloud Computing environment; Provide access to long-term data for Fisheries and Ecosystem management needs; SECOORA will develop new metadata components that will organize and serve important pieces of metadata of observations and products for external catalog efforts and internal project monitoring using Open Geospatial Standard (OGC). SensorML is being researched and promoted by Ocean Observing Community which provides standard models and an XML encoding for describing sensors and measurement processes. SensorML can be used to describe a wide range of sensors, including both dynamic and stationary platforms and both in-situ and remote sensors.
Operational Requirements **• Personnel (# of FTEs)** **• Replacement needs (computers, redundant systems)** **• servers**	**SECOORA DMAC system Personnel needs:** Database architects (2.0 FTE), Software Engineers (2.0 FTE), Environmental Data Specialist (1.0 FTE) Network Engineer (1.0 FTE), Web Programmer (1.0 FTE) SECOORA Backup DMAC Center at an offsite location Software Costs (GIS, Graphics, Microsoft and adobe etc.); Hardware Costs (10 servers, 6 Personal computers, 2 Printers, 2 Storage Devices with 100 TB capacity) and factoring the maintenance and replacement costs; Uninterrupted Power Supplies as well as backup generators for SECOORA DMAC center as well as back up site
Participate in national and inter-RA data management coordination and collaboration	SECOORA Staff and SECOORA DMCC members continue to participate in discussions with the IOOS RA DMAC and NFRA groups, which are working to coordinate the RAs DMAC activities. Activities include- an annual meeting of the RA DMAC to evaluate and coordinate the RA DMAC activities to move IOOS RA DMAC forward; Tiger teams and other working groups to address Sensor Observation Service, SensorML and THREDDS, Ontology development, and the IOOS Catalog and Asset Inventory. SECOORA members also actively participate in the QARTOD working group to establish QA/QC standards and procedures; IOOS Data Certification Standards. SECOORA collaborates with neighboring RAs GCOOS, CaRA and MARACOOS in sharing and leveraging their data management expertise via meetings and conference calls. SECOORA's Xenia Relational Database Schema and IOOS Vocabulary developments are some examples in sharing and leveraging the RAs strength and expertise.

Provision of in-situ observations data to WMO GTS from SECOORA Region and Providing HF Radar data to National HF Radar Portal	SECOORA regional coastal ocean observations (in-situ) are submitted to Global Telecommunication System (GTS) via the National Data Buoys Center (NDBC). Sub-regional data providers are directly in contact with NDBC to obtain WMO ID for their observing stations by providing necessary metadata to NDBC. NDBC currently has established two formats to submit data to them to be pushed to GTS: MODEM Kit and a new XML format. The data providers are requested to shift to the new XML format. SECOORA DMAC/DMCC will make sure to coordinate with sub-regional data providers as well as NDBC to make sure all near real-time coastal ocean observations are disseminated to GTS via NDBC. As new data providers come online, SECOORA will have the capacity to provide guidance and technical expertise to submit data to NDBC/WMO. HF Radar operators within the SECOORA region either submit directly to the National HF Radar Portal or Via the HF Radar Node established at University of Miami.

Synthesis Table for Cost Estimation			
DMAC Needs	**Computing Resources Required**	**FTE**	**Other**
IOOS-compliant DMAC	10 Servers, 6 Personal computers, 2 Printers, 2 Storage with 100 TB storage capacity. The distribution of computing environment (locally or in cloud environment) yet to be determined	1.0 FTE Database Architect and 1.0 FTE Software Engineer	$20k for regional and IOOS DMAC workshops; $10k staff travel to support data providers;
Regional Data Management		1.0 FTE Database Architect, 1.0 FTE Software Engineer and Environmental Data Specialist	
Maintenance		1.0 FTE Network Engineer, 1.0 Web Programmer	Software costs $10k/year; Network equipment $5k; Training for the DMAC center staff - $5k per FTE
Development Needs		Development needs are addressed in Product Development Sheet	

SECOORA PRODUCT DEVELOPMENT SUBSYSTEM TEMPLATE

Product Development subsystem rationale: Our overall goal for product development is to integrate the rich data set of remotely sensed, in situ, glider, and model-derived data captured in all of the other subsystems for delivery to multiple stakeholders and decision-makers. Our approach to developing end-use applications begins with the identification and engagement of local, regional and national partners who have articulated a need that can be addressed through coast and ocean observations or predictions. These partners are engaged to develop product specifications that guide the product/service development effort. End-users participate in the design, development and validation of such products. Every product or service has a clear linkage to specific customers and to specific SECOORA-supported observation, model or prediction data streams. Time from the Web Developer that will also work on these products is accounted for in the Governance Subsystem Template.

Synthesis Table for Cost Estimation

Product Name	Development	Geographic Cover	Associated Theme/Issue(s)
Integrated Products			
SECOORA Web Site and Social Media Outreach	Ongoing maintenance and periodic every other year major updates	N/A	All
Interactive map with added capabilities including metadata access, model output access, data download, and integration of biological, bathymetry, and other data as needed	Ongoing maintenance and periodic every other year major updates	Entire	All
Upgrade and support data portal(s) based on user feedback.	Ongoing	N/A	All
Develop Online survey tool to assess user needs.	Development of survey questions and implementation of survey every 3 years		All
Development and delivery of tailored products 1 - Interface development to increase access to model output based on theme / state specific needs 2 - Tool for statistical analysis, subsetting, and filtering data by region, date, or type (including archived data) 3 - Visualization of modeled and observed wave and inundation modeling	Refine product needs with interested stakeholder groups and perform maintenance and updates as required.	Project specific	All
Compile model forcing fields for integration, verification and data assimilation	Ongoing	Model Domains	All
Bathymetry portal for the Region compiling all sources	Annual update	Entire	All
Web based inventory of regional expertise and rapid response resources for event management	Updated annually	Project specific locations	All
Thematic Products			
Alert tool for email and mobile devices with options to integrate data from obs, models, and biological data for alerts			Ecosystems, Fisheries, and Water Quality
Ocean circulation models combined with oil spill trajectory visualization tools		Event driven	Marine Operations
GIS system for Marine Energy Development with ecology, geology, biology and oceanography		Project area driven	Marine Operations
GIS based index and links (bibliography) of regionally-relevant sea level change studies, models and estimates of change			Climate Change
Support the ongoing development and operation of the Environmental Surveillance Network			Ecosystems, Fisheries, and Water Quality
Product Development Needs	**Computing Resources Required**	**FTE**	**Other**
	Network computing resources are captured in the DMAC Subsystem Template; 4 Personal computers	1. 0 FTE Scientific Product Manager 1.0 FTE Data Analyst 1.0 FTE Software Engineer 1.0 FTE GIS Specialist	Software costs $10k/year; Travel: $2,000/FTE $5k per FTE for training; $20k for regional product

SECOORA FIXED PLATFORM SUBSYSTEM TEMPLATE

Observing subsystem rationale: SECOORA proposes a multi platform, multi-variable data collection to provide three dimensional time dependent sampling. Real-time and non-real-time coastal, moorings, profilers, gliders and AUVs are proposed for in-situ data collection. HF Radars, surface drifters for synoptic sampling of surface currents and satellite remote sensing will be used for synoptic sampling of surface currents and surface ocean properties. This subsystem template describe the existing and proposed observing system broken out by observing platforms for the SECOORA region. SECOORA will locate the observational platforms based on scientific justification and will also leverage and coordinate with federal backbone.

	Real-time Coastal Stations	**Real-time Fixed Multi purpose Mooring Stations**	**Wave and Sea Surface Temperature (SST) buoys (Waverider Buoy)**	**Bottom Mounted ADCP Monitoring Stations (Non real-time stations)**	**Non-real time Meteorological Stations**	**Manual Water Quality Monitoring Stations**
Observing platform-Fixed **• Single purpose buoys** **• Shore Stations** **• Offshore platforms** **• Multipurpose buoys** **• Profiling** **• Other** **Descriptor: (e.g. Single Purpose Buoy: water quality or Single purpose buoy: waves or Multipurpose buoy: coastal, etc.)** **Provide a brief description for each of the platform types.**	Automated Coastal Monitoring Stations are a network of Meteorological and Oceanographic Instruments installed on piers, beaches, near shore islands and offshore platforms (structures like Coast Guard markers). The stations are typically designed to measure Meteorological and Oceanographic data; however, stations are designed to also measure flow, water quality parameters in some cases depending upon the nature of monitoring agency, program and resources. The automated stations are suited with data telemetry (GOES satellites, Radio, IP Modem or Cell phone; depending on location, stations can also be hardwired) and programmed to transmit data at desired interval (typically once an hour). The data relayed can be acquired by Ground Station Receiver system.	Automated Fixed Mooring Stations are a network of Meteorological and Physical Instruments installed on buoys and located offshore along the continental shelf (Outer-shelf, mid-shelf and inner-shelf). The stations are typically designed to measure Oceanographic data; however, stations can also measure Meteorological and water quality data depending upon the objectives and mandate of the observing programs and projects, agency and resources. The automated mooring stations are suited with data telemetry (GOES satellites, Radio, IP Modem or Cell phone) and programmed to transmit data at desired interval (typically once an hour). The data relayed can be acquired by Ground Station Receiver system.	Waverider buoys follows the movements of the sea surface, and determines the wave height by measuring the vertical acceleration of the buoy. In addition to wave height and direction, the wave rider buoy also measures sea surface temperature: **Note: We support the National waves plan, but a waverider buoy is not a multipurpose buoy and presently lacks capabilities to measure winds as well as other meteorological parameters. SECOORA will coordinate with NDBC waves plan within the SE region to leverage each others plan on locating resources. Therefore, the number of necessary buoys for column C (Fixed multipurpose) would decrease if Nat'l wave plan is implemented.**	Bottom mounted mooring for measuring currents over entire water column and temperature, salinity and pressure near bottom.	Meteorological stations provide wind speed and direction, air temperature, sea surface temperature, barometric pressure, humidity, and rainfall levels.	In rivers, estuaries, beaches, shellfish monitoring locations, that collect a variety of physical, chemical, and biological parameters. Usually used for special regulatory purposes, i.e. to assess whether standards for swimming, shellfishing, nutrients are met/not met. Also collected as part of spill preparation or response activities.
Theme Issues Addressed	All themes are supported by the Fixed Platforms					
Variables Observed and Resolution (Spatial, Temporal, Accuracy) Requirements List the variables that are required for fulfill themes. This can be a estimate of what is expected (e.g., Water Temperature: 1, 10, 50 m; hourly for 10 mins @1Hz; 0.1˚C)	Meteorological: Barometric pressure, wind direction, speed and gust, air temperature, relative humidity, precipitation, visibility, PAR; Physical: Currents, sea water temperature, water level, waves, Specific conductivity , Pressure (Depth); Water Quality: Water Temperature, Specific Conductivity, Salinity, Dissolved Oxygen, Depth, pH, Turbidity and in some cases Chlorophyll Fluorescence and nutrients, Phycocyanin and Phycoerythrin (HAB areas); Spatial and Temporal Resolution - Data transmission/telemetry is often hourly but the temporal resolution of the data can range from a minute to five minutes to 15 minutes, etc. Spatially need sufficient coverage of coastal water level stations to assess the predictive skill of low resolution ocean circulation models and high resolution coastal inundation models.	Physical Data: Temperature and Salinity at multiple depths, and current profiles; Ancillary Measurements: Waves at shelf break and near shore. Meteorological Data: Barometric Pressure, Relative Humidity, Wind speed, gusts and direction, air-temperature, sea temperatures. Water Quality and Hydrocarbon sensors. Spatial and Temporal Resolution: Once an hour, offshore moorings will be spatially located based on scientific justification, stakeholder product requirements as well as coordination with federal agency programs.	Waves – time series, 30 min spectral values. Centimeter accuracy, 5 degree directional resolution	Currents over entire water column and temperature, salinity and pressure near bottom.	Air temperature, sea surface temperature, waves, accumulated precipitation, altimeter, barometric pressure, dew point temperature, elevation, precipitation rate, relative humidity, solar radiation, visibility, wind direction at gust, wind direction, wind gust, wind speed, sea level pressure	Highly variable

Existing Active Programs and Stations Operated by Government in SECOORA Region	(1) NOAA NOS National Water Level Observation Network (2) NOAA NOS PORTS System (3) NWS NDBC C-MAN (4) NOAA NERRS Weather and Water Quality Monitoring Network (5) USGS National Water Information System Network (6) National Park Service Everglades Marine Monitoring Network (Water Quality and Water Level) (7) USACE	(1) NWS National Data Buoy Center - NDBC Mooring buoys measure and transmit barometric pressure, wind direction, speed, and gust; air and sea temperature; and wave energy spectra from which significant wave height, dominant wave period, and average wave period are derived - Total 10	(1) US Army Corps Engineers (Duck research pier) (2) National Data Buoy Center	NOAA NOS (PORTS Systems) in Tampa Bay	NWS, NERRS sites, state agencies, USGS, EPA (in association with air quality monitoring)	NCDENR, SCDHEC, SCDNR, GADEP, GADNR, FLDEP, FL Water Management Districts, EPA, USACOE, NPS, USGS,
Existing Active Programs and Stations Operated by SECOORA Members (Active and Inactive Stations)	(1) University of North Carolina – Chapel Hill (NCCOOS) has 4 (1 SODAR station inactive, 1 Pier station inactive and 3 Profiler stations in rivers that are active) (2) UNCW (CORMP), USC includes 3 active stations (3) USF (COMPS Coastal Network) total of 14 includes 13 Active and 1 inactive) (4) Florida Institute of Oceanography - has 8 active (5) WeatherFlow network has 89 active (6) Florida Department of Environmental and Protection (FLDEP) tide gages has 17Active and 38 inactive (7) FWRI has 3 Redtide Monitoring stations	(1) University of North Carolina – Chapel Hill (NCCOOS) has 2 active (2) UNCW (CORMP), USC has 8 - active (3) UNF has 1 inactive (4) NOVA Southeastern University has 2 active (5) FIT (Sebastian Inlet) has 1 active (6) USF (COMPS) has 5 Active and 2 inactive (7) FIO SEAKEYS network has 1 inactive (8) Coastal Carolina University has 6 active and 2 inactive (9) Sanibel Captiva Conservation Foundation (SCCF) water quality stations in West FL Shelf has 6 active (10) Florida State University Airforce Navigation Towers K and C - 2 inactive (11) UNC CSI has 1 inactive AWAC station	(I) University of North Carolina Wilmington; (1 active)	NOVA Southeastern University, University of North Carolina Chapel Hill, University of North Carolina-Wilmington, North Carolina State University, Coastal Carolina University, University of South Carolina, FIT, University of Miami, Florida Atlantic University, University of South Florida, Florida State University, University of North Florida	WeatherFlow and Universities within SECOORA Region operate meteorological monitoring stations	State agencies within SECOORA region have water quality monitoring stations that do not have real-time data telemetry. These stations could be enhanced with IOOS partnership and upgraded to near real-time data telemetry. We are proposing a limited number of new real-time coastal stations (see column B) that will be coordinated with states, and likely occupy existing non-realtime stations.
Typical sensor systems used by members	Data Loggers: Campbell Scientific, Stevens, Sutron, zeno 3200 Water Level sensors: Aquatrak, Sea-Bird; Current and Flow- Teledyne, Nortek, Sontek. Conductivity/Salinity - Sea-Bird Electronics, Aanderaa, Campbell Scientific, YSI, RBR, Teledyne; Meteorological: Campbell, AXYS Environmental, Vaisala, Gill Instruments, Coastal Environmental, RM Young; Optical: Hobi labs, Satlantic and Wetlabs; Water quality: YSI, Sutron, ISUS; Waves: Teledyne, Nortek, Datawell (wave rider); Some approximate number of sensors and sensor manufacturer types based on total existing and proposed assets including spares (1) Multipurpose buoys: 109 data loggers and telemetry; 218 wind sensors (RM Young redundancy on the buoys); 109 ADCPs (Waves and Currents Teledyne RDI or Nortek); Conductivity/Salinity sensors (SBE type)Min Three per buoy) - 327; Water Quality sensors (nearshore buoys YSI or similar type) - 30; (2) Coastal Stations: (a) Estuarine Stations - 144 data loggers and telemetry (Sutron YSI type or similar), water quality sensors; 48 Meteorological Data Loggers (Campbell or Vaisala type) and Telemetry; 74 wind sensors (RM Young), PAR (Licor); air temperature/relative humdity, precipitation; (b) Pier Stations: 67 Water level (Aquatrak type), waves (SBE type or similar), met and water quality (similar to (a) estuarine stations sensors); (c) Water Level stations - 64 Data Loggers, water level (Aquatrak type) sensors, wave sensors (SBE type or similar), met and water quality (similar to (a) estuarine stations sensors); (d) Ports and Harbors - 55 Data Loggers, water level (Aquatrak type) sensors, wave sensors (SBE type or similar), met and water quality (similar to (a) estuarine stations sensors), visibility sensors (Vaisala transmissiometer) (3) Bottom Mounted ADCPs - 13 ADCPs (Currents and Bottom temperature - Teledyne RDI or Nortek type)					

Proposed New additional Stations (Based on existing assets network)	(1) Estuarine Coastal met/water quality stations - 108 Water Quality stations and 36 Met stations (2) 50 pier stations (NC, SC, FL, GA); Water Level, Met, Waves, Water Quality (3) Augment existing NOS and water level stations from state and other agencies for 4 states -(Water Level, Met, GPS, Water Quality) Additional water level sites in NC and SC - Sunset Beach, 3 in Albemarle/Pamlico Estuary system, Folly and Apache and piers in SC and 4 additional in Big Bend area of FL (10 new). In addition to WL, wind and basic wq (4) Monitoring in Ports and Harbors within SECOORA - Total Number of Ports 11 - (Water Level, Met, Waves, Visibility and Currents) - 4 sites per port (Total - 44 Sites)	Total 62 new multi purpose (sensors - met,water column measurements of currents, temperature, salinity and waves) mooring stations. These will be placed based on scientific justification and stakeholder area of interest such as Marine Protected Areas. To support a need expressed by recreational and commercial fishermen, a wind and wave buoy will be considered to be installed outside of heavily utilized navigable inlets. We are aware of the NDBC waves plan and will coordinate with NDBC as to our proposed buoys purchase and placement.	National Waves Plan: (1) SECOORA Domain - 24 Buoys proposed in addition to existing arrays maintained by NDBC, CDIP in collaboration with University of South Florida and UNCW - The proposed 24 new buoys covers outershelf, innershelf, offshore, coast	SECOORA proposes to add 4 Bottom Mounted ADCPs on the east coast of FL and maintain existing network of 4 bottom mounted ADCPs maintained by University of South Florida on the West Florida Shelf and 2 maintained by Coastal Carolina University, South Carolina. Bottom mounts in smaller ports are needed, but not included in our current plan.		
Geographic cover / Location and number of buoys	Coastal (nearshore, beaches, coastal) and Inland (Estuaries and Rivers)	Shelf (includes outer-shelf, mid-shelf, inner shelf) and near-shore (regions impacted by estuaries). Scientific justification and stake holder area of interest such as Marine Protected Areas (MPAs)	Inland, Coastal, Shelf, Deep water	Shelf, Slope, Coastal, Inland		
Operational Requirements **• Deployment / Operations (boats, etc)** **• Maintenance (# of service trips/year)** **• Personnel (# of FTEs)** **• Replacement needs (spare parts, redundant systems)** **• Other**	(1) Deployment/Operations - Engineering Design to install new coastal stations; Working with local authorities (state and county) on permit to install coastal stations; Travel and Vehicle to install and Maintain; Data telemetry systems integration (2) Maintenance - 2 trips a year for water level and Meteorology stations and more trips required for stations with in-water sensors (cond. and temp) and water quality sensors; Emergency Visits to replace instruments in case of failure; Calibration of Sensors; Data Telemetry costs (3) Personnel - 1 Coastal Engineer and a Field Assistant per 5 coastal stations (4) Replacement needs - Redundant system with sensors for each site and spare parts, tools etc. (5) Water Level Datum Surveying Needs - Each site needs survey work to establish vertical control measurements of coastal tidal measurement sites in order to reference water level measurements to the NAVD 88 datum - Ideally should be done annually.	(1) Deployment/Operations - Engineering Design to install new offshore stations; Ship buoy launch capacity (staging areas and minimum 2 buoys) time to support the buoy array; (2) Buoy system assembly: Mooring hardware such as shackles, chains and cables; power systems, data telemetry system, data loggers, sensor system testing (3) Maintenance - Bi-Monthly cruises of 3 day durations along the each line of array; Emergency Visits to replace instruments in case of failure; Calibration of Sensors; Data Telemetry costs (4) Personnel - 1 Buoy Deployment Engineer, a Field Assistant per 3 buoys and Divers (5) Replacement needs - Redundant sensors and buoy for each site and spare parts, tools etc.; redundancy in wind sensors as to criticality of the measurement; Replacement Buoy every 5 - 6 years	Deployment: vessel that can launch a 400 lb buoy and 1400 lbs of anchor chain; Maintenance: once every 2 years; Personnel: 3 people to launch (if the data management is included for the data, then it is may be more.) Replacement: new mooring once every 6 years	(1) Deployment/Operations - Engineering Design to install new offshore stations; Ship time to support the buoy array; (2) Maintenance - Bi-Monthly cruises of 3 day durations along the each line of array; Calibration of Sensors; Data Telemetry costs (3) Personnel - 1 Buoy Deployment Engineer, a Field Assistant per 3 buoys and Divers (4) Replacement needs - Redundant system with sensors for each site and spare parts, tools etc.; Replacement Buoy every 5-6 years		

Development Needs (If necessary, describe development efforts required for advancing, operationalizing or refining each of the identified issues.)	Data Telemetry (Two way communication to avoid site visits); Bio-Fouling; Coordination of data acquisitions (Redundancy) between sub-regional systems to avoid outages; Metadata and QA/QC standards development; Standardization and interoperability between sub-systems and national systems as to measurements; Technicians training -- For tide gages, water quality and met stations.	Data Telemetry (Two way communication to avoid site visits); Communication bandwidth as to data packaging and delivery; New sensors evaluation and development; Bio-Fouling; Coordination of data acquisitions (Redundancy) between sub-regional systems to avoid outages; Metadata and QA/QC standards development; Standardization and interoperability between sub-systems and national systems as to measurements; Technicians training - Budget to attend workshops such as ADCP buoy workshops as well as other sensors; Coordination with UNOLS and other federal and state agencies as to boat and ship time; Centralized calibration facility	Addition of Sensors like Air-Temperature and winds			Need Members Input
Observing System Synthesis Table for Cost Estimation						
	Number of stations	**FTEs**	**Capital Cost**	**O&M (sensor spares/repair/spares)**		
Real-time Coastal Stations (Ref row 10 of this sheet)	(1) Estuarine Stations - 36 Sites (3 Water quality and 1 Met stations) @43.5 K per site = $1566 K (2) Pier Stations - 50 Stations (@45 K per site) = $2250 (3) Augment and Upgrade existing network of water level stations = 48@40 K (Water Level, Met, WQ)=$1920 (4) 11 Ports sites - (Water Level, Met, Waves and Currents) - 4 sites per port (44 Sites) @45 K per site - $1980 K	18 (with support and collaboration with local, state agencies and academic institutions)	$7.716M	(1) Estuarine Stations (Spares sensors) - $1098 K (2) Pier Stations (Spares at 1 per 3 sites) - 17 stations (@45 K) = $765 K (3) One per three sites spare water level stations (16@$40k)= $640k (4) Ports sites spares (1 per port) = 11 sites @45 K = $495 K		
Real-time Fixed Multi purpose Mooring Stations* (Ref. row 10 of this sheet)	Multi-purpose buoys - 101 buoys (200 K per buoy) = $ 20200 K	33 (1.0 per 3 buoys)	$20.2M	Multi-purpose buoys (spares with sensors) - 20 buoys (200 K per year) = $4000 K		
Bottom Mounted ADCP Monitoring Stations (Non real-time stations)	Bottom Mounts (non real-time) - 10 buoys (60 K per buoy) = $600 K	2.5 (1.0 per 4 buoys)	$600K	Bottom Mounts (spares with sensors) - 3 buoys ($60 K) = $ 180 K		
Non-real time Meteorological Stations, Manual Water Quality Monitoring Stations **Acoustic Mooring Array** **Submarine Underwater Cable**	**Support for non real-time Meteorological stations, manual water quality monitoring stations, acoustic mooring arrays (passive acoustics on most of the moorings to expand the existing acoustic array offshore) and submarine cable (to measure transport in ocean currents and climate variables) are being considered to meet the stakeholders product needs. Cost estimates for these systems are yet to be determined. Presently NOAA AOML is maintaining a submarine cable that runs between Fort Lauderdale and Bahamas and data is available on transport in Florida Strait for the past 25 years. According to International Telecommunication Union, deploying a new cable is $50 K per km and $25 K per km to relocate a cable. The stake holders in our region would like to have the existing continued as well as recommending relocation (re-use) of existing abandoned telecommunication cables. There are also retired submarine cables (e.g., between Keys and Cuba and possibly in the other major passes in the area Yucatan, Old Bahama, NW Providence Channel) that could be re-purposed to measure transport as well as climate variables such a bottom ocean temperature, salinity and pressure.**					

* Note to cost estimators: These bouys need to be wave riding buoys, i.e. capable of withstanding high wave environment

SECOORA MOBILE PLATFORM SUBSYSTEM TEMPLATE

SECOORA MOBILE PLATFORM SUBSYSTEM TEMPLATE

RATIONALE: Mobile assets (drifters, gliders, profilers) are an important aspect of a coordinated observing sand modeling system. Drifters carried by surface currents may be used to track hazardous spills and are of value for search and rescue. Gliders sample water properties (temperature, salinity, chlorophyll, CDOM, oxygen, optical properties, acoustics, currents) with very high spatial resolution. Profilers deployed as a spatial array sample such water properties synoptically in time with very high vertical resolution. When deployed together with gliders the attributes of both of these mobile assets achieve both high resolution in space and synoptic sampling in time. These mobile asset data support all IOOS programmatic needs: marine weather, search and rescue, event response, ecosystem and climate modeling, serving stakeholders in ecosystems management, fisheries, coastal hazards and marine operations. Glider and profiler observations also provide valuable data of assimilation into coastal ocean circulation models, which, when coupled with biological models comprise ecosystems models. It is through the coordination of observations and models that we can best describe and understand the complex workings of the coastal ocean and thereby best serve the stakeholder community on all matters pertaining to IOOS. Without such understanding and predictive capabilities that derive therefrom it will be difficult to advance concepts such as ecologically based management and marine spatial planning.

Recreational and commercial fishing industry benefits from knowledge of the position of frontal areas where fish are known to congregate, which improves efficiency for catching target species, reduces by-catch, and improves fuel usage efficiency. While satellite-derived products indicate surface fronts, the 3-dimensional information that gliders provide also reveals the presence and development of subsurface fronts. Fisheries management agencies are eager for regular acquisition of data at the shelf-edge, which will enhance understanding of shelf-edge processes and greatly benefit fisheries management in predicting the correlation of spawning and recruitment with 4-D fields of physical and biological conditions. Water quality measurements provide the necessary information to state managers to predict and manage harmful algal blooms, hypoxia, and pollution. In situ oxygen, chl-a and CDOM sensors integrated on the gliders will help determine the offshore conditions favorable for development of nearshore hypoxia in conjunction with nearshore monitoring and via modeling efforts underway to reproduce the hypoxic events (e.g., Sanger et al., 2010; Voulgaris and Sanay, 2010). Gliders were also instrumental in helping to understand the water properties and currents on the West Florida Shelf during the Deepwater Horizon oil spill when the circulation was anomalously upwelling favorable (e.g., Weisberg, 2011).

Search and rescue efforts (U.S. Coast Guard) will benefit from near-surface temperature observations, which are useful for survivability estimations, and from surface velocity measurements for estimation of trajectories (particularly useful in regions not covered by HF radar).

1) Gliders, Profilers and AUVs: SECOORA proposes a fleet of 30 gliders. Gliders would be deployed monthly, traversing the shelf out to the shelf break. Fifty percent (50%) redundancy is required. With these 'back-up' assets, event response and special purpose missions will be executed to address science and management questions. Glider missions will be augmented by arrays of profiling floats to achieve both high spatial resolution and synoptic sampling in time. NOTE: Gliders are a technology that is rapidly evolving. It is anticipated that their capabilities will increase significantly over the next decade to allow for uses not currently envisioned.

2) Deep Water gliders: The Loop Current-Florida Current-Gulf Stream system provides the connectivity across the SECOORA region. How its water properties affect the shelf remains poorly sampled. Deployments of deep water gliders for sampling beyond the shelf break are necessary to observe these deep ocean shelf interactions. Three deep water AUVs will be deployed quarterly to provide baseline information on Gulf stream characteristics necessary to adequately model circulation, potential impacts from spills, ecosystem processes and fish population dynamics.

3) Ships: As part of the semi-annual moored asset maintenance program, ships will collect biological, physical, chemical and met data to augment other observing asset datasets

4) Along with their tandem use with gliders previously discussed, bottom stationed ocean profilers that are capable of maintaining their location provide multi-disciplinary data with very high vertical resolution in augmentation of instruments deployed on fixed buoys

5) Surface drifters: In addition to those assets provided by industry, which may be proprietary over certain regions (e.g., Horizon Marine) and AOML deep ocean drifters, we envision the regular deployment of satellite tracked surface drifters to help define surface current pathways and for even response (~ 150 to be deployed annually)

6) AXBTs, etc.: Surveys using airborne ocean profilers such as Bathythermographs (AXBT), Temperature, conductivity and Depth (AXCTD), and Current and Temperature Profilers (AXCP) provide synoptic snapshots of the 3-D structure which is critical in mapping events (oil spills, hurricane response) to assimilate into models. They provide profiles of temperature, salinity, density and currents to 1000 to 1500 m.

	Gliders, Profilers and AUVs:	Ships: Transect and/or Event Sampling	Voluntary Observing Ships (VOS)	Surface Drifters	AXBTs, AXCTDs, AXCPs
Observing platform-Mobile • Gliders • AUVs • Ships • Beach transects • Drifters • Other	Underwater Gliders are autonomous underwater vehicles (AUVs) and Profilers programmed to survey the ocean in transects. They can be used for physical and/or water quality sampling (HABs, outfalls, hazardous spills), or with acoustic sea gliders, tracking fish and marine mammals as well as monitoring ambient noise and mapping habitat	Event-based ship sampling for water quality (HABs, outfalls, stormwater, hazardous spills.) Biological sampling related to events and/or regular stock or ecological assessments. Sampling will also be integrated into regular maintenance cruises for other observing assets.	Leverage the large volume of commercial shipping and recreational boat activity to add automated instrumentation packages.	Satellite tracked surface drifters provide a quasi-Lagrangian view of surface circulation and, with caveats regarding their performance relative to Lagrangian trajectories (not necessary surface-confined), provide excellent tools for surface trajectory analyses	Airborne expendable bathythermograph; airborne expendable Conductivity, Temperature, depth; airborne expendable current profilers
Theme Issues Addressed- Directly link to all issues addressed in the previous section	Climate Variability and Change; Ecosystems, Fisheries and Water Quality; Coastal Hazards; Marine Operations	Climate Variability and Change; Ecosystems, Fisheries and Water Quality; Coastal Hazards; Marine Operations	Climate Variability and Change; Ecosystems, Fisheries and Water Quality; Coastal Hazards; Marine Operations	Climate Variability and Change; Ecosystems, Fisheries and Water Quality; Coastal Hazards; Marine Operations	Climate Variability and Change; Ecosystems, Fisheries and Water Quality; Coastal Hazards; Marine Operations

SECOORA MOBILE PLATFORM SUBSYSTEM TEMPLATE

Variables Observed and Resolution	water temperature, salinity, pressure, chlorophyll fluorescence, acoustic backscatter, velocity, CTD, CDOM, Optical back scatter; water quality, acoustic signals, benthic habitat	water temperature, salinity, pressure, chlorophyll fluorescence, acoustic backscatter, velocity, CTD, CDOM, Optical back scatter, currents, winds, bathymetry, biology	Biogeochemical parameters, Meteorological and physical parameters	SST, Surface Velocity	Profiles of temperature, salinity, density and currents to 1000 to 1500 m.
Existing Active Programs and Stations Operated by Government in SECOORA Region	None	NOAA, FWRI, SAFMC, SCDNR	None	NOAA AOML, USCG, FWRI and State Agencies	NOAA AOML, AOC and EMC in SECOORA and GCOOS Regions From NOAA WP-3Ds and G-IV (Located In Tampa). May want to explore the use of USCG aircraft particularly WC-130s for ocean surveys.
Existing Active Programs and Stations Operated by SECOORA Members (Active and Inactive Stations)	UNC-CH, UNCW, NCSU, UGA - 1 each (Webb Electric Slocum Gliders). USF - 6 (Webb Electric Slocum Gliders); AUVs: FAU - 1 (Bluefin 1000-m AUV); USF - Bottom Stationed Ocean Profiler - 30; Mote-2 gliders; FAU-Harbor Branch - 2 (1000-m Spray gliders); Coastal Carolina University (May be available for Bathymetry and Habitat Mapping) - Seismic profiler and Multi beam sonars	We can provide a list of regional vessels. None are currently conducting active programs	SeaKeepers	Academic Institutions and Private.	RSMAS at UM
Proposed New additional Stations (Based on existing assets network)	Gliders: Sawtooth pattern traversing the nearshore out to the shelf break deployed monthly. Fifty percent (50%) redundancy is required. Deep Gliders: 3 deep water gliders deployed quarterly beyond the shelf break 20 300km habitat mapping transects	Repeated shipboard surveys of biogeochemical variables and biota in conjunction with moored asset and glider deployment and maintenance operations. Habitat mapping cruises w/multibeam sonar		150 drifters per year (monthly releases at a dozen locations)	In collaboration with NOAA's Hurricane Field Program that deploys GPS sondes (atmospheric conditions) and expendable ocean profilers (AXBT, AXCTD, AXCP) and deployment during USCG operations using aircraft for the 3-D current field. 10 flights per year deploying 500 AXCPs/AXCTDs and 500 AXBTs
Geographic cover / Location and number:	Gliders (20) and BSOP (80): Shelf (includes outer-shelf, mid-shelf, inner-shelf) AUVs Habitat Mapping Strategy: 20 300 km transects from inner shelf across Blake Plateau using 2 shallow and 2 deep AUVs. Priorities include unmapped benthic essential fish habitat including the shelf, deepwater MPAs and coral HAPCs: Deep gliders (3): Beyond shelf break to explore Loop Current-Florida Current-Gulf stream	Shelf (includes outer-shelf, mid-shelf, inner-shelf) and slope Approximately 22 transects along moored buoy arrays completed twice per year in conjunction with buoy maintenance to collect biogeochemical variables to complement other observing activities Ship-based Habitat mapping requirement: ~178,000 sq mi/multibeam sonar		Coastal, shelf, slope, deep water	Outer shelf, shelf break and deep ocean deployed along the SE seaboard or in the Gulf of Mexico/NW Caribbean Sea depending on where we have weather/ocean features of interest .Deploy 500 AXCPs/AXCTDs and 500 AXBTs

SECOORA MOBILE PLATFORM SUBSYSTEM TEMPLATE

Operational Requirements **• Deployment / Operations** **• Maintenance** **• Personnel** **• Replacement needs** **• Other**	Glider Deployment: A total of 20 gliders would fly monthly for two weeks along repeated sawtooth tracks across the shelf. Operations: System configuration; Boat time to deploy; Personnel - 1 Engineer and 1 Assistant per 3 Gliders; 1 replacement for every 2 gliders Deep gliders: 3 deployed quarterly with same operational requirements as other gliders.	Ship days for maintenance transects - 66 days of large vessel (30m) ship time assuming 3 days per transect. Will carry full sampling crew (5 personnel) Ship days for multibeam sonar habitat mapping TBD		Operational requirements: Ship time for deployment - small vessel (10m) adequate	Aircraft time from government resources to deploy from available aircraft and profilers will need to be procured each year. Aircraft time: 100 to 120 hours (~5K per hour)= 500 to 600 K. Personnel: $150k/year for scientist and technicians time and travel expenses
	AUV Deployment: Habitat mapping mission. Shallow (20m ship; 2 technicians) and Deep (40m ship; 3 person team). See cell 16B.				
	BSOP Deployment: 80 deployed regionally on the shelf once a month for 2 weeks in coordination with glider deployments System configuration; Boat time to deploy; Personnel - 1 technician per 5 BSOP. 1 spare/5 units				
Development Needs If necessary, describe development efforts required for advancing, operationalizing or refining each of the identified issues.	System integration, QA/QC, Data Telemetry, Communications, Reliability	We need additional ships to serve the operational needs of the proposed RCOOS		Coordination with USCG and NOAA AOML	Coordinating with NOAA AOML and USCG (perhaps working from their C-130 aircraft for deployment of profilers). In collaboration with NOAA's Hurricane Field Program or USCG operations from WC-130's that deploys GPS sondes (atmospheric conditions) and expendable ocean profilers (AXBT, AXCTD, AXCP).

Observing System Synthesis Table for Cost Estimation

Observing Platform	Variables Observed	Sensors (#)	Geographic Cover and Quantity	Capitol Cost	Operational cost
Gliders	water temperature, salinity, pressure, chlorophyll fluorescence, acoustic backscatter, velocity, CDOM, Optical back scatter, dissolved oxygen, pH		Shelf; 20@$150k Deep: 3@$200k	$3M $600k	System configuration; Boat time to deploy; Personnel - 1 Engineer and 1 Assistant per 3 Gliders
Gliders spares			shallow: 10: deep: 1	$1.5M: $200k	
Mapping AUVs with passive listening acoustics	bathymetry, benthic community and substrate	Multibeam sonar, digital still camera	Shelf (shallow): 2 Beyond shelf (deep): 2 Based on 20 300km transects (~2.5 days/transect)		$3k/day $11k/day
AUV spares					
BSOPs	conductivity, temperature, depth and water quality		Shelf: 80 @ $40k ($35k w/o water quality)	$3.2M	System configuration; 1 technician/10 units Ship time to deploy
BSOP spares			1/5 units	$640k	
Ship biochem. Cruises	phytoplankton and zooplankton surveys; macro- and micro-nutrient water sampling; CO2 species; ADCP and CTD; fisheries surveys (active acoustics)		Shelf and slope		66 days x daily rate ($10K) = $660,000/yr+ science crew costs
Ship habitat mapping cruises	multi-beam sonar		TBD		

SECOORA MOBILE PLATFORM SUBSYSTEM TEMPLATE

Surface drifters	surface currents	GPS	Region: 150	$300	1.0 FTE, Ship time to deploy
AXBTs, AXCTDs, AXCPs	water temperature and current water temperature, conductivity and depth	AXCPs/AXCTDs AXBTs	500 @ $1.5k/probe 500 @ $0.5k/probe Outer shelf, shelf break and deep ocean	$750k $250k	
Habitat	**Depth (m)**	**Square miles**	**mi2 mapped**	**Remaining to be mapped (sq mi)**	**Mapping rates & costs**
shelf	10 to 45	35,423	9909	25,514	100-m AUV: 24 hr dive + 6 hr battery turnaround = 150 linear km & 18.75 sq. km; $3k/day plus support vessel
shelf edge	46 to 70	3,634	652	2,982	100-m AUV: 24 hr dive + 6 hr battery turnaround = 150 linear km & 18.75 sq. km; $3k/day plus support vessel
shelf break	70 to 140	3,716	538	3,178	Bluefin AUV: 2 person team ~$3k/day plus support vessel
shelf offshore	141 to 300	8,969	449	8,520	Ship Multibeam; $12k/day
deep	> 300	138,539	9	138,530	Eagle Ray AUV: 3 person team ~11k/day plus support vessel
SA EEZ		190,281	11557	178724	

SECOORA LAND BASED REMOTE SENSING OBSERVING SUBSYSTEM TEMPLATE

Land-Based Subsystem Rationale: Land based Remote Sensing systems such as High Frequency Radars (HF Radar) and Weather Doppler Radar (Next Generation Radar - NEXRAD) are important components of the Coastal Ocean Observing System (COOS). HF Radar measures surface current speed and direction, wave height and wind direction and provides critical support to stakeholders involved in search and rescue, marine transportation, pollutant tracking, circulation modeling and harmful algal bloom monitoring. HF Radars are also augment the existing in-situ measurements, and provide increased spatial and temporal resolution. Doppler Weather Radar systems are maintained primarily by NOAA National Weather Service and Private Sectors provide rainfall amounts and 3D wind vectors in near real time at a full resolution required for weather prediction models.

	Land Based High Frequency Radar Systems	**Weather/Doppler Radar**
Remote Sensing: Land-based (HFRadar) and Other	HF Radars require FCC approval to transmit radio waves near the 5 MHz, 13 MHz, 25 MHz and 48 MHz bands. The radio waves propagate over the horizon along the conductive ocean surface, limiting freshwater applications. Transmitted radio waves scattered by ocean waves and surface vessels are then observed by the HF Radar receivers. HF Radars operating in the lower frequency bands provide more range with less resolution, and those operating in the higher frequency bands provide more resolution at shorter ranges. The HF radar systems are either direction-finding (CODAR) or beam-forming techniques (Wellen Radar: WERA) to acquire radial currents from the Bragg peaks in the Doppler spectra.	Doppler weather radars transmit out radio waves from an antenna. Objects in the air, such as raindrops, snow crystals, hailstones or even insects and dust, scatter or reflect some of the radio waves back to the antenna. All weather radars, including Doppler, electronically convert the reflected radio waves into pictures showing the location and intensity of precipitation. These systems provide rain amounts and 3D wind vectors in near real rime at full resolution required to initialize regional atmospheric model.
Theme Issues Addressed: Directly link to all issues addressed in the previous section	1. Maritime Operations: Safe and efficient commercial shipping and recreational boating, Search and Rescue, Spill Response, Offshore Energy. 2. Climate Variability and Change: Changes in ocean conditions over time. 3. Ecosystems, Fisheries and Water Quality: Healthy & Productive Ecosystems, Sustainable Fisheries, HABS, Hypoxia, Minimizing the Impact from polluted waters. 4. Coastal Hazards: Providing hazard and disaster information when and where it is needed.	
Variables Observed and Resolution (Spatial, Temporal, Accuracy) Requirements (e.g., Surface Currents: Hourly vector maps at 6 km spatial resolution across the continental shelf for the entire region)	Variables Observed: Surface current speed and direction, Wave Height and Wind Direction; Spatial, Temporal and Accuracy of Existing systems: CODAR and WERA offers varying range and resolution based on frequency and bandwidth. Currently, the long-range, SeaSondes (SS) were deployed to sense surface currents at hourly intervals and a 6 km resolution along the WFS and the NC Shelf. The medium and long-range WERA were deployed along the WFS, Florida Straits and along the SAB with spatial resolutions of 1.2 to 3 km sampling at time scales of minutes. Accuracy: Long Range HFR - 5-12 cm/s; 5-6 cm/s Tidal Subtidal, Medium Range and High Resolution HFR - 2-12 cm/s; 2-4 cm/s Tidal and Subtidal	Velocity data of objects at a distance, the radar systems such as NEXRAD (Next Genration Radar) weather information (precipitation and wind) based upon returned energy.
Existing Active and Existing Inactive and Proposed HF Radar Stations and Type of Systems	**Total Number of Existing Active CODAR (Sea-Sonde Stations) - 7**; **Total Number of Existing Active WERA Stations - 8**; **Total Number of Inactive and in the process of relocation - 4 WERA Stations**. **Total Number of Proposed Stations and sustaining the proposed network (next 10 years) - 30** for SECOORA from North Carolina to the Florida Panhandle and from Coon Key to St Andrew Sound. **Total number of Spare Units**: **17** The SECOORA proposed sites on the WFS partially overlap with those of GCOOS and appropriate Cost Estimates and sharing between the two RCOOS's will be carried out.	Primarily National Weather Service and Private Sectors.
Proposed Very High Frequency Stations for PORTS and Harbors	Total Number of Harbors in SECOORA Region; 11 (NC - Wilmington; SC - Charleston and Georgetown; GA - Brundswick and Savannah; FL - Jacksonville, Cape Canaveral, Port Everglades, Port Palm Beach, Miami and Tampa) - Two VHF radars per harbor **-** **Total Number of Proposed VHF Stations and sustaining the proposed network (next 10 years) - 22**	Augmentation of the National Network and Private Radar Systems is proposed.
Geographic Coverage	Geographic region of deployment of HF Radar systems can extend from the estuaries, bays, harbors to about 200 km offshore, covering the full geographic area from Coastal to Deep Ocean. For HF Radar sites, onshore locations with direct road access, power and communications are preferred where possible for ease of maintenance and operations and FCC license compliance. Island stations, offshore platforms and transmitter buoys may be desired or required in some locations to complete spatial coverage. Radars sites must be close to the waters edge to limit attenuation of the radio waves over dry land.	SECOORA Region.
Operational Requirements: Deployment / Operations; Maintenance; Personnel; Replacement Needs and Other	Deployment/Operations: Frequency Approval and Allocations; Permit for Sites along the coastal and port areas; Protection against lightning strikes and extreme events; communication links between sites and data centers; Procurement and Installation expenses (travel etc.); For operations, As per the HF Radar Gap Analysis SECOORA document (FTEs): One technician/3 sites supervised by Scientists. For Ports and Harbors: One technician/Port or Harbor. Graduate students/postdocs will be responsible for the R&D. The Technician should be supported by a sound DMAC system; Computer and System spares for each site (A redundant system for every 4 sites site or a common pool of system and spares); Security Clearance for technicians to maintain systems in harbors; Regular scheduled maintenance as well as emergency maintenance; Availability of systems for event driven response; Training and retaining technicians as well as students.	

	Land Based High Frequency Radar Systems	Weather/Doppler Radar		
Development Needs, If necessary, describe development efforts required for advancing, operationalizing or refining each of the identified issues.	HFR surface current data is already of sufficient quality (with uncertainty measurements) for operational use such as supporting USCG Search and Rescue and NOAA HAZMAT Spill Response. Improvements to operational parameter settings at all levels of data acquisition and processing can be explored and implemented over time to further improve the quality of the surface current product. Surface wave height time series and perhaps freshwater measurements are considered by the National HFR Network Steering Committee to be of sufficient quality for operational use now, with more research recommended for additional wave parameters such as real time directional wave measurements. Vessel and Tsunami detection is a new product with proven value that needs further research in a sustained testbed to operationalize the detection product for Maritime Domain Awareness applications.	Better integration with National Weather Service and Private sector to aggregate and make available the weather radar data for SE Region atmospheric modelers.		
Synthesis Table for Cost Estimation (Existing and 10 Year Plan)				
Observing Platform	**Number of Radar Systems (Existing and Proposed)**	**Equipment Cost**	**FTEs**	**O&M Costs**
Proposed HF Radar Stations (WERA or CODAR) - 49 Units	49 Total Existing and Proposed	$200K per unit	17.0 FTE HFR Technicians (1.0 FTE HFR Technician per 3 units)	20% Equipment cost
Spare HF Radar Systems	17 spares at a rate of 1 per 3 units	$200K per unit		
Proposed VHF Radar Stations for Ports and Harbors (WERA or CODAR) - 22 Units	22 Total Proposed	$200K per unit	11.0 FTE HFR Technicians (1.0 FTE HFR Technician per every 2 ports or harbors)	20% Equipment cost
Spare HF Radar Systems for Ports and Harbors	11 spares at 1 per port or Harbor	$200K per unit		

SECOORA SATELLITE REMOTE SENSING OBSERVING SUBSYSTEM TEMPLATE

Satellite Remote Sensing Rationale: Satellite remote sensing provides an integrated component of any Coastal Ocean Observing System (COOS), as demonstrated in the most recent oil spill event. The value of the satellite remote sensing component in SECOORA Regional COOS lies in its unique data products tailored just for regional needs by various stakeholders. These products are often difficult or impossible to find elsewhere, as they often result from the most recent research efforts driven by both science and societal needs. This Satellite Subsystem template outlines some example products, sensors and satellite missions (past, present and future). This also emphasizes the need for sustaining and funding existing satellite data reception facilities and operational infrastructure and research /development within the SECOORA region to develop and deliver unique products using satellite data to meet a variety of stake holders needs.

Satellite measured Variables	Data Products	Primary sensors flown on past, current and future satellite missions (Spatial and Temporal Resolution)	Sensors and Satellite Missions (past, current and future Missions)
Sea Surface Temperature	Sea Surface Temperature	AVHRR, MODIS and VIIRS (1 km, Two to Three times daily), GOES and GOES-R (4 km, 15 min), AMSR and AMSR-E (5-50 km, Daily), GLI	AVHRR (NOAA-6-19), MODIS (Terra, Aqua), GOES and GOES-R (GOES), AMSR (ADEOS II) and AMSR-E (Aqua), GLI (ADEOS-II)
Ocean Color	Ocean color and oceanic chlorophyll-a concentration, PAR, primary production euphotic depth, CDOM, turbidity, water clarity (transparency), total suspended matter True Color (RGB)derived from ocean color	MODIS (250 m to 1 km, Daily), MERIS (300 m, every 3 days), SeaWIFS (1 km, daily), CZCS (825m, every 2 days)	MODIS (Terra, Aqua, current), MERIS (Envisat, current), SeaWIFS (orbView-2, 1997-2010), CZCS (Nimbus, 1978-1986)
Sea Level (Ocean Surface Topography) and Sea State	Sea surface height provides insights into ocean circulation, climate, cycles, sea-level rise, and ocean tides. Wave height and other measures of sea state (wave direction, wavelength, time period)	Altimeter (25 km, every 7-8 days), ASAR (30 - 1.2 km, intermittent), SAR (30 - 50m, intermittent)	Altimeter (Jason 1 and 2, Envisat, TOPEX/Poseidon, Poseidon -2), ASAR (Envisat-1), SAR (ERS-1,2, RadarSAT)
Ocean Salinity	Research towards the measurement of changes in sea-surface salinity	Aquarius (150 km, 7-day revisit), MODIS (1 km, Daily), SMOS (200 X 200 km, 10-30 day)	Aquarius (Aquarius SAC-D, current), (MODIS (Terra, Aqua), SMOS (ESA Satellite)
Winds	Ocean Vector Winds (Near sea surface wind speed and direction.	SeaWinds, ASCAT and NSCAT (25 km, >Daily)	SeaWInds (QuickSCAT, ADEOS II), NSCAT (ADEOS),
Other Atmospheric variables	Cloud Properties, Precipitation, Aerosol, Greenhouse gases, Water Vapour	Cloud Properties (Visible/IR imagery and IR/Microwave Soundings); Precipitation (Passive microwave radiances;High-frequency geostationary IR measurements; Active radar (for calibration); Aerosol (VIS/NIR/SWIR radiances); Green house gases (NIR/IR radiances); Water Vapour (Passive microwave radiances; UV/VIS radiances;IR imagery and soundings in the 6.7 µm band; Microwave soundings in the 183 GHz band.	GOES, AVHRR, METEOSAT, TRMM and other future missions
Bathymetry	Shallow-water bathymetry	LIDAR (centimeters, intermittent), SAR (meters, intermittent), Thematic Mapper (30 m, 16-day revisit)	LIDAR (Aircraft missions), SAR (ENVISAT, ERS-2, ALOS/Palsar, RadarSat, COSMO-SkyMed, TerraSAR-X), Thematic Mapper (Landsat Missions)
Theme Issues Addressed	1. Maritime Operations: Safe and efficient commercial shipping and recreational boating, Search and Rescue, Spill Response, Offshore Energy. 2. Climate Variability and Change: Changes in ocean conditions over time. 3. Ecosystems, Fisheries and Water Quality: Healthy & Productive Ecosystems, Sustainable Fisheries, HABS, Hypoxia, Minimizing the Impact from polluted waters. 4. Coastal Hazards: Providing hazard and disaster information when and where it is needed. 5. Integrated Products: Coastal Marine Spatial Planning.		
Geographic Coverage: •	Lakes, Estuaries, Coastal and Open Ocean (Gulf of Mexico, Southeast, Caribbean)		
Existing Data Reception and Data Delivery by Federal Agencies	NESDIS (http://www.osdpd.noaa.gov/ml/index.html) and Ocean Data Products (http://www.osdpd.noaa.gov/ml/ocean/index.html), NASA (http://podaac.jpl.nasa.gov/dataaccess), NOAA National Oceanographic Data Center, USGS and NOAA (LIDAR Data)		
Existing Satellite Data Reception, Delivery by SECOORA Members	Florida State University (Satellite Ground Station - Meteorology), University of South Florida (IMaRS), University of South Florida (Optical Oceanography Virtual Antenna), University of Maimi, University of North Florida, University of South Carolina (AVHRR); ROFFS Integrated Virtual Array		

Satellite measured Variables	Data Products	Primary sensors flown on past, current and future satellite missions (Spatial and Temporal Resolution)	Sensors and Satellite Missions (past, current and future Missions)
Operational Requirements: Deployment / Operations; Maintenance; Personnel; Replacement Needs and Other	Operational support to existing satellite data receiving Stations for data capture and integration; Hardware upgrades to sustain present data collections and to enable reception of data from new satellites to be launched by the U.S. and other nations; 4 Satellite Ground Receiving Stations; Recurring costs include software development and licensing, and the IT and science personnel dedicated to ensuring robust and redundant satellite data reception through coordination between capture sites and other SECOORA observing elements, and dedicated to real-time processing as well as archival, delivery, and integration; Product Development for theme areas (Unique to meet stake holders needs and to fill in existing gaps in products that are produced and made available); Training of Technicians		
Development Needs, If necessary, describe development efforts required for advancing, operationalizing or refining each of the identified issues.	Development and validation of new data products: baseline maps of ocean and estuary variables for stakeholders; mean and anomaly states of ocean and estuary variables, PAR, primary production euphotic depth, CDOM, turbidity, water clarity (transparency), total suspended matter, Particulate organic and inorganic carbon (POC, PIC), cyanobacteria, HABS, Fog, Oceanic Fronts, Internal Waves, Salinity (Experimental), Ocean currents (including Loop Current and eddy detection, tracking and characterization). Efforts required to develop these products vary substantially. Need coordination on Satellite Remote Sensing with neighboring RAs, coordination with RAs and Federal Agencies involved in Satellite Remote Sensing for data acquisition, processing, storage and delivery.		

Observing System Synthesis Table for Cost Estimation

Satellite Ground Stations	FTEs	O&M (Includes antennas, computer systems etc.) and upgrade	Other		
4 Ground Stations within SECOORA region having capabilities to receive necessary data and support product development	8.0 FTE includes 1.0 FTE Remote Sensing Scientist and 1.0 FTE IT Specialist per station.	$500k/year	Training/Conferences - $5k /Year/Staff		

SECOORA MODELING & ANALYSIS SUBSYSTEM TEMPLATE

Modeling Subsystem Rationale: SECOORA region will support and fund a solid numerical modeling framework within SE region (sub regional to regional scales models) to produce and provide modeling products for managers and other users. SECOORA plans to advance modeling/prediction sub-systems that would include: nesting of very high-resolution inner shelf and estuarine models; the coupling of dynamical models (coastal mesoscale meteorological, coastal hydrological, and coastal wave models); the coupling of application models (e.g., eco system, sediment transport, and wave models); and the utilization of advanced numerical modeling methods (e.g., data assimilation schemes, non-hydrostatic models, and unstructured and adaptive grids). The modeling frame work will encompass both comprehensive baroclinic operational circulation models (essential for adjective and turbulent transport estimates, water quality and ecosystem models) and integrated barotropic operational tide, storm surge, and wave models (essential for coastal inundation estimates, sediment transport models).

MODEL REQUIREMENTS

Type of Model	**Atmospheric (hindcast/forecast) - Provides meteorological forcing for circulation, wave models etc. (e.g., WRF)**	**Circulation (Hindcast/Nowcast/Forecast-Estuaries, Coastal, Shelf and deep ocean circulation models (e.g., ROMS, HYCOM, FVCOM, NCOM etc.) and trajectory models**	**Inundation - Very high resolution regional surge/inundation/circulation models/rip currents that addresses coastal hazards and flooding of the land areas**	**Wave**	**Hydrological**	**Sediment Transport**	**Water Quality/Ecosystem**	**Fisheries**
Themes/Issues Addressed	1. Maritime Operations: Safe and efficient commercial shipping and recreational boating, Search and Rescue, Spill Response, Offshore Energy. 2. Climate Variability and Change: Changes in ocean conditions over time. 3. Ecosystems, Fisheries and Water Quality: Healthy & Productive Ecosystems, Sustainable Fisheries, HABS, Hypoxia, Minimizing the Impact from polluted waters. 4. Coastal Hazards: Providing hazard and disaster information when and where it is needed. 5. Integrated Products: Coastal Marine Spatial Planning.							
Geographic Domain (entire region, specific harbor, etc)	Deep ocean, continental shelves, coastal and estuaries in SECOORA foot print							
Modeling forcing needs, verification and data assimilation needs	Forcing needs: High-resolution accurate bottom and coastal topography, mesoscale atmospheric forcing, tidal forcing, open boundary conditions, freshwater fluxes (rivers, precipitation and ground water), surface waves. Typically at 1 hr temporal resolution, 1 km horizontal resolution and 10 m (non-uniform) vertical resolution; Verification and Data Assimilation Needs: SST, winds, pressure, profiles of temperature, salinity and currents, surface currents, waves, salinity, tide gauge data, satellite derived sea surface height etc.							
Operational needs: Computing infrastructure, including redundancy of operations, storage etc	Computing: Adequate computing power (#CPUs) to run proposed models; Assembly and delivery of forcing functions required for models; Storage and delivery of model output; Product development; For the forcing functions and archive SECOORA plans to leverage the existing federal resources. SECOORA plans to address the local archival needs as per product development needs.							
Development Needs	Implementation of variational data assimilation of buoy, HF radar, and satellite observations; Air-sea-wave coupling; refinement of ecosystem model couplings; Improved model interface for better integration with regional observations; Transition from R&D to operational; Better coordination with existing federal modeling efforts such as NOS CO-OPS PORTS Nowcast/Forecast efforts; Training of stake holders (coastal managers); Model skill assessment; Coordination between observations and models; Coordination with SURA test bed activities; Coordination with IOOS on interoperability experiments; Advancing data sharing methods; GIS output delivery methods for marine spatial planning							

Synthesis Table for Cost Estimation

Model Resource Type	**FTEs**	**Computing resources (Hardware, software and storage)**						
Atmospheric/Ocean/Bio-geo-chemical (Total of 5 Model Groups)	10.0 FTEs includes a Model Scientist and IT specialist per model group.	$250k/group						

SECOORA RESEARCH AND DEVELOPMENT SUBSYSTEM TEMPLATE					
Synthesis Table for Cost Estimation					
Overall R&D Need	**Associated Theme**	**Personnel and other costs**	**RA Role**	**Role of Others**	**Adoption Process**
Sponsored workshops to determine stakeholder (which includes federal scientists) requirements for R&D including: (1) Observing requirements related to identifying shifts in species distribution associated with climate variability (2) Coupling of models, such as fish/stock assessment and circulation models; atmospheric and circulation; downscaling, etc. (3) Impact studies on impacts of oil and dispersants (4) Alerts/warnings when ocean conditions may become unfavorable due to changes in ocean acidification	All Thematic Areas	Program Manager to organize and facilitate workshops $25k per workshop for travel, meeting venues	Gather regional information from workshop and help group prioritize needs	Stakeholders to understand what observing system can do and provide feedback on needs the system can provide. Scientists to listen to the needs and provide feedback on the potential for research and approaches.	
Sponsor workshops with industry and members to discuss technology R&D needs including: (1) Telemetry (2) Dissolving sensors (3) Corrosion and bio-fouling (4) Technologies to explore interactions between boundary current and shelf.	Observing Subsystem Elements	RCOOS Manager to organize and facilitate workshops $25k per workshop for travel, meeting venues	Gather regional information from workshop and help group prioritize needs	Scientists to provide feedback on the issues they face with the technologies and their needs for the future. Private sector to listen to the needs and provide feedback on the current options available and ideas on timing for making new technologies operational.	