Integration of Coastal Ocean Observing Systems into Emergency Management in the New York/New Jersey Bight
Acknowledgements

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We consulted with many members from the coastal ocean observing community, emergency managers, atmospheric and oceanic meteorologists and civil service and military personnel. We would like to acknowledge their help and thank them for their time and invaluable information.

Group Members:
Jeb Berman, Jannel Gabriel, Amanda Gambill, Lauren Grochmal, Bek Hamed, Erik Jorgensen, Ashley Mercer, John Toniolo, Kathleen Szleper, Shu Wang, Larron Win

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Executive Summary

Ocean observing technology has the potential to play a central role in aiding emergency management activities across the nation. In light of the economic importance of New York City and the coastal population density of the New York/New Jersey Bight region, the need for accurate storm surge and flooding predictions cannot be understated. The Mid-Atlantic Regional Ocean Observing System (MARCOOS) incorporates ocean-observing data from the New York/New Jersey Bight region into models that can achieve accurate oceanic condition predictions. These models could be profoundly useful for emergency managers in the region. The use of MARCOOS data products in the New York/New Jersey Bight region is potentially limited by communication inefficiencies, liability obstacles, and data standardization barriers.

This report analyzes ocean observing activities, data products, and communication practices in the New York/New Jersey Bight in order to recommend methods for MARCOOS to fill in communication and technological gaps. A comparison of ocean-observing systems throughout the national Integrated Ocean Observing System (IOOS) is the basis for recommendations to MARCOOS to improve the efficiency of their research efforts and applicability of their data products.

Despite the ability of models to accurately predict ocean behavior, many predictive models developed in Regional Ocean Observing Systems remain underutilized due to technological, legal, and information dissemination limitations. The expertise of MARCOOS’ observing activities and modeling efforts are not yet fully accessible for emergency management purposes. The National Weather Service (NWS) is the main source of weather prediction information in the United States, including predictions for major natural disasters. Currently, the NWS cannot integrate CODAR and glider data (central data sources of MARCOOS) into their predictive models because of data incompatibility barriers and thus miss the value of these sources. MARCOOS is also constrained by liability issues, as non-governmental agencies are not afforded the same legal
liability protections as the NWS in predicting weather patterns. As a result, MARCOOS is open to liability claims in civil court proceedings for incorrect predictions. Further, due to nascent communication networks between MARCOOS and stakeholders, MARCOOS has not fully established all valuable partnerships. This limits MARCOOS’ ability to engage with and tailor data products for their users.

Within the framework of the constraints listed above, we examine ways in which MARCOOS can bridge the organizational and technological gaps that currently inhibit the development and utility of its data products within the New York/New Jersey Bight Region. We provide the following recommendations for MARCOOS:

- Conduct a stakeholder and user needs analysis of a broader range of users in the entire MARCOOS region. This will increase opportunities to form partnerships with unique users that are not currently using MARCOOS models.
- Initiate new pilot projects to limit the scope of new initiatives and increase the likelihood of successful implementation. Once successful, continue to develop these pilot projects into larger scale applications.
- Standardize MARCOOS data. Standardizing data will allow for more efficient development of MARCOOS’ models as well as facilitate regional ocean observing research and development.
- Create a more user-friendly web interface, which can include the integration of the currently separate MARCOOS observing website with the regional association (MACOORA) website.
  - Create niches for modeling efforts outside of emergency management in order to broaden the spectrum of applications for MARCOOS’ data products.
  - Improve formal and informal communication, both internally and externally. Increases in communication between modelers, between regional associations and stakeholders, and between regional ocean-observing associations nationally will facilitate MARCOOS research and development.
The world’s ocean covers seventy percent of the earth’s surface. The United States (US) borders this ocean along a 12,380-mile coastline and, for 200 miles seaward, maintains jurisdiction over the world’s largest Exclusive Economic Zone (EEZ). This EEZ is bigger than the US’ landmass. The marine ecosystems in the US EEZ range from coral reefs in the Caribbean and Central Pacific to rocky shores in Alaska and the Gulf of Maine. It is a diverse interconnected marine ecosystem, which provides a wide variety of goods and services for human benefit. A 2000 study conducted by the US Commission on Ocean Policy estimated that the services of coastal and marine ecosystems, including fisheries, transportation and recreation, generate one-tenth of US GDP at a value of roughly $1 trillion. They also estimate that:

- The United States fishing industry exceeds 28 billion dollars annually.
- Seven hundred billion dollars of goods enters the United States through coastal seaports.
- Tourism is the fastest growing US business sector, with coastal recreation responsible for an important portion of this increase.

With all of these benefits at hand, more than half of the US population resides near coastal zones with many major urban centers (e.g. New York City, Los Angeles, Miami) sitting directly on the ocean’s edge.

The importance of marine and coastal environments to the ecology, economy, national security and culture of the United States cannot be understated. The ocean’s central role has long motivated efforts to understand and predict the physical, chemical and biological conditions of coastal areas. Initially conceived by the United States Navy and academic researchers, ocean observing systems use remote sensing and in-situ technology to observe, model and predict wind, waves, temperatures and other oceanic variables. While the Navy remains involved in ocean observing for national security purposes, a new wave of ocean observing system users including: fishermen, emergency

“America is a nation intrinsically connected to and immensely reliant on the ocean.”

managers and common beach enthusiasts. They have all responded enthusiastically to the developments in real-time observing technology that help assess and predict ocean conditions.

Ocean observing systems also provide opportunities to better understand and predict some of the negative impacts in coastal regions, especially from storms and hurricanes, which are fueled by ocean conditions. During these events, coastal areas are susceptible to storm surge as the ocean water reaches the coastline and is pushed inland, causing flooding. Such events have serious economic impacts and can cost lives. For example, in a major US city like New York City potential flood damage estimates show storm surge from a level 4 hurricane could cause total direct and indirect losses in Gross Regional Product estimated to total between 28.6 to 42 billion dollars.

The modeling tools and data inputs used in ocean observing systems can allow scientists to forecast future conditions of coastal waters. Such information can be vital to emergency and coastal zone managers involved in planning and organizing emergency responses to storms and hurricanes. Ocean observing systems can offer advanced and increasingly precise warnings for disasters, which can facilitate appropriate mitigation protocols. Because ocean observing systems can also provide data and information on the direction of ocean currents, other beneficial applications include forecasting the spread of hazardous ocean events like an oil spill or a harmful algal bloom, which may help with containment strategies.

In light of many of these benefits, over the past decade ocean observing programs have received increasing federal support and recognition. The recommendations of the Pew Oceans Commission and US Commission on Ocean Policy, published in 2003 and 2004, respectively, both emphasized the importance of ocean observing capabilities. These documents informed creation of President Bush’s Ocean Action Plan (OAP), released in 2004, which provided for a multi-agency ocean governance structure under the President’s Council on Environmental Quality. Established by 10 cooperative federal agencies, the Inter-agency Working Group on Ocean Observations is part of the governance structure envisioned by the OAP and manages “Ocean.US,” the National Office for Integrated and Sustained Ocean Observations.

Ocean.US is responsible for coordinating all ocean observing in the United States into a coherent, integrated ocean observing system. The National Oceanic and Atmospheric Administration (NOAA) has many resources to contribute in developing an Integrated Ocean Observing System (IOOS). NOAA’s IOOS program office is chiefly concerned with establishing a national data management and communications backbone for coastal ocean observations and integrating legacy ocean observing systems (e.g. National Weather Service, National Data Buoy Center) into the new framework. NOAA’s observational capabilities in coastal areas are enhanced by a network of 11 Regional Coastal Ocean Observing Systems (RCOOS). These regional entities work under the guidance of Ocean.US and NOAA but are largely independent in their decision-making. Although IOOS’ authorizing legislation refers to RCOOS, many regions have developed Regional Associations (RAs) that bring industry, non-profit, state, local and Federal partners together to manage ocean observing systems in the region.

**MARCOOS & MACOORA**

The Mid-Atlantic IOOS region includes: Massachusetts & Rhode Island Bays, Long Island Sound, New York/ New Jersey Bight, Delaware Bay and Chesapeake Bay. The Mid-Atlantic Regional Coastal Ocean Observing System (MARCOOS) and its regional association, the Mid-Atlantic Coastal Ocean Observing
Regional Association (MACOORA), are together responsible for ocean observing in the Mid-Atlantic.

Report Overview

This report examines three distinct areas that affect the integration of MARCOOS technology into coastal ocean emergency management in the New York/New Jersey Bight region. The three key sections of this report discuss:

1. **Ocean observing technology and agencies in the New York/New Jersey Bight.** This will provide an understanding of the technical aspects of obtaining the ocean data and developing predictive forecasts.

2. **Coastal zone emergency management in the New York/New Jersey Bight.** An analysis of emergency communication pathways during hurricanes, storm surges and spills will help to highlight potential avenues for MARCOOS’ integration.

3. **Best practices and lessons learned from Regional Coastal Ocean Observing Systems outside the Mid-Atlantic.** An overview of Regional Associations and their implementation strategies present important lessons learned that can be used in the future by MARCOOS.

We present each of these sections as a part of this report, but they are also designed to be stand-alone background documents on key considerations for integrating information from MARCOOS into emergency management in the New York/New Jersey Bight. Combined, the three sections represent a comprehensive backbone that informs the recommendations provided for MARCOOS in the final section.
The analysis and findings in each section were informed by 45 consultations and informational interviews with various professionals. The primary sources are listed below, by section:

**Section 1: Ocean Observing Technology:**
- Principal investigators of the observing technology
- Ocean observing predictive modelers
- National Weather Service (NWS) data technicians

**Section 2: Emergency Management**
- County emergency managers

**Section 3: Coastal Ocean Observing Systems**
- Ocean Observing Systems’ executive directors
- Ocean Observing Systems’ pilot study managers
- Ocean Observing Systems’ public relations officers

Figure 1: The New York/New Jersey Bight
The science of ocean and atmospheric forecasting involves many complex and technical processes, which can be classified into three main phases: observation and data collection, data assimilation, and forecast prediction and dissemination.

To begin the process, ocean and atmospheric weather conditions must first be observed with accurate and reliable technology. Traditionally these technologies consisted of buoys, weather balloons and standard equipment such as anemometers, thermometers and barometers. Advancements now allow meteorologists to make more precise observations using satellites and radars. More recent advancements in the field of ocean observing have expanded observing technologies, as discussed in the following section. Data may in fact come from a wide variety of sources, such as the U.S. Voluntary Observing Ship (VOS) program, in which weather data is collected from transit ships during the course of their travels.

In the second phase of weather forecasting, observations of current oceanic and atmospheric conditions are gathered from
multiple sources and fed into supercomputers to create forecasts using weather prediction models. Numerical weather prediction models are used to generate predictions of future oceanic and atmospheric conditions based on current conditions within the region. Global models are used to establish the boundary conditions for the area within which the forecast is made. The observations are also used to verify the precision of the forecasts and allow modelers to make necessary adjustments for enhanced accuracy.

Once the second phase of the forecasting process is completed, forecasts must be distributed to the appropriate users. This means that the data must be readily accessible, and displayed in a form that is understood by the average user. The format is often adapted to suit a target audience; for example, a more technical form will be presented to other modelers, while a more user-friendly version will be used for the general public. The overall forecasting process is generalized in Figure 1.

Figure 1 shows the dynamic interaction between the ocean observing system, the prediction models and the system of data dissemination. During this process observations of marine and atmospheric conditions are collected, analyzed and processed to create nowcasts and forecasts and then distributed to the general public. Adapted from Urban Ocean Observatory at the Center for Maritime Systems at Stevens Institute of Technology.
Observation & Data Collection

Technologies and Parameters Monitored

This section describes the technologies used to monitor ocean and atmospheric conditions in the New York/New Jersey Bight and the specific parameters that these technologies are capable of accurately observing.

Satellites

Geostationary Satellites (GOES)
GOES satellites capture visible light, water vapor, and infrared images. GOES satellites circle the earth once every 24 hours; they hover 22,236 miles above earth’s surface, which creates a stationary appearance. The satellites use both image and sound to collect data and can be used to generate a host of different products.¹ The images can produce information on: surface albedo, surface insolation, cloud top pressure (CTP), 20 day clear sky composite, cloud albedo, cloud cover, and 11µm-3.9 µm (fog). The sounds can produce information on surface skin temperature, total precipitable water, as well as CO₂ slicing CTP.² The US operates two meteorological GEOS satellites, one for the east coast and one for the west coast.

Polar Orbiting Satellites (POES)
Polar orbiting satellites circle the earth at about 520 miles above the earth’s surface and make 14.1 polar orbits a day. Since this is not an integer number two morning and evening satellites are required, this also means that no two images are from the same location.³ They provide excellent detailed views of the polar region and cover the globe four times a day.⁴

Buoys

Weather buoys are floating devices used to collect data on air temperature at the ocean surface, water temperature, wave height, dominant wave period, barometric pressure, wind speed and wind direction. The data is conveyed to weather centers via satellite transmission. National Data Buoy Center (NDBC) uses both moored and drifting buoys to create operational weather and ocean forecasts, and provide information for legal proceedings, scientific research and responding to chemical spills.⁶
Radar

Coastal Ocean Dynamics Applications Radar (CODAR)

CODAR is a High Frequency (HF) radar system that measures ocean surface currents and is able to develop a complete map of ocean currents. Each HF radar station contains two antennas and a small 6’ x 8’ shed. One antenna transmits a 40-watt signal and the other receives the returned signals. This information can provide safe and efficient navigation, oil and hazardous material spill trajectories, search and rescue help, and scientific research information.

Autonomous Underwater Vehicles or Gliders

These vehicles are approximately 64 inches long and weight as little as 92 pounds. They are designed to operate without humans on board and so can explore a wider oceanic range. An example of an underwater vehicle is the Remote Environmental Monitoring Units (REMUS), a glider created by the Office of Naval Research. The gliders travel along the coast and reach depths of 14,764 feet or more, including underneath ice. They provide useful information on sea-floor conditions, including data on:

- Acoustic Doppler Current Profiling (ADCP),
- Optical backscatter
- Conductivity
- Temperature
- Navigation data
- Sound speed
- Bathymetry

REMUS Gliders are also used by the military for detecting mines. Woods Hole Oceanographic Institute has a variety of such vehicles at its disposal.

Rutgers University Gliders:
Rutgers University maintains a fleet of underwater gliders that can travel from the Atlantic coast to the continental shelf (approximately 120 kilometers) collecting steady information on temperature, salinity, light absorption and light scattering.
Expendable Bathythermographs (XBTs)

A XBT is a probe that is dropped from a ship and measures the temperature of the water as it falls. Typically, the temperature is read every 2 meters, and the information is carried along a copper wire in the XBT. It is designed to fall at a known rate, so the depth can be calculated. This is the primary means used to obtain data on ocean conditions under the VOS system.

Observation & Data Collection

Institutions

Various organizations and institutions currently conduct oceanic and atmospheric observations within the New York/New Jersey Bight. This section represents an inventory of their efforts. The data presented was compiled through rigorous Internet research and communications with modelers at institutions such as the National Weather Service, Stevens Institute of Technology, Rutgers University, State University of New York at Stonybrook and the University of Connecticut. Also included is the work of other governmental and educational organizations, which do not run forecast models, but provide observational data significant to understanding the coastal and atmospheric dynamics of the region.
Federal Ocean Observing Institutions

National Weather Service (NWS)
The NWS is one of six line offices within the National Oceanic and Atmospheric Administration (NOAA). In the Mid-Atlantic region, there are five local forecast offices: Mt Holly, NJ, Upton, NY, Taunton, MA, Sterling, MD, Wakefield, VA.

These offices observe oceanic and atmospheric parameters in the New York/New Jersey Bight. The NWS is the primary source for weather, hydrologic, and climate forecasts and warnings for the US. The data and products provided are amalgamated in the National Climate Data Center (NCDC), a national information database and infrastructure that can be used by other governmental agencies, private companies, and the public. As seen in the figure below, the NWS collects data from sources such as National Data Buoy Center buoys, observations from major universities in the region, the NJ DEP, and the Barnegat Bay National Estuary Program (NEP).

The National Weather Service model incorporates data from the various collection systems and runs it through multiple models to create numerous predictions, which can then be compared to each other. One such model is the North American Mesoscale (NAM) model for regional ocean forecasts. NAM is the terminology used to describe whichever regional scale model is being used by NCEP. At present, the model being used is the Weather Research Forecast model (WRF).

WRF is a 3-dimensional variational data assimilation mesoscale model. This model predicts and simulates with a high level of accuracy- atmospheric conditions on a regional level at scales ranging from meters to thousands of kilometers. WRF has been designed to improve, not only the reliability of ocean forecasts, but also to develop a better comprehension of the way the atmosphere behaves and the observations that are made. This results in improved communications between atmospheric scientists and modelers. There are several different variations of the model used by agencies such as the National Center for Environmental Prediction (NCEP) and the National Center for Atmospheric Research (NCAR).

In addition, the NWS also uses the Harvard Ocean Prediction System (HOPS), a primitive-equation dynamical model providing nowcasts and forecasts on a regional scale. It has the capacity to
operate as a stand-alone system using data gathered from ships only. However, the standard configuration of HOPS assimilates biological, physical and acoustical data from several sources, including NDBC, to create predictions of ocean conditions. HOPS is valued in multidisciplinary oceanographic research as it provides a basis for integrating realistic, coupled physical-biogeochemical model simulations of ocean conditions, and estimating future conditions.

Figure 3 & 4: The increase in the National Weather Service’s spatial coverage of the New York Bight when data collected by universities and research institutions are included.

National Data Buoy Center (NDBC)
NWS works closely with the National Data Buoy Center (NDBC), another NOAA agency. The NDBC is responsible for managing the development, operations, and maintenance of a national buoy network. This network provides meteorological and environmental data in real time and also operates a Coastal-Marine Automated Network (C-MAN). The buoys can provide information on parameters such as sea surface winds, temperature, salinity, waves, and currents.

NOAA’s Hurricane Center
The hurricane center is a sector of NOAA that aims to save lives and mitigate property loss by issuing the best warnings and forecasts of hazardous tropical weather. NHC runs a series of models ranging in complexity (dynamical or statistical), spatial scale (global or regional) and run time (6 or 12 hours).
Rutgers University Coastal Ocean Observing Laboratory (RUCOOL)
The Rutgers University Coastal Ocean Observing Laboratory collects marine and coastal area data for the Mid-Atlantic coastal region, using satellite, CODAR, underwater glider, and seafloor cabled observatory data.¹⁹

All data collected is run through the Regional Ocean Modeling System (ROMS), a primitive-equation, free surface, hydrostatic model, developed and implemented by the university. ROMS has been expanded from a previously existing format to include a variety of new features including high-order advection schemes, accurate pressure gradient algorithms, parameterizations, atmospheric, oceanic, and benthic boundary layers, biological modules, radiation boundary conditions, and data assimilation.

Stevens Institute of Technology
The Center for Maritime Studies at the Stevens Institute of Technology is a leader in advanced ocean observing technology, generating high-resolution observations and creating accurate forecasts. The Institute has three main research divisions including the renowned Davidson Laboratory, which integrates coastal and ocean engineering, physical oceanography, marine hydrodynamics and maritime security to address the data needs of the New York/New Jersey maritime community.¹⁷

In collaboration with the Office of Naval Research, Steven’s Institute has developed NYHOPS- The New York Harbor Observing Prediction System.¹⁸ The NYHOPS model forecasts waves, winds, currents, temperatures and salinities for the New York/New Jersey Bight within a 48-hour time frame. It also produces real-time data on these parameters. Fishermen, port workers, recreational beach users and emergency response officials use predictions made by the NYHOPS model.

University of Connecticut
The University of Connecticut is responsible for providing real-time data on the quality of water in the Long Island Sound as part of the MYSound Project (Monitor Your Sound). This project is funded by NOAA, and uses a series of telemetering data buoys stationed around the Sound to collect data on water temperature, salinity and dissolved oxygen. The data collected is incorporated into the Long Island Sound Integrated Coastal Observing System (LISICOS) in an attempt to understand and predict changes in this sensitive estuarine environment as a result of natural and human driven activity.

University of Massachusetts
The School for Marine Science and Technology (SMAST) at the University of Massachusetts at Dartmouth also has ocean-modeling capabilities and runs a ROMS model for the North Atlantic. They also run what is called FORMS, or feature-oriented regional modeling system, which incorporates currents, eddies, jets and other persistent features.²⁰
Marine Technology
Coastal Ocean Observing System (MARCOOS)

MARCOOS is an integrated ocean observing system that combines data from satellites, CODAR and gliders to create forecasts of ocean conditions within the New York/New Jersey Bight. The primary goal is to assist in enhancing maritime safety in the Bight and to provide ecological decision support to fisheries managers and marine ecologists.

The data collected from MARCOOS’ CODAR and gliders complies with Global Meteorological Standards. This differs from the formats used by the NWS and surrounding coastal ocean observing systems. MARCOOS uses NYHOPS, HOPS and ROMS to generate three unique ocean predictions based on the observed regional conditions. These are then compared and used to estimate uncertainty of the final forecast. The Global Forecast System (GFS) is used to predict the global boundaries for the region within which the prediction is being made. MARCOOS’ observation system is unique in the fact that it assimilates high-resolution data from CODAR and gliders, thus enhancing its accuracy and predictive capabilities.
Forecast Model Types

Forecast models are computer programs that predict the circulation and conditions of the ocean and atmosphere. They generally use equations to simulate the behavior of ocean and atmospheric systems but use different techniques to solve these equations, thus creating forecasts. Some examples include:

- **Dynamical models** which use mathematical equations governing the behavior of the atmosphere. Their sources of error lie in a lack of complete knowledge of initial atmospheric conditions, which reflects a lack of data.
- **Global models** which solve mathematical equations about the atmosphere at every point on the globe. Four common global forecast models are GFDL, GFS, UKMET, and NOGAPS.
- **Regional dynamical models** which monitor a specific area on the globe. They provide a clearer and more accurate prediction within the specified region in comparison to the global model.
- **Statistical models** which do not try to solve mathematical equations on a grid. Instead, they use information from extrapolation of observed parameters to predict future behavior of the system. The advantage of these statistical models is that they are fast to run and can provide output in a few minutes e.g. STPS (Short Term Prediction System).

In order to enhance the output of their models, modelers assimilate data from as many available sources as possible. There are two main criteria for selecting sources to be incorporated: compatibility and accuracy.

![Figure 5: Forecast models are designed to use data from the previous day, or a hindcast, as well as data from the current day, or a nowcast, in order to project atmospheric and oceanic variables in the future. This method allows for models to readjust and correct themselves every time a forecast is produced. Figure 5 shows an example of this process for a 2 day forecast.](image-url)
## Modeling Parameters

A summary of the major institutions that produce atmospheric and oceanic forecast models in the NY/NJ Bight, the technologies and models that they use, as well as the specific parameters that they monitor is placed below.

<table>
<thead>
<tr>
<th>Organization</th>
<th>Model</th>
<th>Technologies Used</th>
<th>Air Pressure</th>
<th>Atmospheric Temperature</th>
<th>Precipitation</th>
<th>Wind Speed</th>
<th>Water Vapor</th>
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<td>WRF</td>
<td>Buoys, Weather Stations, Satellite, Observations by</td>
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<td>UConn</td>
<td>LISICOS, MiTgcm, STPS</td>
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<td>Stevens Institute of Technology</td>
<td>NYHOPS</td>
<td>Same as NWS along with CODAR and Gliders</td>
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<tr>
<td>SUNY Stony Brook</td>
<td>MMS</td>
<td>2 Buoys, 6 Sea Cats</td>
<td>X</td>
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<tr>
<td>Rutgers</td>
<td>ROMS</td>
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## Oceanic Parameters

<table>
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<th>Model</th>
<th>Technologies Used</th>
<th>Bathymetry</th>
<th>Chlorophyll Concentration</th>
<th>Current Direction</th>
<th>Current Speed</th>
<th>Salinity</th>
<th>Sea Surface Temp</th>
<th>Voroscity</th>
<th>Wave Direction</th>
<th>Wave Height</th>
<th>Wave Period</th>
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<td>MARCOOS</td>
<td>UMass HOPS, Rutgers HOPS, Stevens NYHOPS</td>
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Emergency Management Related Models

Other models used in the Bight to track weather events and assist emergency response managers include HURREVAC, SLOSH, GNOME and HAZUS.

HURREVAC or Hurricane Evacuation is a computer program that tracks the movement and development of hurricanes. The program provides data on discrete regions of the country and thus assists government emergency managers in making decisions for their communities under a hurricane threat. The program plots maps using information from the National Hurricane Center to estimate when various evacuation decisions should be made. It provides timing decisions on the arrival of gale force winds, clearance times, and predicted evacuation times. The model is available at: http://www.hurrevac.com/about.htm

The Sea, Lake and Overland Surges from Hurricanes or SLOSH model, predicts the impact that hurricanes will have on storm surge heights and winds. This allows disaster preparedness officials to anticipate inundation in affected areas. SLOSH also provides insurance companies with data to make various decisions. The models are produced on a house-by-house, street-by-street basis for the different categories of hurricanes. There is room to improve this model with current real-time data in order to determine inundation prior to an event occurring.

The General NOAA Oil Modeling Environment (GNOME) is the oil-spill model used by NOAA’s Office of Response and Restoration (OR&R) to project the trajectory of oil spills using real time weather and ocean data. Research is being conducted to improve the capacity of the GNOME in the New York Harbor. The model was created by NOAA and is available for download, at no cost to the public at: www.response.restoration.noaa.gov.

The HAZUS is a regional multi-hazard loss estimation model that was developed by FEMA and the National Institute of Building Sciences. The primary purpose of the software is to provide calculations for multi-hazard losses at a regional scale. Local, state and regional officials can use these data products to plan, strategize, and reduce risks from multiple hazards. Emergency response and recovery plans can be produced as well.

Distribution of Forecasts

Steven’s Institute has a readily accessible and easy-to-use forecast distribution system which allows the users to log onto their website and select which parameters they would like to view. This provides customized and individualized service and ensures that users only get the information they request.

Rutgers University also has a comprehensive means of displaying data products and forecast information to users.

MARCOOS products are currently shared through Open-source Project for a Network Data Access Protocol (OPeNDAP). This software system allows remote access to data regardless of its storage format. This is particularly useful for facilitating information sharing in scientific environments.
Analysis

Coverage
The map on the following page shows the current range of different technologies used in the New York/New Jersey Bight. As discussed previously, these technologies are highly sophisticated and can confidently produce observations of the conditions in the regions with very high resolution in some cases. The full range of atmospheric conditions observed by these technologies includes:

- Ambient temperature,
- Barometric pressure,
- Dew point,
- Pressure
- Tendency
- Wind speed,
- Wind direction,
- Air pressure and
- Relative humidity

Parameters covered in coastal marine observations include:

- Sea surface temperature,
- Water level,
- pH,
- Chlorophyll-a,
- Concentration,
- Turbidity,
- Dissolved oxygen,
- Salinity,
- Dominant Wave height,
- Average wave period,
- Mean average wave direction

As the map shows, the combined efforts of the various institutions have resulted in thorough and sufficient spatial coverage of atmospheric parameters for the region. However there is room for improved collection of marine parameters such as chlorophyll-a, salinity, bathymetry, and wave data.

Conversations with modelers have revealed that the level of accuracy with which salinity and visibility are currently being observed is insufficient and needs improvement. This is due in part to the nature of the parameters being observed as well as the technological sophistication of the tools being used to collect the data. For example, ocean visibility relies on observations made by common U.S. citizens and persons on ships.

Data Assimilation Issues
Relevant data collected by gliders and CODAR are not assimilated into the NWS weather forecasting models due to issues with data format incompatibility. The gliders have the potential to collect high-resolution ocean data, and measure multiple parameters. The CODAR is also very useful in providing direction of currents, speed, and wave height information, all of which are not being used by the NWS. CODAR can also provide a variety of short range, high-resolution data as well as long range, moderate resolution data. This information has the ability to be assimilated into ocean prediction models and provide for users in the region. The process required to convert glider and CODAR data into a format that can be used by the NWS is an activity that currently is not undertaken. It may be a difficult and expensive venture to fully incorporate this data into the NWS. As well, there currently is not a fully coupled ocean atmosphere prediction model that can fully utilize this data.

The existence of a national standard for data formatting would prevent such incompatibility issues from arising in the future and allow useful high-resolution data to be incorporated into the NWS forecast systems. Currently work is being done to develop such standards.
Figure 8: Data collection sights across the entire Mid-Atlantic region for the NWS (white), and MACOOS CODAR collection sights (blue). As well, the area in which autonomous gliders can cover (brown).

Figure 9: Data collection from sites used by the NWS

Figure 10: CODAR data collection stations (blue) and the potential glider coverage area in the Bight (brown). This data is not collected by the NWS.
Lessons Learned

Developing an inventory of the ocean and atmospheric observing projects and technologies currently available in the NY/NJ Bight is a valuable tool for modelers. This report represents a preliminary composite of the region. In light of rapidly developing observing technologies, it is essential that modelers remain knowledgeable about these resources. This can be done by initializing and participating in information sharing initiatives among modelers at regional observing systems.

Modelers should continue open sharing of non-proprietary information, via systems such as OPeNDAP. This also reduces redundancy and allows observing systems the ability to make decisions on the most beneficial allocation of resources. Formal and informal communication among modelers promotes more creative solutions for ocean observing. Annual workshops and formal conferences within academic institutions and professional associations provide a locale for this information exchange. Increases in these opportunities will facilitate the sharing of each area’s successes and modeling needs, and provide a chance for modelers to learn about the capacities of other experts in the field.

A common issue in data management involves challenges with data assimilation from various sources. The current lack of data standard(s) to format the output from gliders and CODAR render it difficult to assimilate with other agencies or ocean observing systems. NWS has a historic standard that must be matched in order to integrate ocean-observing data into their models. This may require continuing research on viable, fully coupled ocean modeling systems that would use all the useful parameters of the data collected by gliders and CODAR, not just a very limited amount. Another data standard option is to work with surrounding COOSs to develop towards their standards. For example: working with SECOORA to better track hurricanes originating in the South, and establishing fixed standards for CODAR data formats like MARCOOS’ current collaborations with the University of Rhode Island.

High-resolution data collected from gliders may be able to monitor poorly collected parameters such as salinity and visibility. The result would be better coverage of the parameters as well as maximizing glider potential. They can also be used in emergency response management projects. For instance, they can be used to monitor chemical spills, providing real-time, on-site data, which would be extremely useful to emergency response crews. They can also be used to improve the input and accuracy of GNOME and inundation models, which are currently unable to give real time forecasts.

Data and product presentation varies considerably between agencies that work within the Bight. The main considerations for designing a data dissemination system should be ease of use, clarity of data products and adaptability to user needs. Confusing terminology and technical, unappealing fonts should be avoided. The Rutgers University and Stevens Institute websites have been cited as good benchmarks as they display all of these characteristics. Maps provide an easy way to inform the public of data products. Display maps have been used by SEACOOS and GOMOOS with great success.
Footnotes

6 National Data Buoy Center Buoy Program. 10 April, 2008 <http://seaboard.ndbc.noaa.gov/mooredbuoy.shtml>.
16 Stevens Institute of Technology <http://hudson.dl.stevens-tech.edu/maritimeforecast/info/> 12 April, 2008.
19 School of Marine Science and Technology. Oceanographic Modeling and Analysis Laboratory. 12 April, 2008 <http://www.smast.umassd.edu/modeling/>.
20 Jeff Tongue, NWS – Upton Office.

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Page 7: Jeff Tongue – NWS Upton Office
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MARCOOS is developing a number of data products that provide information on hurricanes, storm surges and marine spills. The creation and integration of these products into emergency management is an organizational priority for MARCOOS, as the system already provides information for maritime safety operations. In the MARCOOS coastal region, these data products provide high-resolution and detailed predictions for emergency managers and emergency preparedness organizations. This represents an important user group in need of ocean-observing data products. Here we describe the ways in which ocean observing and weather prediction information are currently being used and are communicated between the agencies responsible for emergency and coastal management in the New York/New Jersey Bight. In particular, the focus is on the emergency communication of hurricane, storm surge and hazardous marine spill information.
Agencies in the New York/New Jersey Bight

The primary emergency and coastal management agencies with responsibilities for coastal incidents in the New York/New Jersey Bight area are:

**Federal Agencies**

Federal Emergency Management Agency
National Oceanic and Atmospheric Administration
- National Weather Service (NWS)
  - National Hurricane Center (NHC)
- Center for Operational Oceanographic Products and Services (NOAA CO-OPS)
- Emergency Response Division (NOAA ERD)

United States Coast Guard
United State Army Corps of Engineers

**State Agencies**

New Jersey State Police
- New Jersey Office of Emergency Management (NJOEM)

New Jersey County Office of Emergency Managers
New York State Emergency Management Office
New York City Office of Emergency Management

**County Agencies**

Westchester County Department of Emergency Services
Municipal Office of Emergency Management
- Atlantic County OEM
- Bergen County OEM
- Burlington County OEM
- Cape May County OEM
- Cumberland County OEM
- Essex County OEM
- Hudson County OEM
- Middlesex County OEM
- Monmouth County OEM
- Nassau County OEM
- Ocean County OEM
- Suffolk County OEM
- Union County OEM
Emergency Management Communication

We consulted with emergency agencies in order to understand the nature and flow of communications pertaining to hurricane, storm surge and hazardous marine spill information. These agencies are involved in providing, receiving and responding to this information in the New York/New Jersey coastal region. Those providing the information include a number of divisions that are under NOAA, such as the NWS, Emergency Response Division (within the NOAA Ocean Service Office of Response and Restoration) and the Center for Operational Oceanographic Products and Services. The agencies we consulted that receive and respond to coastal weather and observation information included state, city and county emergency managers, as well as the US Coast Guard and the US Army Corps of Engineers.

Legal and Policy Framework

Emergency and coastal management agencies in the New York/New Jersey Bight are subject to a number of legal regulations and policies. The legislative authorities for emergency management at the US Federal level, New York State and New Jersey State levels are included in Appendix 3. This section takes a brief look at the requirements regulations for the operation of emergency communications in the New York/New Jersey Bight. This includes: incident management systems, provisions for ‘home rule,’ and the liability issues involved in providing predictive weather information. This allows us to better understand the formal context in which emergency and coastal management agencies operate.

“I ALWAYS TRIED TO TURN EVERY DISASTER INTO AN OPPORTUNITY.”

-John Rockefeller
Incident Management Systems

The National Incident Management System (NIMS)

After the September 11, 2001 attacks on the World Trade Center and the Pentagon, a number of steps were taken to improve prevention, preparedness, response, recovery and mitigation capabilities and coordination processes across the country. The National Incident Management System (NIMS) was developed to provide a consistent framework for incident management at all jurisdictional levels regardless of the cause, size or complexity of the incident. This framework forms a basis for interoperability and compatibility that aims to enable a diverse set of public and private organizations to conduct well-integrated and effective incident management operations. NIMS lays out guidance for communications and information management, however, there is much more work to be done on common communications and data standards. NIMS provides that national interoperable communications standards are to be developed by the NIMS Integration Center in partnership with recognized standards development organizations.

Federal Level

State Level

Homeland Security Presidential Directive 5 makes the adoption of NIMS a prerequisite for State and local governments to receive federal preparedness assistance.

New Jersey Executive Order 50 establishes NIMS as the incident management system for the State of New Jersey. In addition, the New Jersey Office of Emergency Management has released a set of directives that implement NIMS for the state of New Jersey.

New York State has adopted NIMS pursuant to Executive Order 26.1 and recently released the State of New York NIMS 2008 Implementation Strategy. The Strategy includes the NIMS compliance requirements for all levels of government in New York State for Fiscal Year (FY) 2008, and projects compliance objectives for FY 2009 and FY 2010.

For FY 2008, the Implementation Strategy emphasizes the application of common and consistent terminology and the presentation of consistent and accurate information during incidents. In FY 2009 and beyond, the communications requirements become more specific, with requirements to develop and institute procedures and protocols for standardized data collection, analysis and communication.

City Level

New York City (CIMS)

The New York Citywide Incident Management System (CIMS) Protocol is New York City’s implementation of the National Incident Management System (NIMS). While CIMS has been developed to address New York City’s unique incident management requirements, its full compliance with NIMS ensures compatibility with incident command systems in use in other states and federal agencies. CIMS is also designed to be scalable, facilitating the integration of additional organizations, such as private sector and non-profit entities. In the event of a weather emergency or natural disaster, CIMS designates a unified command structure, and identifies the following as primary agencies: the New York City Office of Emergency Management, the New York Police Department, the Fire Department of New York, New York City Department of...
Legal Considerations

Home rule provisions
Constitutional and legislative provisions in both New York and New Jersey, provide authority for ‘home rule.’ Home rule, as provided for in the New Jersey Home Rule Act 1917, is the “intention to give all municipalities... the fullest and most complete powers possible over the internal affairs of such municipalities for local self-government.”

In practice, this means that local agencies have control over an emergency incident unless the incident affects other jurisdictions, and/or incident response exceeds the capacity of the municipality. NIMS also recognizes that most incidents are typically handled on a daily basis by a single jurisdiction at the local level.\(^4\)

Liability
The Federal Torts Claims Act limits tort liability for any negligent or intentional misrepresentation by employees of the US government. In addition, the Act limits Federal liability for any “discretionary function” of government, which courts have interpreted to include weather forecasts.\(^5\) NOAA and NWS are therefore protected against lawsuits resulting from the provision of weather and ocean information. As a non-government entity, MARCOOS may be protected from liability issues by delivering predictive information through NWS. However, there are a number of other considerations to be taken into account when determining the best method for disseminating weather and ocean prediction and observation information.

Despite not being covered from liability by this exemption, many commercial providers also provide weather forecast information. Commercial vendors limit their liability through the use of disclaimers, and may additionally purchase liability insurance.\(^6\) Given this, it may be satisfactory for MARCOOS to take similar protective measures and provide predictive and observing information on this basis.

Figure 1: Inundation flood map of the Carolina Coast
Case Study: Metropolitan Transit Authority Storm Report

On the morning of August 8, 2007 – during morning rush hour, the New York metro area suffered a severe storm that brought with it heavy rains and flooding and the first tornados to hit parts of Brooklyn in over 100 years. MTA subways, buses, commuter railroads and connecting roadways to Bridges and Tunnels facilities were overcome by flooding. By mid-morning, over two and a half million transit customers were affected. Following this weather-related disruption of MTA service, the Governor of New York directed the MTA to assess the agency’s performance and vulnerability.

The MTA set up a taskforce to conduct the assessment. As part of their review, the taskforce made the following findings related to prediction and communication:

• The storm was not predicted early enough by weather forecasters, hindering the MTA’s response.
• Communication across agencies was not as well-coordinated, efficient, and frequent as it could have been.
• Customers did not always have access to accurate information in stations.
• Customers lacked access to real-time service information on the go.
• Many customers had difficulty accessing the MTA’s website, or easily finding critical information on the site.
• Information on the severity of the NYC Transit disruption was delayed reaching media outlets.

In response to these findings, the Taskforce developed a set of recommendations for the MTA, which included:

• Create Early Warning and Response Capability.
• Create an MTA Emergency Response Center.
• Revise Agency Storm Operating Protocols.
• Standardize Storm Category Designations.
• Formalize Inter-Agency Coordination/Notification Plans.
• Develop Capacity for Real-time Email and Text Messaging Service Alerts.
• Improve communication between operations centers and field personnel.
• Implement consistent agency-wide media protocol.
• Improve customer information by developing clear emergency communications protocols and designating communications specialists at operations centers.
• Standardize Procedures for Communicating with Operating Personnel, Customers, and Other External Stakeholders.
• Establish Common Structure for Employee Emergency Response Teams; create a common structure to contact geographically dispersed employees (by email, telephone, text messaging, or fax) in emergencies.
**Information Flow for Coastal Emergencies in the New York/New Jersey Bight**

The route that information travels during an emergency is outlined under legislation and emergency plans to ensure efficiency and effectiveness. The routes within the NY/NJ Bight are similar with the exception of New York City. The schematics of this section represent the flow of information in a storm and spill event.

**Spill Protocol**

1. **US Coast Guard (USCG) to NOAA SSC** - After a spill is reported to the USCG, they contact the NOAA SSC regarding the spill substance, size, and location, vessel type and other pertinent spill details. The NOAA SSC relays information between the USCG, who manage the operations, and the scientific advisors from NOAA ERD.

2. **NOAA ERD to SCC** - The ERD will use the GNOME software by inputting the data NWS has given them and the data ERD has on the location to help graphically determine where the spill will flow to or spread. Once all the analysis is complete, the ERD will give all the data and information to the SSC.

3. **NWS to NOAA ERD** - The ERD will contact the closest NWS office to the spill location to find out what the current weather conditions, tidal height, sea surface temperature, salinity, and anything that the NWS can provide for the given area.

4. **Academic partners to NOAA ERD** - To obtain supplementary information for the GNOME model, NOAA ERD sometimes partners with academic institutions. This is particularly useful for generating specific geographic location models.
1) **NHC to NWS** - While the National Hurricane Center is a subsidiary of NWS, they produce the official warnings and communicate these alerts to NWS during hurricane events.

2) **NWS to State, County and Municipality** - The NWS distributes forecasts, including storm warnings, through their website, RSS feeds, facsimiles, NOAA weather radio broadcasts and commercial television stations. It is incumbent on emergency managers to seek this information. Most emergency management offices have the tools to follow these warnings.

3) **NWS to State and County** - In the preceding a major storm event, NWS will hold conference calls with emergency managers and other major stakeholders (for example major utilities, port authorities and marine safety officers). These calls may be initiated by the NWS, or by a state or county emergency management office.

4) **NHC to State and County** - The NHC offers e-mail service that state and county officials can subscribe to. The NHC also input the real-time forecast data into the HURREVAC computer program used by coastal state and county emergency managers to track severe storms and assist in evacuation decision-making in their communities.

5) **Commercial/Academic to State and County** - Some proactive state and county emergency management offices seek out additional information from private vendors and academic institutions running their own models. These state or county agencies tend to be those responsible for particularly vulnerable areas.

6) **State, County and Municipality** - There is a dynamic relationship between all three depending on the state and the scale of the incident. Due to home rule provisions, incidents will be dealt with at the municipal level in the first instance. It will be scaled up to higher levels of government if the incident affects more than one jurisdiction, or it exceeds the capacity of the municipality. However, during a large-scale emergency, these three levels of government work together using the incident management system outlined in NIMS.
New York City - The Exception

Office of Emergency Management

New York City is a massive urban center within the NY/NJ Bight. Its large and dense population makes emergency management a high priority for the city. Especially after the attacks of September 11th, 2001, the City has focused on citywide emergency management and evacuation plans. As such, they have established their own Emergency Management Office (OEM). Like a county or municipality, they employ a Citywide Incident Management System (CIMS). The CIMS, is an adaptation of NIMS, and consists of three main components: 1) after-action reviews; 2) NIMS training and testing; and 3) testing drills. This plan, however, is highly classified and challenging to review because it contains Manhattan evacuation plans, which are considered “need to know” by US Homeland Security. The added dynamic of New York City in New York State emergency management can complicate some information pathways. It is important to note that the city is a formidable actor in the planning process and has a major office to make these decisions.

Case Study: New York City

Overview of Coastal Storm Plan

The full New York City Coastal Storm Plan is not available to the public as there are heightened security restrictions on obtaining management plans. However, the overview of the Coastal Storm Plan indicates that the plan provides for a scalable response to coastal storm events, ranging from Nor’easters to a worst-case scenario Category 4 hurricane. The plan consists of six operational strategies describing the decisions, processes, and coordination activities needed to respond to a coastal storm. Of these, there are two strategies that are particularly relevant in the context of emergency communication of coastal incidents.

1) Storm tracking and notification, i.e., the collection, review, and dissemination of meteorological information to New York City agencies and other partners

2) Public information, i.e., mechanisms to inform the public about preseason preparedness, hazards, evacuation orders, and protective actions the public can take.

Secondly, this plan requires a response to a coastal storm as early as 96 hours prior to a storm’s forecasted landfall. The timeline of the response has been divided into eight operational phases; the first phase, monitoring, is suggested as the one where the majority of action should take place related to information gathering and notifications. This is initiated in advance of the 96 hour protocol and consists of information from NWS.
Communication Themes & Issues

Local Control and Home Rule
Most of the state and county level emergency managers interviewed for this report emphasized that New York and New Jersey are “home rule” states, meaning that there is a presumption that local level managers will manage an incident until it begins to affect other jurisdictions, or there is a requirement for additional support. Communication is generally good between local level emergency managers and county and state level emergency managers. Mutual Aid agreements are provided for under NIMS. There have been instances of conflicting local responses, for instance in the case of neighboring municipalities making different decisions on evacuation – in these cases, it is incumbent on the county or higher levels of government to assist in co-ordination.

Information Flow Between Levels of Government
In the case of predictions of large-scale incidents, the NWS usually coordinates with state and/or county level emergency agencies. It is generally incumbent on state and county agencies to engage the relevant municipal level representatives. This ensures that local levels of government have easy access to information.

In order to make prediction and observation information more relevant to local managers, information should be more specific to smaller areas. NWS data predictions and alerts are generally at a state level, with commercial vendors providing more specific alerts. The distinction between the roles of the government and commercial vendors in providing such information has a history of controversy, however, municipal and county level governments are often not in a position to pay for additional commercial services.

Communication Between Government and Community
Emergency management agencies face a number of challenges in communicating with the general public during an emergency incident. These include technical, logistical, social, and behavioral challenges. A major development is the introduction of ‘reverse 911’ emergency notification systems which can send telephone notifications to all residents and businesses in an affected area in the event of an emergency. The limitations of this form of notification system are that there are capacity constraints in terms of the number of calls that may be made in a certain amount of time, and that it does not contact cellular

Collaborations: Present and Future
The NEW Mount Holly is currently running an experimental version of MARCOOS’ predictive model, funded by a NOAA grant. This runs on a separate computer that may be consulted by the meteorologists. This is an opportunity for MARCOOS to test their predictive data with NWS on compatibility and operability.

The Emergency Response Division (ERD) is also looking for accurate ocean data that will increase their oil flow predictions when spills occur in the ocean. The advances technology and expertise of MARCOOS prediction models, may assist the ERD by providing ocean data, specifically current direction, wave height, and wind direction to increase ERD’s response time.
phones (unless registered separately), and therefore misses people without landlines. Communicating with visitors is of particular concern to managers in coastal New York and New Jersey, as many of these areas attract high volumes of tourists. Emergency managers have also encountered resistance from communities to having their lives interrupted for emergency preparedness activities – evacuation drills are considered too disruptive and there are instances where local areas have refused to install warning sirens.

Despite these challenges, communities in the New York/New Jersey Bight region had to deal with the major emergency that ensued with the September 11, 2001 attacks in New York City, which had the effect of heightening awareness and preparedness for emergencies. New York City in particular, has engaged in major efforts, such as the "Ready New York" campaign where the city has been educating millions of New Yorkers to all hazards, including weather. The NWS has designated New York City as StormReady in recognition of its preparedness and outreach efforts.

Redundancy in Emergency Communications Media
There is a need for multiple methods of communication for receiving and disseminating emergency incident information. The nature of emergencies makes redundancy necessary. Also – in the current technological environment, there is an expectation and desire for more immediate, specific and portable options. But, there is still a need to maintain lower-tech communication options, such as NOAA weather radios or alert sirens as a backup to more technologically advanced forms of communication.

Ensuring that data products can be converted into multiple communication formats is important if the information is to be used in an emergency management context.

NIMS Implementation
All emergency management agency personnel are required to undergo NIMS training. At the state, city and county level in the New York/New Jersey Bight region, agencies report being up-to-date with training. However, there are training gaps at the municipal level and among elected officials. It can be difficult for municipal level managers, who are often police, fire or emergency personnel, to take time out of their regular work to undertake training.

NIMS guidance on communication and information management recognizes that communications, data standards and systems interoperability is critical. However, national interoperable communications standards have not yet been determined.

To ensure that agencies are prepared for the foreshadowed national interoperable communication standards, efforts should be made to take an active interest in the development of the standards.

NWS Central Role in Weather Prediction
The primary source of weather prediction information for emergency and coastal managers is the National Weather Service. The
National Hurricane Center and the Emergency Response Division (both also under the NOAA umbrella) provide specialized information on hurricanes and hazardous marine spills respectively. The NWS is a trusted source, and for some agencies is the sole information source for weather-related information. More proactive agencies may seek additional sources of weather and ocean prediction and observation information.

In order for MARCOOS observation and prediction information to get to the widest possible range of users, MARCOOS data products could be linked into the NWS system. The NWS has collaborated with research institutions, to use data or models on an experimental basis, before incorporating the information into their system if they are satisfied with the quality.

The NWS uses Advanced Weather Interactive Processing System (AWIPS), an interactive computer system that integrates meteorological and hydrological data, satellite and radar data. All incoming data products need to be compatible with AWIPS in order to be incorporated into the NWS system.

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**NWS’ Ready, Set, Go! System**

The Ready, Set, Go model is a system of the NWS to make sure the correct steps are taken during an incident so that nothing goes unnoticed or unwarned. It is an internet based protocol to reach the maximum number of people quickly. NOAA weather radio is also used to broadcast the warnings. This is mostly for emergency managers and boats/ships since specific equipment must be purchased to tune in. In order to be most efficient, redundancy is important so as to have multiple means of reaching the public in case of a weather emergency. This is achieved by the various mediums of info transmission. *(The chart below is adapted from the NWS Missoula)*

**READY:** At this stage, the NWS predicts a potential event that may end up being a widespread severe weather event in the future. The **HAZARDOUS WEATHER OUTLOOK** issued by the local NWS offices will state this information.

**SET:** In this stage, it is assured that a hazardous weather event will occur, but the exact timing, location, or impact of the event are not fully clear. A **WATCH** is issued to give the public warning that they need to be prepared for the possibility of severe weather within the next 8 hours.

**GO:** NWS is confident that a storm will produce severe weather and a **WARNING** is issued. The lead time can be minutes to an hour. At this stage, immediate action should be taken and shelter taken.
Potential collaboration with NOAA ERD for marine spills

NOAA ERD is central agency for providing scientific and modeling information for hazardous marine spills. ERD uses GNOME, an oil spill trajectory model that predicts movement and chemical changes. **A location file for the New York Harbor is due to be released by ERD soon.**

ERD has established some partnerships with educational institutions to provide inputs into their system and remain open to collaborations in the future.

**Liability**

_NWS is protected from liability_ as it is a government agency. This protection does not extend to MARCOOS/MACOORA. Being aware of the changing legislation and legal issues is important to future data product development.
Footnotes


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Introduction

In our efforts to provide the MARCOOS with a suite of recommendations concerning how to best insert itself into the ocean hazard prediction and emergency management community currently dominated by the NWS, we provide a comparative analysis of the 11 IOOS regions regarding their data product and communications development. This analysis examines a broad range of data products and organizational partners beyond those concerned with emergency management or disaster prediction, because the lessons learned in creating non-emergency data products and communicating with non-emergency partners can potentially be applied towards linking emergency management with ocean observing in the Mid-Atlantic.

To enable the attribution of best practices and lessons learned to specific factors affecting each region, the same data were collected for each Regional Association (or Regional Coastal Ocean Observing System) and are presented in Appendix 1. We explore the genesis of ocean observing projects in the regions, the governance and stakeholder context within which each Regional Association

Ocean Observing Regions
The nation’s coastal ocean is split into 11 regions for the purpose of ocean observing.
(RA) operates and the priority research themes identified through conversations with stakeholders. In order to provide the reader with a basic understanding of what each RA does from day-to-day, we review the ocean observing technologies being used in each region, the real-time or predictive data products generated by the observing networks and any forecasting models being employed. Finally, we identify specific instances where RAs have developed and successfully communicated data products to interested user groups.

<table>
<thead>
<tr>
<th>Region</th>
<th>Novel Data Products</th>
<th>Sample Users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pacific</td>
<td>Beach safety predictions</td>
<td>Hawaii Lifeguard Association</td>
</tr>
<tr>
<td></td>
<td>Shoreline erosion/ coastal change patterns</td>
<td>Kauai, HI Planning Department</td>
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<td></td>
<td>Search-and-rescue drift predictions</td>
<td>US Coast Guard</td>
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<tr>
<td>Northeast</td>
<td>Coastal storm damage projections</td>
<td>Emergency managers</td>
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<td>Harmful algal bloom predictions</td>
<td>Local fishing communities</td>
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<td>Mid-Atlantic</td>
<td>Search-and-rescue drift predictions</td>
<td>US Coast Guard</td>
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<td>Combined sewer overflow drift predictions</td>
<td>Monmouth County, NJ Health Department</td>
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<td></td>
<td>Coastal inundation modeling</td>
<td>Emergency managers</td>
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<tr>
<td>Northwest</td>
<td>Shoreline erosion/ coastal change patterns</td>
<td>OR Department of Parks &amp; Recreation; OR Department of Land Conservation &amp; Development</td>
</tr>
<tr>
<td></td>
<td>Shellfishery water quality alerts</td>
<td>Local fishing communities</td>
</tr>
</tbody>
</table>

Table 1: A sampling of new data products designed to address emerging user needs in various regions of the country. While most regions are able to provide observational data on current ocean conditions (e.g. wind and wave speed and direction, sea surface temperatures), few have been able to leverage existing resources into new data products that appeal to a broader audience than that interested in meteorological forecasting.
Regional Associations (RAs) across the nation have encountered numerous difficulties in trying to fulfill the promise of the Integrated Ocean Observing System (IOOS). Many of these problems concern communication: efficient networks for interaction and the exchange of ideas do not yet exist in many regions of the country. Furthermore, RAs must ensure that ocean observers, forecast modelers and user groups are constantly communicating with and among one another in order to meet IOOS’ seven societal goals. Using ocean observations to inform climate change and weather predictions; enhance the safety and efficiency of maritime operations; mitigate the impacts of natural hazards; improve national security; address public health issues; protect and restore coastal ecosystems and enable sustainable marine resource use requires RAs to find common ground among diverse stakeholder groups. It is clear that formal and informal communication networks are an invaluable asset for RAs attempting to provide ocean observations that are capable of generating important and useful data products.

Formal and Informal Communication

Most regions have experienced successes with workshops and other meetings arranged specifically to solicit input from local, state, Federal, non-profit and industry stakeholder groups. These conferences serve a dual purpose: they allow RAs to disseminate information to interested stakeholders and the public at large and also provide a venue for RAs to hear stakeholders voice their comments and concerns. When periodic meetings are scheduled and potential attendees notified in advance, relevant parties will have ample opportunity to explain their perspectives and participate in broader discussions about regional objectives and opportunities. The dissemination of formal contact lists that identify key personnel at relevant agencies will encourage additional discussion outside of scheduled times. By demonstrating a solid understanding of regional expectations, needs and

Legacy Ocean Observing Assets

♦ National Data Buoy Center
♦ Physical Oceanographic Real-Time System
♦ National Water Level Observation Program
♦ Coastal Ocean Monitoring and Prediction Systems

Working closely with the University of South Florida, the Southeast Coastal Ocean Regional Observing Association (SECOORA) uses data from about a dozen nearshore buoys, seven offshore buoys and three high-frequency CODAR systems to provide ocean observations along the southeastern coast. These observing systems are part of the region’s Coastal Ocean Monitoring and Prediction System (COMPS), which uses ocean observations in hydrodynamic models to forecast ocean conditions and currents. In addition, SECOORA satellite data and pulls real-time observations and historical data from the Physical Oceanographic Real-Time System (PORTS) and National Water Level Observation Program, respectively, through the National Oceanic and Atmospheric Administration’s Center for Operational Oceanographic Products and Services (NOAA CO-OPS).
priorities, RAs can anticipate criticisms and keep stakeholders engaged by responding before problems reach crisis proportions.

Observing systems and RAs may also consider promoting informal communication networks by encouraging observers, modelers and users to form relationships that extend beyond the direct responsibilities of their jobs. Informal communication provides critical advantages that encourage potential collaborators to begin joint projects, maintain them and bring them to conclusion. It also helps ocean observing staff learn about each other and the work being done in disparate research disciplines or government agencies. Regional associations are generally more flexible and responsive to user needs than are Federal ocean observing agencies constrained by bureaucratic and political forces. Informal communication enhances this regional flexibility and responsiveness by creating efficient means of information sharing that go beyond the limitations of Federal government action. Without informal communication, many cooperative programs would not exist and others would founder before reaching their objectives.

Stakeholder Identification and User Group Integration

Ocean observing systems have existed under the guidance of the US Navy and academic institutions for roughly 20 years, and the technological advances in real-time data collection achieved in the 1990s were instrumental in shifting ocean observing activities from a research-focused approach to one more concerned with user needs. Identifying regional stakeholders and their various needs is one key goal of implementing fully functional communication networks. Although all 11 RAs have made good-faith efforts to connect with interested observers, modelers and users, dedicated stakeholder and user needs analyses contracted to outside entities seem to provide the most comprehensive and unbiased view of user groups and regional observing, data and modeling requirements. These stakeholders and user needs must be explicitly identified early in RA development in order to enable proper prioritization of projects and allocation of staff and funding. In pursuing service of emergency management and disaster prediction user needs, RAs must be sure to include assorted state and local government entities, the

Create a Metadata Database

Potentially the nation’s most user-friendly source of ocean observing data, the Central and Northern California Ocean Observing System’s (CENCOOS) OceanObs system is a web-based metadata management tool that uses a central database, website and mapping application to manage a comprehensive index of web-accessible ocean observing data streams. Accessible through the CeNCOOS website, OceanObs can be used to find data on the 28 variables common to all 11 Integrated Ocean Observing System regions and an 80 additional variables registered in Central and Northern California alone. The easily-accessible, user-friendly OceanObs database has proved to be a successful tool for the collection and organization of diverse data streams. The system has helped identify duplicated effort in the region while providing numerous opportunities for collaboration on specific projects. Participation in the OceanObs system is free of charge, creating further incentive for partnership organizations to get involved.

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Develop Data Products to Address Coastal Change

The Pacific Integrated Ocean Observing System (PACIOOS) has successfully applied its observational data in the calculation of erosion rates for vulnerable shorelines. Because an overwhelming majority of the regional population lives within one mile of the coast, shoreline changes can have important implications for development and onshore safety. In this case, the Kauai Planning Department has incorporated PacIOOS erosion rates, generated from historical aerial photography and LIDAR (Light Detection And Ranging) overflight, into its setback regulations for shoreline construction. Permits now require that development occur far enough from the beach to allow for 50 years of erosion.

The Northwest Association of Networked Ocean Observing Systems’ (NANOOS) coastal change products have allowed the association to approach and work with state planning authorities concerning engineering works and development along shorelines. Erosion rates, pre- and post- storm beach observations are used by Oregon’s Departments of Parks and Recreation and Land Conservation and Development in evaluating permitting decisions for coastal structures. Coastal change data is thought to be particularly useful in assessing the short- and long- term beach response to the El Niño-Southern Oscillation, storms and climate change. Understanding these issues can help managers determine the proper locations for jetties, breakwaters and other coastal modifications.

Some RAs have already solicited feedback from user groups regarding data visualization or website design, an adaptive approach to data product provision in which tools are developed together with user groups could create benefits applicable to the entire Global Earth Observing System of Systems (GEOSS), of which IOOS is part. Allowing stakeholders to choose a preferred format for the transmission of data products or emergency alert messages (e.g. email, SMS text message, fax) may encourage greater user participation, better serve stakeholders without ready access to the Internet and enable RAs to broaden the communities in which they operate. Similarly, designing data visualization schemes in concert with users will result in websites and user tools that serve stakeholder needs in the most efficient way possible. RAs should ensure that all publicly available data products are user-friendly and easily accessible: an excellent first step may be to consolidate separate websites used for Associations and Coastal Ocean Observing Systems, respectively. While the subtle distinction between these two types of organization

National Weather Service (NWS) and other National Oceanic and Atmospheric Administration (NOAA) programs (e.g. PORTS, CO-OPS, NERRS, NDBC). Engaging a diverse assortment of stakeholders and ensuring that work to identify additional user groups continues will enable RAs to accurately define regional user needs and avoid duplicating efforts already underway.

Providing easy access to user tools is one possible method of encouraging greater community interaction and maintaining stakeholder support. Although some RAs have already solicited feedback from user groups regarding data visualization or website design, an adaptive approach to data product provision in which tools are developed together with user groups could create benefits applicable to the entire Global Earth Observing System of Systems (GEOSS), of which IOOS is part. Allowing stakeholders to choose a preferred format for the transmission of data products or emergency alert messages (e.g. email, SMS text message, fax) may encourage greater user participation, better serve stakeholders without ready access to the Internet and enable RAs to broaden the communities in which they operate. Similarly, designing data visualization schemes in concert with users will result in websites and user tools that serve stakeholder needs in the most efficient way possible. RAs should ensure that all publicly available data products are user-friendly and easily accessible: an excellent first step may be to consolidate separate websites used for Associations and Coastal Ocean Observing Systems, respectively. While the subtle distinction between these two types of organization

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may be clear to regional managers, stakeholders and members of the public in search of specific user tools may be confused and not know which source to trust. In an environment where the alternative data sources are only a click away, RAs need to ensure that their websites provide quick access to readily identifiable, easily interpreted user tools.

IOOS Collaboration

Although each IOOS region faces different coastal hazards and operates within specific ecosystems, shared, nationwide challenges ought not be solved independently 11 different times. All regions could benefit from additional interaction, which could potentially be moderated by the US National Federation of Regional Associations (USNFRA). Some regions have already found niches and begun sharing topical expertise – on metadata collection and visualization or high-frequency radar data standardization, for example – with others. As a common forum for communication between IOOS regions and the Federal government, USNFRA’s role in coordinating regional action will continue to increase as the national ocean observing network matures, and RAs may want to strengthen their relationships with USNFRA and each other as this transition occurs.

Significantly, USNFRA may be able to accelerate the pace at which common data formats are accepted by the RAs. Regional data management and communications (DMAC) committees may favor more widely accepted standards, including those utilized by NWS and other NOAA agencies, or choose alternative formats used by close partners within the region. Although this choice will depend on the specific observing systems, models and data products generated in each region, DMAC committees may be able to identify preferred standards by coordinating early and often. With USNFRA’s help, synchronized RAs can ensure that the multi-agency National Office for Integrated and Sustained Ocean Observations (Ocean.US), where the national DMAC standardization process is slowly getting under way, eventually selects formats favored by

Engage the US Coast Guard on Maritime Safety

The 14th District of the US Coast Guard (USCG) has made excellent use of PacIOOS data in pursuit of its maritime safety mission. Wave radar (WERA) information on the direction and speed of waves is fed directly into the Coast Guard’s search-and-rescue models, allowing them to more accurately pinpoint the location of lost mariners. Although the relationship between PacIOOS and USCG has been strengthened over half a decade of cooperation, PacIOOS’ ability to aid the Coast Guard will be even further enhanced by the installation of additional radar stations. In addition, the several USCG officers currently studying surface currents at the University of Hawaii will ensure that the connection between PacIOOS and the Coast Guard remains strong.

Despite the fact that NANOOS has yet to develop a relationship with the US Coast Guard’s 13th District, partner organizations including OHSU’s Columbia River Observation Network (CORIE) have collaborated with the Coast Guard on maritime operations data products. CORIE’s surface current data, while not integrated directly into Coast Guard search-and-rescue models, has been used to predict the location of lost mariners. Given this positive introduction, it is possible that the Coast Guard will make use of NANOOS’ regional surface current data in the future.
Coastal Ocean Observing Regional Associations

emergency management remains important for Federal, state and local managers alike. In fact, NOAA has identified inundation as a priority research area for the national IOOS program. On the Atlantic Coast, inundation is usually associated with the storm surge resulting from hurricanes and other disaster events, while West Coast states face inundation troubles related to long-term climate change and sea level rise.

Although RAs may be able to produce marine condition, inundation and other forecasts following the passage of legislation that limits their liability, the best current opportunities for RAs to showcase useful data products seem unrelated to emergency management. Several regions have been successful in cooperating with the US Coast Guard to use surface current observations in drift model and search-and-rescue data products. Since all 11 regions are operating high-frequency radar systems and collaboration with the Coast Guard is already a proven success, regions lacking a direct connection to their local Coast Guard District should pursue a relationship without delay. In the Pacific, several regions have produced user tools concerning coastal erosion and change and successfully

Cooperate with Industry Partners

The Gulf of Mexico is a center for ocean drilling projects, and a unique partnership between oil companies and the Gulf of Mexico Coastal Ocean Observing System (GCOOS) accrues benefits to both parties. Real-time ocean observations (e.g. wind speed, currents, salinity) are collected automatically from oil platforms – even during hurricanes. This technology provides high resolution, in-situ measurements of atmospheric and oceanic variables for GCOOS modeling efforts, the results of which can be used by oil companies to understand the current and wave stresses on offshore platforms. GCOOS’ Gulf circulation research is critical for safe and profitable extractive industry practices: the organization has recently received a $1.3 million grant to pursue ocean eddy research and improve circulation models. Efforts to ensure that ocean observing data is free to GCOOS and the public were complicated by industry reluctance to release proprietary data. These limitations, a major challenge of broad cooperation with the private sector, were quickly overcome in negotiation, and GCOOS data remains public regardless of its source.

ROOS and Emergency Management

In most cases, RAs have been reluctant to develop data products concerning needs related to ocean hazard prediction, because they are unwilling to assume liability for the negligent misrepresentation of future ocean conditions. Unlike NWS, whose employees are exempted from tort liability, RAs are worried about lawsuits in cases where incorrect forecasting leads to a loss of life or property. Associations that do not provide predictive models are able to ignore this issue for now, and lengthy disclaimers regarding the accuracy of predictions are offered in regions where forecasts are currently being issued. In late March 2008, the US House of Representatives passed legislation that would free RAs from the tort liability concerns that have thus far limited their engagement on emergency management issues. House Resolution 2342, the National Integrated Coastal and Ocean Observation Act of 2008, will next be considered in the Senate, where proponents anticipate its passage. Despite the legal restrictions on forecasting and the slow pace at which most regions have engaged emergency managers, the application of ocean observing systems to regional personnel.

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integrated them into coastal state planning and permitting processes. This is another non-emergency issue area where RAs face few barriers to entry and have a wealth of information to contribute.

**Pilot Projects**

*Pilot projects may be excellent tools for proving the utility of new, non-emergency data products.* Small-scale test programs are currently operating in several regions and offer exceptional opportunities for observers, modelers and users to refine their data collection, analysis and visualization methods before the technologies are ready for large-scale application. In addition, pilot projects allow RAs to focus on population centers and essential infrastructure before expanding to lower-priority areas. Given the current funding constraints for IOOS programs, pilot projects may be initiated more easily than region-wide programs. Despite this positive note, receiving continued funding for successful pilot projects is a major challenge for ocean observers. RAs desiring greater budget appropriations would be well served to *support the passage of pending IOOS legislation*, which will make important regulatory changes concerning RA activities and organize RA governance to allow for better funding in the future.

**Case Study:**

*MARCOOS in Action*

MACOORA proved its potential to contribute substantively to emergency preparation discussions as Tropical Storm Ernesto moved towards the Mid-Atlantic Bight in Fall 2006. As the storm approached, the Delaware River Basin Commission (DRBC) was hoping to prevent inland flooding by opening dams and allowing retained waters to flow towards the ocean. MARCOOS modelers, however, had forecasted higher-than-normal water levels for coastal areas, so they were aware that additional water flowing down the Delaware River would induce flooding along the coast. With this knowledge in hand, MARCOOS alerted the DRBC that Tropical Storm Ernesto was more likely to induce flooding along the coast than inland. In response, DRBC abandoned its plans to open dams upstream and probably prevented some coastal inundation. Although MARCOOS can provide real-time and forecast data in support of emergency management missions, it maintains no formal relationships with emergency managers. The DRBC episode, enabled by informal cooperation between DRBC and MARCOOS personnel, underscores the utility of easy, off-the-record information-sharing in the Mid-Atlantic.
Conclusion and Final Recommendations

Conclusion

The aim of this report is to determine ways in which MARCOOS technology could be integrated into the analysis and communication tools available for emergency and coastal management in the New York/New Jersey Bight. To inform our analysis, we collected and assessed the following information:

- An inventory of ocean observing technology and the resulting predictive models used in the New York/New Jersey Bight as compared.
- Emergency management communication procedures in the New York/New Jersey Bight, according to consultations with emergency coastal managers in the region, NWS personnel, and assessments of local, state, and national emergency management plans and policies.
- An overview of RCOOS communication schemes and ocean observing activities.
- Comparisons of ocean observing activities and applications in order to benchmark best practices for MARCOOS to potentially adopt in the mid-Atlantic region.

The recommendations that follow, address the themes that currently limit the efforts of ocean modelers and emergency managers while suggesting ways in which MARCOOS in conjunction with MACOORA can begin to address these obstacles.
Recommendations for MARCOOS

Define Stakeholders and User Needs

To enhance the utility of its data products and research efforts, MARCOOS must define its stakeholders and tailor products to fit the needs of its users. This is important for MARCOOS as it will inform effective funding allocation. Understanding potential users will assist in building a foundation of stakeholder support for ongoing modeling efforts, as well as allow MARCOOS to expand their products into new user areas. Through engaging a new and diverse swath of stakeholders, like the fisheries community, the New York/New Jersey port management and recreational users, MARCOOS may increase its data product utility and funding opportunities. This report contains an analysis of one particular user group, emergency management stakeholders in the New York/New Jersey Bight. This can be expanded spatially, to the entire Mid-Atlantic region and generally, through outreach efforts to user groups who are not currently the foci of MARCOOS’ research and data products. As seen in the analyses of the ROOSs nationally, there are often niches for predictive models that can be filled by products created through user-driven consultation.

Disseminating Information to Emergency Managers

The NWS is the central source of weather and ocean condition information for emergency management agencies. Therefore, MARCOOS may want to consider disseminating information through the NWS to effectively communicate their data and data products to emergency managers. An additional advantage of releasing data and products through the NWS is that the NWS is protected against liability claims under the Federal Torts Claims Act, whereas non-government organizations (such as MARCOOS) are not accorded this protection.

Releasing information directly to users in a range of communication formats is also an option for MARCOOS, either in addition to dissemination through the NWS or as a stand-alone option. Directly releasing emergency incident information and other data products would provide MARCOOS with more flexibility in the types of products they could provide as well as the ways in which they communicate their
products. Emergency managers have expressed a preference for fast, direct communication methods such as emails and text messaging services, while maintaining multiple communication routes in case of failure of one or more communication methods in times of emergency. More localized prediction information and alerts than those provided by the NWS would also be useful for many managers, particularly those working at the local or county level. From a legal liability standpoint, MARCOOS should seek legal advice before committing to the direct provision of forecasts. Our understanding is that non-government organizations are not currently protected from liability for weather predictions. However, many commercial operators limit their liability through the use of disclaimers, and may additional purchase liability insurance to minimize risk. MARCOOS could potentially use similar precautions. Working directly with commercial vendors to disseminate their information to users and emergency managers is another option for MARCOOS, however further investigation would be necessary to determine the viability of this option.

Initiate New and Applicable Pilot Projects

Major region-wide programs can be costly and logistically difficult. Implementing small-scale pilot projects as a pre-cursor to large region-wide implementation is a successful method to address these concerns. The success of pilot implementation projects throughout IOOS and across regional observing associations has helped inform additional research opportunities intended to meet user needs and create new niches of research. Other notable advantages of pilot projects include:

- Opportunities to form relevant partnerships with stakeholders and engage in modeling efforts explicitly intended to address a particular user need. The intimacy afforded by small scale projects allows a specific tailoring to user needs and thus a higher chance of success.
- Avenues for MARCOOS to qualify for more unique types of funding.
- A manageable project whose implementation successes can prove system competency and whose implementation challenges can be addressed on at a controllable level.
- A chance to learn important implementation lessons for the larger-scale deployment of a program.

Data and Communication Standardization

MARCOOS should stay abreast of and contribute to the development of inter-agency data and communications standards. MARCOOS should also look into ways in which they can standardize their data with other agencies.

A common issue in data management involves the challenge of assimilating data from multiple sources. This is a major obstacle in the way of creating a national ocean observing network.
incorporating MARCOOS data into NWS forecasts and ensuring communications interoperability in emergency situations.

MARCOOS needs to determine which systems should be prioritized for ensuring compatibility. MARCOOS should also expand on this report’s meta-inventory of data products for the whole Mid-Atlantic region, so they can determine which standards would be most effective to implement.

To work towards compatibility with other ROOSs, MARCOOS should keep track of data integration efforts being pursued through the NOAA IOOS Program, and should look into potential collaboration efforts with other systems. An example of regional data integration is the three observing systems within California that have a universal HF radar system with unified outputs and data management protocols. Active engagement with neighboring ROOSs and with the US National Federation of Regional Associations may assist in achieving the goal of data standardization between MARCOOS and other ROOSs.

If MARCOOS determines that integrating the system’s data into NWS forecasts is a priority, then MARCOOS should strive to package data and new products into formats that can be easily integrated into AWIPS and/or other NWS systems. Data output from CODAR and the MARCOOS gliders is currently not used by the current NWS forecast models. There is potential for some parameters to be incorporated into the current modeling systems (for example, glider-collected ocean temperature data), but in many cases, the parameters collected are not part of the current NWS models. The NWS is, however, conducting research into a fully coupled ocean-atmosphere forecast model. MARCOOS should stay up-to-date with these model developments and communicate with the NWS on potential new data products they can cooperatively produce.

The National Incident Management System (NIMS) recognizes that communications, data standards and systems interoperability are critical. However, national interoperable communications standards have not yet been determined. MARCOOS should take an active interest in the development of the standards, to ensure their products are interoperable with emergency management systems.

Create User-Friendly Access to Data and Data Products
MARCOOS should create an easily accessible online database that is comprehensive and clear. Some initial steps in this process would be:

- Review other IOOS databases where users and modelers can interact and exchange information, such as OceanObs for the Central California Regional Association.
- Strive to integrate the currently separate MARCOOS and MACOORA interfaces in order to create one clear locale that users can easily access. In the short term, clearly provide links to the other’s websites on the respective homepages with a brief explanation of the MARCOOS/MACOORA relationship.
- Clarify who is responsible for information and access to modeling efforts and available data products.

Collaboration Opportunities
MARCOOS has the potential to engage in strategic partnership and collaboration opportunities. These potential opportunities contribute to the production of coastal inundation models, in
conjunction with regional NWS offices. They also may pursue a partnership with NOAA ERD to provide inputs into their marine spill trajectory models.

Evident from our consultations was the need for street-level (high-resolution) storm surge inundation models that are able to provide near real-time information to emergency and coastal managers during severe storm events. MARCOOS could identify potential research partners to develop such a model, with MARCOOS’ glider and CODAR data potentially providing the precision that this type of mapping requires.

As outlined in the data and communications standardization recommendation above - in order for MARCOOS information to get to a large range of users, MARCOOS data could be linked into the NWS system. Regional NWS offices sometimes engage in collaborations with research institutions to use data or models on an experimental basis before incorporating the information into their system once satisfied with its quality. MARCOOS may wish to liaise with local NWS regional offices regarding opportunities to collaborate in this way.

NOAA ERD is the central provider of scientific and modeling information for hazardous marine spills. NOAA ERD has established some partnerships with research institutions to incorporate inputs into their modeling system and is open to the possibility of additional partnerships. NOAA ERD is preparing location models for use with its GNOME trajectory spill modeling. A location file for the New York Harbor is due for release soon, so this may be a good time for collaborative work between MARCOOS and NOAA ERD.

Create Niches for Modeling Efforts Outside of Emergency Management
Considering that the NWS does not currently have the capabilities to integrate glider data into its models, MARCOOS should investigate other predictive models that are currently able to use glider data, or that may benefit from high-resolution data. Specific opportunities where data assimilation may be more feasible are:
- Spill response efforts and harmful algal bloom tracking
- Fisheries and industries that manage marine resources

Improvements in Formal and Informal Communication
In order to increase external information sharing, MARCOOS should engage Data Management and Communication Committees throughout IOOS and aim to create a national inventory of modeling efforts across coastal regions. MARCOOS data managers should be engaged in regular communication with other managers, particularly those on the Eastern seaboard. MARCOOS could host a conference for regional associations on the US east coast as a way to initiate potential integration of modeling efforts, data standardization and identify overlaps in research.

MARCOOS could also participate in emergency management workshops and conferences, where there is potential for discussing the integration of MARCOOS data products. An active commitment to get involved in the development of data and communications standards would entail communicating with other ROOSs and federal agencies.

MARCOOS should also emphasize informal communication as it can often lead to more efficient collaboration and to increased innovation. Informal communication can also help overcome some of the formal barriers in government institutions.
Final Recommendations

Ocean Observing and Emergency Management: The Big Picture

This report demonstrates the ways in which ocean observing technology can most efficiently inform emergency management, specifically in the New York/New Jersey Bight. This report also shows the potential for these technologies to be useful in fields other than emergency management. The limitations of ocean observing technologies have traditionally been and continue to be technological barriers and current schemes of communication. These inefficiencies are found throughout the scientific observing field, the emergency management field, as well as communication between these two fields.

Modelers and emergency managers interviewed for this report have provided excellent insight into ways in which these challenges hinder productivity in both fields, and we offer a set of potential solutions to bridge the gaps in both communication and data compatibility. Many of our recommendations involve taking proactive steps in information gathering, that will inform a more efficient and useful data product for MARCOOS, as well as a wider swath of applications that MARCOOS could consider for its data products and future research endeavors.

Observing activities are sometimes initiated and continue to advance without always recognizing what specific user needs and applications of the research will be. We have found that these kinds of limitations are often a result of funding restrictions and regional contexts, but we offer some solutions that could be used by MARCOOS and MACOORA to address these limitations and increase their impacts on the fields of both emergency management and ocean observing.

Despite many gaps observed in communication areas, we witnessed several successes in ocean observing applications that form the basis for many of our recommendations. MARCOOS can refer to this report in order to realize current successes and can use these as bench marks to inform further steps towards increased applicability and efficiency.

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Appendix 1

Coastal Ocean Observing Regional Associations

Pacific          PACIOOOS
Central and Northern California  CENCOOS
Northeast        NERACOOS
Great Lakes      GLOS
Caribbean        CARA
Gulf of Mexico   GCOOS
Southern California  SCCOOS
Alaska           AOOS
Mid-Atlantic     MARCOOS
Northwest        NANOOS
Southeast        SECOORA
Having recently received a 3-year, $7 million grant for ocean observing, the University of Hawaii is concentrating on the development of observing capabilities for coastal zones near major population centers and essential infrastructure. A pilot project is underway for the island of Oahu, intended to prove the utility of a full-fledged observing system that can be expanded to encompass all of Hawaii. PacIOOS’ work outside of Hawaii is restricted to needs assessments at present, though expansion of the full observing network to these areas is a long-term goal.

The PacIOOS regional association is in the process of convening. Potential members of this association have not yet signed a memorandum of agreement (MOA), but the essential planning document is targeted for completion in the near future. Staff at the University of Hawaii are in constant contact with a wide range of stakeholders and potential signatories, and annual stakeholder meetings are envisioned once the regional association is officially constituted. In addition, an executive board (described in the MOA) will meet two to four times per year to ensure that observing operations and data products continue to meet user needs in the region. As part of the planning process, PacIOOS will hold a stakeholder meeting in late May 2008 to identify local leaders and ocean observing priorities.

Ocean observing in Hawaii, where the bulk of PacIOOS’ efforts are located, is generally founded on high-frequency radar arrays and buoys. The program currently operates two WERA (WavE RAdar) systems and pulls data from National Data Buoy Center and National Marine Fisheries Service buoys and moorings in the region. In addition, the University of Hawaii’s Kilo Nalu nearshore reef observatory provides real-time data on waves, tides and currents near Honolulu. Projects to install three additional long-range radar arrays and a nearshore, high-resolution system have been delayed by funding cuts and difficulty coordinating with state permitting officials.

DATA PRODUCTS

PacIOOS data is already being used to produce several publicly available data products, though none of these are directly concerned with emergency preparation or disaster response. The major ocean hazards faced in the Pacific region are tsunami, hurricanes and
coastal inundation. NOAA’s Pacific Tsunami Warning and Central Pacific Hurricane Centers are responsible for detecting and predicting tsunami and hurricanes, respectively. PacIOOS has focused on raw data provision in these areas, while the development of predictive data products has centered on non-emergency user needs.

Beach safety is one such need. Hawaii’s large population of recreational ocean users was identified by PacIOOS participants as an important stakeholder group for further engagement, motivating state and city agencies to join with lifeguards and the University of Hawaii in development of a user-friendly website to inform beach-goers about coastal hazards. The site uses wave, surge and offshore current data to provide updated hazard conditions for Hawaiian beaches every four hours. As an easy-access communications tool providing highly useful predictive information to the public, the website has been a great success. In December 2007 alone, over 11,000 visits were recorded.

Another successful use of PacIOOS data has been in the calculation of erosion rates for vulnerable shorelines. Because an overwhelming majority of the regional population lives within one mile of the coast, shoreline changes can have important implications for development and onshore safety. In this case, the Kauai Planning Department has incorporated PacIOOS erosion rates, generated from historical aerial photography and LIDAR (Light Detection And Ranging) overflight, into its setback regulations for shoreline construction. Permits now require that development occur far enough from the beach to allow for 50 years of erosion.

The 14th District of the US Coast Guard (USCG) has also made excellent use of PacIOOS data in pursuit of its maritime safety mission. WERA data on the direction and speed of waves is fed directly into the Coast Guard’s search-and-rescue models, allowing them to more accurately pinpoint the location of lost mariners. Although the relationship between PacIOOS and USCG has been strengthened over half a decade of cooperation, PacIOOS’ ability to aid the Coast Guard will be even further enhanced by the installation of additional radar stations. In addition, the several USCG officers currently studying surface currents at the University of Hawaii will ensure that the connection between PacIOOS and the Coast Guard remains strong.

**COMMUNICATIONS**

One pillar of PacIOOS’ success in coordinating with other ocean-related agencies is their close proximity in Honolulu. PacIOOS has neither defined relationships with emergency managers in the Hawaii State Civil Defense nor predictive data products concerned with ocean disasters, yet regular phone calls and interaction between PacIOOS staff and emergency managers promote informal information sharing and keep communication lines open. Similarly, PacIOOS has worked well with the National Weather Service (NWS), despite the lack of any formally developed relationship between the two organizations.

PacIOOS’ determination to engage multiple stakeholder groups
and identify key user needs will become increasingly important as the system continues to mature. Choices that have been made thus far, including the decision to start with a pilot project on Oahu, seem to reflect a keen understanding of resource constraints, short-term objectives and goals for the future. By aiming to provide a single, integrated website for the dissemination of raw data and predictive data products to government agencies and the public, PacIOOS shows that thinking big can require starting small.
CENCOOS

The Central and Northern California Ocean Observing System uses its OceanObs system to index disparate data streams and provide a user-friendly interface for the public.

CeNCOOS observes the Pacific coast and continental shelf from Point Conception, just north of Santa Barbara, to the California-Oregon border. The system benefits from the various academic and institutional marine research centers located throughout coastal California: 18 of 28 CeNCOOS member organizations are either academic or non-profit. Other signatories of the 2006 CeNCOOS Memorandum of Agreement include industry and Federal, state and local government representatives. CeNCOOS addresses the geographic extent of the California Current ecosystem by actively collaborating with the Southern California Coastal Ocean Observing System.

DATA PRODUCTS

Potentially the nation’s most user-friendly source of ocean observing data, the OceanObs database was developed for CeNCOOS by the Sanctuary Integrated Monitoring Network, a National Oceanic and Atmospheric Administration program in Monterey Bay, and the National Coastal Data Development Center. OceanObs is a web-based metadata management tool that uses a central database, website and mapping application to manage a comprehensive index of web-accessible ocean observing data streams.1 Accessible through the CeNCOOS website, OceanObs can be used to find data on any of the 28 variables common to all 11 Integrated Ocean Observing System regions and 80 variables registered in Central and Northern California alone. In addition to OceanObs, CeNCOOS offers simple, direct links to partners’ data products (e.g. wind vector maps, ocean current forecasts, and bathymetry) and information on current coastal conditions from sources including the National Data Buoy Center and National Weather Service.

COMMUNICATIONS

The easily-accessible, user-friendly OceanObs database has proved to be a successful tool for the collection and organization of diverse data streams. The system has helped identify duplicated effort in the region while providing numerous opportunities for collaboration on specific projects. Participation in the OceanObs system is free of charge, creating further incentive for partnership organizations to get involved.
NERACOOS
The Northeastern Regional Association of Coastal Ocean Observing Systems has engaged diverse stakeholders in a drive to provide the most useful data products possible.

With leading coastal ocean observing systems that stretch from the Gulf of Maine to Long Island Sound, NeRACOOS draws on a strong scientific foundation to address five priority areas. Harmful algal blooms (HABs), water quality, living marine resources, marine operations and inundation were identified as focal areas by stakeholders in a series of 2006 workshops – now the challenge is advancing research to inform new data products while continuing to develop a better understanding of user needs.

NeRACOOS was established in 2005 following the University of Southern Maine’s reception of a grant intended to fund the development of an IOOS regional association in the Northeast. Currently, NeRACOOS is drafting bylaws, seeking board members and performing other tasks that will lead to the association’s incorporation as a 501c(3) non-profit entity in summer 2008. While drawing on the strengths of existing assets in the northeast, including the Gulf of Maine Ocean Observing System (GoMOOS), NeRACOOS struggles to integrate legacy ocean observing systems and personnel into the regional association’s new governance structure.

Ocean observing data is collected in the Northeast region by a number of sub-regional systems that were in place before NeRACOOS development began. GoMOOS is the largest of these systems; as the first region to receive earmarked funding for integrated ocean observing, the Gulf of Maine benefits from an observation network designed from the ground up to serve user needs. At present, GoMOOS operates ten buoys in the Gulf of Maine and provides access to data from the National Data Buoy Center and other partners. In addition to buoys, GoMOOS uses satellites and high-frequency radar systems to generate ocean observations for the Gulf of Maine. NeRACOOS leverages GoMOOS abilities, and those of GoMOOS partners (e.g. the Universities of Maine and New Hampshire, Bowdoin University, the Long Island Sound Coastal Ocean Observing System and the Martha’s Vineyard Coastal Observatory), to provide ocean observations in the Gulf of Maine and other coastal areas in the Northeast.
DATA PRODUCTS

While NeRACOOS is developing a pilot project to predict coastal inundation, the association currently provides no region-wide emergency management or response data products. The demonstration program, which operates in Portland, ME, uses real-time water level and wave height data to create web-accessible, 24-hour coastal storm damage forecasts that can be utilized by coastal zone managers and property owners alike. The Coastal Flooding and Erosion Forecast System being used in the Northeast was generated by GoMOOS in partnership with the National Weather Service (NWS); in fact, NWS’ Gray, ME forecast office played a significant role in initiating development of the storm damage data product. Building on pre-existing GoMOOS collaboration, NeRACOOS has built a healthy relationship with NWS through its Gray, ME and Taunton, MA field stations.

To address its other priority areas, NeRACOOS has a combination of predictive and real-time data products available through the GoMOOS website. Current ocean and atmospheric condition data collected using buoys, HF radar and satellites throughout the Northeast region is presented in a user-friendly format: data include wind speed and direction, surface currents, sea surface temperatures and more. NeRACOOS’ suite of predictive products is also easily accessed: GoMOOS provides links to marine and water level forecasts hosted elsewhere, in addition to wind and wave, circulation and right whale birth predictions generated by GoMOOS itself.

COMMUNICATIONS

To serve user needs related to water quality and HABs, NeRACOOS is operating a prototype notification system that sends alerts to state marine resource managers when HABs are more likely to occur. The system uses real-time ocean observations to evaluate whether thresholds for HABs have been exceeded and then sends emergency notifications via email or text message. Although this system is not available to the public, NeRACOOS is working with state shellfishery managers to ensure that authorities know when to order closures.

Although the the Long Island Sound Coastal Ocean Observing System has a strong relationship with the US Coast Guard (USCG) based on the integration of CODAR surface current data into USCG search-and-rescue models, NeRACOOS is not actively pursuing development of this data product elsewhere in the Northeast. Both NeRACOOS and the USCG are reluctant to cooperate on search-and-rescue data integration because of funding limitations. The Coast Guard, in particular, does not want to become dependent on an observation system (in this
case, high-frequency radar) that lacks guaranteed future funding.

The majority of GoMOOS’ users are mariners – mostly fishermen – though other stakeholder groups include surfers, academic researchers, the USCG and NWS. One important element of the Northeastern region’s success in providing useful data products to its stakeholder community has been active engagement of stakeholders during all phases of data product development. In practice, this means that users suggest tools to be developed by the regional association, then evaluate these data products to provide feedback on visualization and other issues. GoMOOS and NeRACOOS benefit from the participation of eager stakeholder groups. NeRACOOS has proven its ability to remain aware of user priorities by communicating with partners early and often.
Created in 2003 by the Great Lakes Commission (GLC), an interstate governance association responsible for the Lakes and associated natural resources, GLOS provides lake observations and forecasting for Lake Erie, Lake Huron, Lake Michigan, Lake Ontario and Lake Superior. The association builds on the work of the Great Lakes Information Network (GLIN), established by GLC in 1993 to encourage information sharing.\(^1\) Due to its experience with GLIN, the GLC was well suited to spearhead the formation of the Great Lakes’ Integrated Ocean Observing System regional association. Data managed by GLOS are collected and provided by lake observing systems and organizations in both the United States and Canada.

**DATA PRODUCTS**

GLOS provides data from a variety of sources in a user-friendly, web-accessible format. The association’s website integrates access to data products – including weather forecasts, beach and boating advisories, surface and water temperatures, fishing conditions and water levels – produced by the National Weather Service, Great Lakes Environmental Research Laboratory, GLIN and others. Local governments and recreational user groups, such as boaters and fishermen, use many of these lake condition data products. GLOS is working on the development of a storm surge inundation data product and hopes to broaden its user base to include emergency managers when the storm surge tool comes online in April 2008. Emergency notification systems are included in the forecasting models: if water fluctuations are extreme, or if certain areas are iced over, the database will send out user alerts regarding these conditions.

**COMMUNICATIONS**

Communication has always been a key issue of concern for GLOS given the multi-national character of the region. In an early effort to ensure that information was shared adequately, GLIN was founded on the realization that traditional forms of communication would soon become outdated as the Internet continued to gain popularity. GLOS’ website is not its only communication tool. Through GLIN, GLOS has been able to continue information sharing efforts including bi-annual data exchange conferences intended to promote data integration and improve the development of standardized best practices\(^1\). These conferences help GLOS ensure that stakeholders and data experts share a common vision and coordinate research and outreach efforts to align with common goals.
In its preliminary development stages, CaRA began operations in December 2007 following recognition of the need for ocean condition forecasting to sustain the Caribbean’s tourism industry. The regional association has since drafted a Memorandum of Agreement that counts industry and local interest group representatives as signatories. In addition, a Stakeholder Council was developed to parallel CaRA’s Executive Committee and is designed to formally address stakeholder concerns and ensure that they are tackled in future executive decision-making. CaRA’s ocean observing data is derived from the Caribbean Regional Integrated Coastal Ocean Observing System (CaRICOOS) which works with researchers in the US Air Force, at the University of Puerto Rico, Mayagüez and the National Weather Service’s San Juan office to integrate ocean observing data into the CaRA database. The assimilation of multiple data sources is designed to enable creation of the easily accessible suite of user products needed by regional stakeholder groups.

**DATA PRODUCTS**

Recent CaRA funding has been allocated towards the development of local forecasting models. Although CaRICOOS has yet to develop its own modeling capabilities, collaboration with the National Weather Service (NWS) and Naval Research Laboratories allows CaRA to provide regional nowcasts and forecasts for sea surface temperature, height and salinity; wind; and waves. In addition, CaRA uses satellite imagery to provide observations of sea surface temperature and atmospheric visibility several times per day. Unlike many other regional associations that have avoided direct involvement in emergency preparation and response, CaRA is a key partner in the Puerto Rico Tsunami Warning and Mitigation Program. This program combines bathymetry with tidal gauge and buoy data to provide real-time warnings and hazard maps for impending coastal disasters. As CaRA matures, the association looks forward to working more closely with NWS in the development of data products for Caribbean users.
Although CaRA is a relatively young regional association, it has emphasized extensive communication with stakeholders in the early stages of its implementation plan. This focus is based on principles gleaned from other regional associations and observing systems – those which have experienced successes with local communication and outreach strategies – such as the Gulf of Maine Ocean Observing System. Stakeholder outreach efforts have played a fundamental role in shaping CaRA’s current and future goals. The association’s governance structure strives to be representative and aims to integrate members from the private sector; federal, state and local agencies; research organizations; academic institutions; and non-governmental organizations. Frequent community information sessions are offered to educate public and private users about currently available data products, user tools that are in development and the utility of such products in various contexts. These educational workshops are used to inform tourism operators, fishers, and boaters about how to access currently available data products, including nowcasts available through the CaRA database. More importantly, information in these public sessions flows from CaRA to users and vice-versa: in addition to reaching out to stakeholders to encourage the use of available data, CaRA also strives to identify user needs for future data product development. By intensively engaging stakeholders in the developmental stages of its regional association, CaRA ensures that it can efficiently allocate funding and research efforts into observing systems that serve local needs.
The Gulf of Mexico Coastal Ocean Observing System represents a broad community of stakeholders – not just scientific research.

Ocean hazards in the Gulf of Mexico include harmful algal blooms (HABs) and hurricanes, to which Gulf Coast communities are particularly vulnerable. These threats endanger the proper functioning of coastal ecosystems and moderate the activities, including offshore oil extraction, commercial fishing and recreation, that fuel the Gulf Coast’s lucrative economy. GCOOS has developed the following priorities in response to Gulf of Mexico ocean hazards.

1. Develop comprehensive, gulf-wide circulation models
2. Improve hurricane tracking and prediction
3. Develop storm surge mapping capabilities
4. Track and predict harmful algal blooms

Although Texas A&M is the lead institution for GCOOS activities, stakeholders and researchers are widely dispersed in the Gulf Coast region. Throughout the MOA process, GCOOS has strengthened diverse partnerships with private, non-profit, academic, federal and state entities, representatives of which sit on the GCOOS Board of Directors and Stakeholder Council.

The first workshops organizing GCOOS were held in 2000. GCOOS used the National Data Buoy Center (NDBC) as a conduit for early information and worked closely with the Texas General Land Office. The Memorandum of Agreement was created and originally signed in January 2005 by a variety of individuals who both use and provide data to GCOOS. Voting rights within the organization are allocated amongst individual or group donors, including Shell International Exploration & Production Inc., Texas A&M University, the Tampa Bay Estuary program and many private individuals.

**Data Products**

GCOOS has prioritized user needs in a drive to design data products that have real-world utility for stakeholders. Extensive communication with users has allowed staff to develop a keen understanding of needs in the Gulf Coast region, and GCOOS has worked closely with stakeholders to ensure that data products will meet user expectations. Despite laying a solid foundation for the distribution of data products, GCOOS is currently unable to provide predictive information to the public due to the technical requirements of real-time data.
integration. The implementation of this technology is feasible but inadequately funded, and progress is slow. At present, only individual datasets are publicly available through the GCOOS website.

The Gulf of Mexico is a center for ocean drilling projects, and a unique partnership between oil companies and GCOOS accrues benefits to both parties. Real-time ocean observations (e.g. wind speed, currents, salinity) are collected automatically from oil platforms – even during hurricanes. This technology provides high resolution, in-situ measurements of atmospheric and oceanic variables for GCOOS modeling efforts, the results of which can be used by oil companies to understand the current and wave stresses on offshore platforms. GCOOS’ Gulf circulation research is critical for safe and profitable extractive industry practices: the organization has recently received a $1.3 million grant to pursue ocean eddy research and improve circulation models. Efforts to ensure that ocean observing data is free to GCOOS and the public were complicated by industry reluctance to release proprietary data. These limitations, a major challenge of broad cooperation with the private sector, were quickly overcome in negotiation, and GCOOS data remains public regardless of its source.

COMMUNICATIONS

Concerning its data and predictions related to ocean hazards, GCOOS cooperates with the National Weather Service (NWS) through the National Data Buoy Center (NDBC). Buoy data are integrated into NDBC’s national database and GCOOS’ regional weather predictions. While the integration of buoy data into NWS models has been ongoing for some time, incorporation of more advanced GCOOS ocean observations, such as wave height, wave direction and sea surface temperature, remains difficult due to incompatible data formatting. Although coastal zone and emergency managers do not interact formally with GCOOS at present, the organization hopes to provide inundation mapping data products to emergency managers in the future.

GCOOS has made a substantial effort to engage federal, state and local agencies, non-profit organizations and other stakeholders in the regional association development process. A full-time Outreach and Education Coordinator is responsible for developing brochures, fact sheets, public displays, classroom material and presentations to educate potential users and the public about the role of ocean observing systems and coastal ocean issues more generally. Staff and directors have recognized that the association needs to represent a broad community beyond the academic researchers and scientists who operate regional ocean observing systems. In pursuit of diverse perspectives, GCOOS has partnered with the Gulf of Mexico Alliance, composed of gulf-state environmental agencies, the National Oceanic and
Atmospheric Administration, Environmental Protection Agency and other Federal agencies. Close collaboration across state boundaries is essential in the Gulf of Mexico, particularly in cases where organizational mission goals overlap.

Communication and cooperation between Integrated Ocean Observing System regions can often help to identify gaps and opportunities. GCOOS’ regional association has demonstrated the utility of this interaction through a workshop series held in conjunction with SECOORA (the Southeast Coastal Ocean Observing Regional Association) and designed to facilitate a better relationship with the US Coast Guard through the integration of Coastal Ocean Dynamics Applications Radar data into search-and-rescue models. The success of these workshops suggests future collaboration with SECOORA is likely, as it will allow GCOOS to integrate the lessons learned in another region into local observing system and regional association development.
SCCOOS serves major population centers along the Southern California Bight, including Los Angeles and San Diego. Coastal ocean observing is of particular importance in this region because the economy is sustained by marine ecosystem services; for example, healthy and clean beaches represent a $1.5 billion dollar annual tourism industry.\(^1\) SCCOOS' research priorities address needs associated with the many human uses of the Southern California Bight. These focal areas include marine safety, wildlife and fisheries, harmful algal blooms and non-point source pollution.

**DATA PRODUCTS**

A wide range of ocean observations is provided publicly by SCCOOS. Web-accessible data include the following.

- Bathymetry
- Meteorological observations
- Wind and precipitation forecasts
- Ocean circulation modeling
- Satellite imagery
- Surface current maps
- Chlorophyll and harmful algal blooms
- Wave conditions

**COMMUNICATIONS**

SCCOOS has been very active in courting stakeholders and has involved many potential users in the process of data product development. Sample users of SCCOOS data products include beach-goers; water quality, shoreline and marine resource managers; maritime safety and transportation authorities; and oil spill responders. Most recently, SCCOOS has approached human health experts in an attempt to integrate SCCOOS observations and risk predictions into the National Oceanic and Atmospheric Administration’s Oceans and Human Health Initiative.

Californians and their elected representatives are generally quite supportive of an integrated coastal ocean observing system that could aid coastal decision-making. As such, sufficient funding has reached both regional coastal ocean observing systems in the state. SCCOOS works closely with its Northern California counterpart to ensure comprehensive and compatible coverage of the entire coast. This relationship is codified in the associations’ MOU, which commits to common standards for data. The two regions also share surface current display tools and operating procedures with the Northwest Association of Networked Ocean Observation Systems.\(^1\) Staff are hopeful that this system of data interoperability will become the foundation for a national surface current mapping network.
APPENDIX 1: Coastal Ocean Observing Regional Associations

Alaska

AOOS

Dotted with islands and inlets, the longest coastline in the nation presents special challenges for the Alaska Ocean Observing System.

With 47,300 miles of tidal shoreline to monitor, coastal observing in Alaska is quite challenging—and expensive. The state’s population is fairly low, and the majority of coastline is located in dense wilderness far from the population centers of Anchorage, Fairbanks and Juneau. Large distances not only limit the feasibility of effective, real-time data collection but also prevent basic understanding of coastal properties and processes. For example, accurately mapping the coastline, which could enable inundation and coastal erosion monitoring and prediction, is infeasible at this time due to funding constraints. In addition to being far removed from research centers, the Alaska coastal ocean freezes from October to June every winter. This is a unique feature of the AOOS region not faced by any other Integrated Ocean Observing System or association. Despite these various internal and external challenges, AOOS has started operations with a pilot project in Prince William Sound, recognizing the key ecological and economic of this area.

AOOS was constituted in 2004 under an informal Memorandum of Agreement (MOA). As the Federal government has long maintained a strong presence in Alaska, ocean observing in the region was initially tasked to agencies such as the National Weather Service (NWS) and National Oceanic and Atmospheric Administration. As a result, academic institutions and state agencies are currently inadequately represented in the Alaskan ocean observing community, having chosen not to duplicate efforts underway in Federal agencies. Since Federal agencies face significant restrictions when considering partnership arrangements such as MOAs, AOOS lacks formal relationships with major ocean data providers.

DATA PRODUCTS

The primary institution responsible for AOOS implementation, and home of the system’s principal investigators, is the University of Alaska, Fairbanks. For the past three years, AOOS modelers have been working there to define and test the boundaries of predictive
atmospheric, oceanic and wave models. Building on this experience, AOOS hopes to further enhance operations in summer 2008 by using drifters and gliders to obtain higher-resolution observing data from the Prince William Sound pilot project. Staff are hopeful that more accurate data and models will accelerate the pace at which data products can be delivered to the public.

Funding represents the major challenge for AOOS' provision of data products. At present these products are dependent on a combination of short-term grants to individual researchers, resulting in a funding stream for Alaskan ocean observing that is highly variable and often restricts progress on important projects. For example, funding cuts have left AOOS unable to provide oil spill tracking for southeast Alaska, even though this data product was identified as a priority in conversations with stakeholders.

**COMMUNICATIONS**

Still in its nascent stages, AOOS is in the process of developing networks for external communication. The organization has adjusted some data outputs to conform with NWS standards in preparation for future information sharing; even so, AOOS is not currently providing any ocean observing data to NWS.
Stretching from Cape Cod to Cape Hatteras, the Mid-Atlantic ocean observing region includes the Massachusetts & Rhode Island Bays, Long Island Sound, the New York Bight, Delaware Bay and the Chesapeake Bay (the world’s largest estuary). The region is densely populated and contains essential infrastructure in urban areas including New York City and Washington, D.C. Ocean hazards in the Mid-Atlantic include harmful spills and plumes, hurricanes and destructive storm surge. The region’s ocean observing community is unique because MACOORA was officially constituted prior to MARCOOS (the Mid-Atlantic Regional Coastal Ocean Observing System) itself. While MACOORA incorporated as a non-profit in 2005, MARCOOS is still developing a Memorandum of Agreement to guide organizational activities. The majority of MACOORA’s research funding, included grants renewed in 2007, is funneled through Rutgers University in New Jersey, home of the association’s principal investigator.

**DATA PRODUCTS**

Ocean observing in the Mid-Atlantic has been ongoing for roughly 10 years and is based on data collection technologies such as high-frequency radar (CODAR), satellite remote sensing and autonomous underwater gliders. MARCOOS’ raw data, including high-resolution glider observations, are publicly available online. In addition to developing an easy-access website, MACOORA has worked with regional stakeholders to identify user needs for which MARCOOS can generate specific data products. Currently the program is focused on maritime safety products, including those concerning search-and-rescue and hazardous spill response, and ecological decision support products such as fishery forecasts.

For example, CODAR surface current data will soon be integrated into US Coast Guard search-and-rescue modeling in an effort to improve the accuracy of these predictions. MARCOOS’ partnership with the Coast Guard is not formally defined but instead built on long-standing, informal relationships between individuals. The Monmouth County Health Department, in New Jersey, is also utilizing CODAR data to track and predict New York City’s combined sewer overflows in the Hudson River. This kind of inshore circulation is not modeled by the National Weather Service and may represent a promising avenue for MACOORA’s
future data product development.

**COMMUNICATIONS**

At present, MACOORA is actively seeking greater involvement in Mid-Atlantic emergency management preparation and response through cooperation with the National Weather Service (NWS), which issues warnings for hurricanes and other coastal hazards. Ocean observers at Rutgers University are currently working with NWS' Mount Holly, New Jersey forecast office to enhance the accuracy of MARCOOS' experimental weather research and forecasting model. Although this model functions independently of operational NWS forecasting models, it can provide meteorologists in Mount Holly with higher-resolution results than are otherwise available for the Mid-Atlantic. MARCOOS' relationship with NWS is allowing researchers to evaluate how their current observation and modeling efforts fit into NWS' national, networked system. Staff are hopeful that MARCOOS will soon be able to coordinate with NWS' Wakefield, Virginia field station, and three others in the Mid-Atlantic, in a similar fashion.

MACOORA proved its potential to contribute substantively to emergency preparation discussions as Tropical Storm Ernesto moved towards the Mid-Atlantic Bight in Fall 2006. As the storm approached, the Delaware River Basin Commission (DRBC) was hoping to prevent inland flooding by opening dams and allowing retained waters to flow towards the ocean. MARCOOS modelers, however, had forecasted higher-than-normal water levels for coastal areas, so they were aware that additional water flowing down the Delaware River would induce flooding along the coast. With this knowledge in hand, MARCOOS alerted the DRBC that Tropical Storm Ernesto was more likely to induce flooding along the coast than inland. In response, DRBC abandoned its plans to open dams upstream and probably prevented some coastal inundation. Although MARCOOS can provide real-time and forecast data in support of emergency management missions, it maintains no formal relationships with emergency managers. The DRBC episode, enabled by informal cooperation between DRBC and MARCOOS personnel, underscores the utility of easy, off-the-record information-sharing in the Mid-Atlantic.

Conversations between MARCOOS and other regional ocean observing systems and associations have been restricted despite their close proximity to one another. For instance, contact with the Northeastern Association of Coastal Ocean Observing Systems has been limited to clarification of regional boundaries. Although MARCOOS has yet to formally engage colleagues in the Southeast, Rutgers University researchers operate a North Carolina CODAR station in partnership with Southeast Atlantic Coastal Ocean Observing System personnel.
Building on a 3-year pilot project begun in 2004, NANOOS has continuously sought to integrate disparate regional sources of ocean observing data in order to provide diverse users with a variety of data products and tools. Ocean observing systems in the Pacific Northwest first came together in 2003 to sign the NANOOS charter; two year later an official Memorandum of Agreement was signed to formally constitute the association. NANOOS counts over 25 member institutions that represent a broad range of stakeholders including industrial, nonprofit, academic and research, tribal, local and state entities. In addition, NANOOS has strong relationships with Federal agencies including the National Estuarine Research Reserve System (NERRS). Working together, NANOOS partners have successfully integrated several ocean observing datasets and look forward to including other regional sources. At present, data from NERRS, Oregon Health and Science University (OHSU), the University of Washington and Washington’s Department of Ecology are being integrated to provide users with water quality and coastal monitoring products, among others. Although NANOOS’ preliminary work to identify stakeholders and regional priorities has yielded promising results, funding remains a major obstacle for future organizational development.

NANOOS has successfully leveraged the ocean observing capabilities of academic institutions in the region to provide a fairly comprehensive picture of ocean conditions off the Oregon and Washington coasts. Research foci include waters of the continental shelf, surface currents, estuaries and shorelines, and different observing systems are in place to monitor these zones. For example, six long-range and five standard-range high-frequency radar systems are used to gauge surface currents, while observations of the continental shelf derive from a network of buoys operated by Federal, state and academic partners. NANOOS’ coastal change data products are informed by high-resolution topographic and bathymetric
mapping of the coastal margin.

**Data Products**

Although observing systems in the region are providing a wealth of data to serve user needs, the major areas of interest to stakeholders do not include disaster response or emergency management. Serious ocean hazards such as hurricanes and storm surge are of relatively little concern in the Pacific Northwest, and although tsunami represent a potential catastrophe, this threat is already addressed by the National Weather Service. Discussion with stakeholders reveals that NANOOS can be most useful in providing data products that address maritime operations (e.g., search and rescue, oil spills), ecosystem impacts (e.g., water quality, harmful algal blooms), fisheries and coastal hazard mitigation (e.g., beach retreat, coastal change).

Publicly available data products advertised on NANOOS’ website include beach and shoreline observations from the Oregon Department of Geology and Mineral Industries; surface current maps from Oregon State University and the Oregon Coastal Ocean Observing System; and email alert bulletins about water quality for shellfisheries from NERRS and the Washington Department of Health.

**Communications**

Although its website is nascent, NANOOS aims to develop a more comprehensive web portal through which its entire suite of user products and tools can be easily accessed. Data products are projected to serve a broad community of regional stakeholders, including port authorities, the US Coast Guard and Environment Protection Agency, state resource managers, tribal and local governments, researchers, fishermen, coastal planning authorities and the public at large. Currently, NANOOS’ ability to provide the real-time, value-added products desired by stakeholders is limited, though several data products are available while the production of more advanced tools is ongoing.

Having identified state health and marine resource managers as a key stakeholder group, NANOOS has partnered with NERRS, the University of Washington and several shellfish industry groups to produce email alert bulletins when water quality parameters indicate a risk of harmful algal blooms. This system is based on real-time observations from seven stations in Washington and Oregon; NANOOS also collects data from and provides advisories for two sites in Alaska.

Its coastal change products have allowed NANOOS to approach and work with state planning authorities concerning engineering works and development along shorelines. Erosion rates, pre- and post-storm beach observations are used by Oregon’s Departments of Parks and Recreation and Land Conservation and Development in evaluating permitting decisions for coastal structures. Coastal change data is thought to be particularly useful in assessing the short- and long-term beach response to the El Niño-Southern Oscillation, storms and climate change. Understanding these issues can help managers determine the proper locations for jetties, breakwaters and other coastal modifications.

Despite the fact that NANOOS has yet to develop a relationship with the US Coast Guard’s 13th District, partner organizations including OHSU’s Columbia River Observation Network (CORIE) have collaborated with the Coast Guard on maritime operations data products. CORIE’s
surface current data, while not integrated directly into Coast Guard search-and-rescue models, has been used to predict the location of lost mariners. Given this positive introduction, it is possible that the Coast Guard will make use of NANOOS’ regional surface current data in the future.

Other than the Coast Guard, NANOOS institutions have no contact with emergency management or disaster response agencies.

As NANOOS continues to develop a more comprehensive ocean observing system, modeling ability and suite of data products, it will benefit from ongoing conversations with regional stakeholders. In addition, NANOOS’ relationships with observing systems in British Columbia and Northern California will provide bases for comparison as the association matures.
SECOORA has built upon the Southeast Atlantic Coastal Ocean Observing System’s (SEACOOS) strong foundation to provide the following services for Southeastern ocean users.

1. Data management and communications;
2. Data analysis and modeling; and
3. Data visualization and publishing.

Although the regional association did not have a governing Memorandum of Understanding until 2000, ocean observing test buoys have been sited in the Gulf of Mexico since the late 1990s.

Working closely with the University of South Florida, SECOORA uses data from about a dozen nearshore buoys, seven offshore buoys and three high-frequency Coastal Dynamic Applications Radar systems to provide ocean observations along the southeastern coast. These observing systems are part of the region’s Coastal Ocean Monitoring and Prediction System (COMPS), which uses ocean observations in hydrodynamic models to forecast ocean conditions and currents. In addition, SECOORA uses satellite data and pulls real-time observations and historical data from the Physical Oceanographic Real-Time System (PORTS) and National Water Level Observation Program, respectively, through the National Oceanic and Atmospheric Administration’s Center for Operational Oceanographic Products and Services (CO-OPS).¹

**Data Products**

By partnering with the University of Miami, SEACOOS is able to provide wind, sea surface temperature and surface current forecasting for the East Florida Shelf, while its modeling work at the University of South Florida and University of North Carolina at Chapel Hill yield similar forecasts for the West Florida Shelf and Carolina coast. The accuracy of these predictions has improved over time, in part due to the use of high-
precision instruments and rapid integration of data into computer inundation models. SECOORA also provides access to real-time data on surface currents, wind, sea surface temperatures and water levels.

**Communications**

SECOORA employs an internet-based information-sharing network, known as Workspaces, to allow the free exchange of research and news both internally and between the association and other ocean research parties in the Southeast.¹ To foster communication between biologists, policymakers, conservationists, the military and government personnel, SECOORA is sponsoring the 2008 Association of Southeastern Biologists Annual Meeting.¹ This conference will bring diverse stakeholders together to share current research and showcase new ocean observing system technologies and applications. These communication efforts have yielded several successes involving collaboration across research disciplines and the integration of ocean observing data into useful consumer products. Stakeholders’ desire for specific user tools pushed SECOORA to develop the following data products:

- Accurate flood warning;
- Harmful algal bloom tracking;
- Riverine sedimentation runoff; and
- Ocean circulation.¹

In terms of emergency management, SECOORA’s efforts have focused on communication and collaboration with researchers, modelers and local emergency managers. A 2002 grant allowed SECOORA to participate in a pilot program that sought to provide local emergency managers with ocean condition data collected from offshore buoys, and informal relationships with local emergency managers endure despite the fact that the grant has since expired. In all of its collaborative work, SECOORA demonstrates that cooperation with multiple stakeholder groups can be quite successful when funding is sufficient to initiate and maintain necessary partnerships.
Regional Associations (RAs) across the nation have encountered numerous difficulties in trying to fulfill the promise of the Integrated Ocean Observing System (IOOS). Many of these problems concern communication: efficient networks for interaction and the exchange of ideas do not yet exist in many regions of the country. Furthermore, RAs must ensure that ocean observers, forecast modelers and user groups are constantly communicating with and among one another in order to meet IOOS’ seven societal goals. Using ocean observations to inform climate change and weather predictions; enhance the safety and efficiency of maritime operations; mitigate the impacts of natural hazards; improve national security; address public health issues; protect and restore coastal ecosystems and enable sustainable marine resource use requires RAs to find common ground among diverse stakeholder groups. 

It is clear that formal and informal communication networks are a invaluable asset for RAs attempting to provide ocean observations that are capable of generating important and useful data products.

Most regions have experienced successes with workshops and other meetings arranged specifically to solicit input from local, state, Federal, non-profit and industry stakeholder groups. These conferences serve a dual purpose: they allow RAs to disseminate information to interested stakeholders and the public at large and also provide a venue for RAs to hear stakeholders voice their comments and concerns. When periodic meetings are scheduled and potential attendees notified in advance, relevant parties will have ample opportunity to explain their perspectives and participate in broader discussions about regional objectives and opportunities.
## Appendix 2: Important Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>ADCP</td>
<td>Acoustic Doppler Current Profiling</td>
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<tr>
<td>AOOS</td>
<td>Alaska Ocean Observing System</td>
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<tr>
<td>AWIPS</td>
<td>Advanced Weather Interactive Processing System</td>
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<tr>
<td>CaRA</td>
<td>Caribbean Regional Association</td>
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<tr>
<td>CARICOOS</td>
<td>Caribbean Regional Integrated Coastal Ocean Observing System</td>
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<tr>
<td>CENCOOS</td>
<td>Central and Northern California Ocean Observing System</td>
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<tr>
<td>CIMS</td>
<td>Citywide Incident Management System OR New York City's Implementation of the National Incident Management System</td>
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<tr>
<td>C-MAN</td>
<td>Coastal-Marine Automated Network</td>
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<tr>
<td>CODAR</td>
<td>Coastal Ocean Dynamics Applications Radar</td>
</tr>
<tr>
<td>COMPS</td>
<td>Coastal Ocean Monitoring and Prediction System</td>
</tr>
<tr>
<td>CO-OPS</td>
<td>Center for Operational Oceanographic Products and Services (also NOAA CO-OPS)</td>
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<tr>
<td>CoRie</td>
<td>Columbia River Observation Network</td>
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<tr>
<td>CTP</td>
<td>Cloud Top Pressure</td>
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<tr>
<td>DHS</td>
<td>US Department of Homeland Security</td>
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<tr>
<td>DMAC</td>
<td>Data Management And Communications</td>
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<td>DRBC</td>
<td>Delaware River Basin Commission</td>
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<tr>
<td>EEZ</td>
<td>Exclusive Economic Zone</td>
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<tr>
<td>ERD</td>
<td>Emergency Response Division (also see NOAA ERD)</td>
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<tr>
<td>ESF</td>
<td>Emergency Support Function</td>
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<tr>
<td>FEMA</td>
<td>Federal Emergency Management Agency</td>
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<tr>
<td>GCOS</td>
<td>Gulf of Mexico Coastal Ocean Observing System</td>
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<tr>
<td>GEOSS</td>
<td>Global Earth Observing System of Systems</td>
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<tr>
<td>GFS</td>
<td>Global Forecast System</td>
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<tr>
<td>GLC</td>
<td>Great Lakes Commission</td>
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<td>GLIN</td>
<td>Great Lakes Information Network</td>
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<tr>
<td>GLOS</td>
<td>Great Lakes Observing System</td>
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<tr>
<td>GNOME</td>
<td>General NOAA Oil Modeling Environment</td>
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<td>GOES</td>
<td>Geostationary Operational Environmental Satellite</td>
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<tr>
<td>GOMOOS</td>
<td>Gulf of Maine Ocean Observing System</td>
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<tr>
<td>HAB</td>
<td>Harmful Algal Bloom</td>
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<tr>
<td>HAZUS - MH</td>
<td>Hazards U.S. Multi-Hazard</td>
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<tr>
<td>HF</td>
<td>High Frequency</td>
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<tr>
<td>HOPS</td>
<td>Harvard Ocean Prediction System</td>
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<tr>
<td>HURREVAC</td>
<td>Hurricane Evacuation Modelling System</td>
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<tr>
<td>IMT</td>
<td>Incident Management Team</td>
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<td>ICS</td>
<td>Incident Command System</td>
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<tr>
<td>IOOS</td>
<td>Integrated Ocean Observing System</td>
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<tr>
<td>LIDAR</td>
<td>Light Detection And Ranging</td>
</tr>
<tr>
<td>LISCOS</td>
<td>Long Island Sound Integrated Coastal Observing System</td>
</tr>
<tr>
<td>MABGOM</td>
<td>Mid-Atlantic Bight / Gulf of Maine</td>
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<tr>
<td>MACOORA</td>
<td>Mid-Atlantic Coastal Ocean Observing Regional Association</td>
</tr>
<tr>
<td>MARCOOS</td>
<td>Mid-Atlantic Regional Coastal Ocean Observing System</td>
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<tr>
<td>MOA</td>
<td>Memorandum of Agreement</td>
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<tr>
<td>MTA</td>
<td>Metropolitan Transit Authority</td>
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<tr>
<td>NAM</td>
<td>North American Mesoscale</td>
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<tr>
<td>Abbreviation</td>
<td>Full Form</td>
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<tr>
<td>NANOOS</td>
<td>Northwest Association of Networked Ocean Observation Systems</td>
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<tr>
<td>NCAR</td>
<td>National Center for Atmospheric Research</td>
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<tr>
<td>NCDC</td>
<td>National Climate Data Center</td>
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<tr>
<td>NCEP</td>
<td>National Center for Environmental Prediction</td>
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<tr>
<td>NDBC</td>
<td>National Data Buoy Center</td>
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<tr>
<td>NEP</td>
<td>National Estuary Program</td>
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<tr>
<td>NERACOOS</td>
<td>Northeastern Regional Association of Coastal Ocean Observing Systems</td>
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<tr>
<td>NERRS</td>
<td>National Estuarine Research Reserve System</td>
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<tr>
<td>NHC</td>
<td>National Hurricane Center</td>
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<tr>
<td>NIMS</td>
<td>National Incident Management System</td>
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<tr>
<td>NJOEM</td>
<td>New Jersey Office of Emergency Management</td>
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<tr>
<td>NOAA</td>
<td>National Oceanic and Atmospheric Administration</td>
</tr>
<tr>
<td>NOAA CO-OPS</td>
<td>Center for Operational Oceanographic Products and Services</td>
</tr>
<tr>
<td>NOAA ERD</td>
<td>Emergency Response Division</td>
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<tr>
<td>NRP</td>
<td>National Response Plan</td>
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<tr>
<td>NWS</td>
<td>National Weather Service</td>
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<tr>
<td>NYHOPS</td>
<td>New York Harbor Observing and Prediction System</td>
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<tr>
<td>OAP</td>
<td>Ocean Action Plan</td>
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<tr>
<td>OEM</td>
<td>Office of Emergency Management</td>
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<tr>
<td>OHSU</td>
<td>Oregon Health and Science University</td>
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<tr>
<td>ONR</td>
<td>Office of Naval Research</td>
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<tr>
<td>OPeNDAP</td>
<td>Open-source Project for a Network Data Access Protocol</td>
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<tr>
<td>OR&amp;R</td>
<td>Office of Response and Restoration</td>
</tr>
<tr>
<td>OSC</td>
<td>On-Scene Coordinator (for Spill Response)</td>
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<tr>
<td>PACIOOS</td>
<td>Pacific Integrated Ocean Observing System</td>
</tr>
<tr>
<td>PLUSNet</td>
<td>Persistent Littoral Undersea Surveillance Network</td>
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<tr>
<td>POES</td>
<td>Polar Orbiting Environmental Satellite</td>
</tr>
<tr>
<td>PORTS</td>
<td>Physical Oceanographic Real-Time System</td>
</tr>
<tr>
<td>RA</td>
<td>Regional Association</td>
</tr>
<tr>
<td>RCOOS</td>
<td>Regional Coastal Ocean Observing System</td>
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<tr>
<td>REMUS</td>
<td>Remote Environmental Monitoring Units</td>
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<tr>
<td>ROMS</td>
<td>Regional Ocean Modeling System</td>
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<tr>
<td>RSS</td>
<td>Really Simple Syndication</td>
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<tr>
<td>RUUOOL</td>
<td>Rutgers University Coastal Ocean Observing Laboratory</td>
</tr>
<tr>
<td>SCCOOS</td>
<td>Southern California Coastal Ocean Observing System</td>
</tr>
<tr>
<td>SEACOOS</td>
<td>Southeast Atlantic Coastal Observing System</td>
</tr>
<tr>
<td>SECOORA</td>
<td>Southeast Coastal Ocean Observing Regional Associations</td>
</tr>
<tr>
<td>SEMO</td>
<td>New York State Emergency Management Office</td>
</tr>
<tr>
<td>SLOSH</td>
<td>Sea, Lake and Overland Surges from Hurricanes modeling system</td>
</tr>
<tr>
<td>SMAST</td>
<td>School for Marine Science and Technology</td>
</tr>
<tr>
<td>SSC</td>
<td>Scientific Support Coordinator (NOAA ERD)</td>
</tr>
<tr>
<td>STPS</td>
<td>Short Term Prediction System</td>
</tr>
<tr>
<td>USACE</td>
<td>United States Army Corps of Engineers</td>
</tr>
<tr>
<td>USCG</td>
<td>US Coast Guard</td>
</tr>
<tr>
<td>USNFRA</td>
<td>US National Federation of Regional Associations</td>
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<tr>
<td>VOS</td>
<td>Voluntary Observing Ship</td>
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<tr>
<td>WERA</td>
<td>Wave Radar</td>
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<tr>
<td>WRF</td>
<td>Weather Research Forecast</td>
</tr>
<tr>
<td>XBT</td>
<td>Expendable Bathythemograph</td>
</tr>
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</table>
Appendix 3: Legal Statutes Relevant to Emergency Management

Federal Statutes
(As adapted from www.state.nj.us/njoem/documents/fedlaw.doc)

**FEDERAL CIVIL DEFENSE ACT OF 1950**
Establishes the Federal framework for providing fiscal assistance to the state’s emergency management activities.

**ROBERT T. STAFFORD DISASTER RELIEF AND EMERGENCY ASSISTANCE ACT**
Enabling legislation for the development of the Federal Disaster Recovery Program.

**DISASTER MITIGATION ACT OF 2000**
The Disaster Mitigation Act of 2000 amends the Stafford Act (42 U.S.C. 5121 et seq.), establishes a national program for pre-disaster mitigation, streamlines the administration of disaster relief, and aims to control Federal costs of disaster assistance.

**44 CFR PART 350**
Establishes policy and procedures for the review and approval by the Federal Emergency Management Agency (FEMA) of state and local emergency plans and preparedness for responses to incidents at commercial nuclear power plants. Review and approval of these plans and preparedness involves preparation of findings and determination of adequacy of the plans and capabilities of states and local governments to effectively implement the plans.

**44 CFR PART 351**
Assigns federal agency responsibilities for assisting state and local governments in emergency planning and preparedness for incidents at commercial nuclear power plants. Assigns responsibility to FEMA for all offsite nuclear emergency planning and response.

**PL-99-400 “SUPERFUND REAUTHORIZATION ACT”**
Requires chemical handling facilities to prepare annual chemical inventories and maintain emergency response plans. It also requires an emergency planning structure be instituted for the state and local emergency planning committees.

**FEDERAL PROPERTY ADMINISTRATION SERVICES ACT**
Establishes the procedures for the transfer of excess and surplus federal property to the states.

New York Statutes
(As adapted from http://www.semo.state.ny.us/about/legal.cfm)

**FEDERAL CIVIL DEFENSE ACT OF 1950**
This act established Federal Civil Defense policy during the 1950s. It created a Federal Civil Defense Agency and provides monetary assistance to states for preparedness activities.

**NEW YORK STATE DEFENSE EMERGENCY ACT OF 1951**
This act established State Civil Defense policy and created the State Civil Defense Commission. The act assigned Civil Defense responsibilities to County and Chief Executive Officers and City Mayors.

**ROBERT T. STAFFORD DISASTER RELIEF AND EMERGENCY ASSISTANCE ACT OF 1974**
This act established Federal Disaster Assistance policy, which provides monetary assistance for disaster recovery.
PRESIDENTIAL REORGANIZATION PLAN #3 OF 1978
This plan created the Federal Emergency Management Agency (FEMA) and shifted emphasis from civil
defense to all-hazards.

NEW YORK STATE EXECUTIVE LOW ARTICLE 2-B
This article created State Disaster Preparedness Commission (DPC), shifting emphasis from Civil Defense to
all-hazards preparedness activities and mission. It assigned responsibility for off-site radiological emergency
preparedness for commercial nuclear power plants. This created State Emergency Assistance Program in
1993, which provides reimbursement to eligible municipalities for public damages from natural disaster.

FEDERAL SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT OF 1986
These act amended federal hazardous waste policy. It established Community Right-To-Know legislation
and mandated establishment of State Emergency Response Commissions and Local Emergency Planning
Committees to oversee enhanced hazardous substance monitoring programs.

New Jersey Statutes
(As adapted from http://www.state.nj.us/njoem/law_lawlist.html)

ENABLING AUTHORITIES
Reorganization Plan of Civilian Defense Director
The Office of Civilian Defense was transferred from the Department of Defense to the Department of Law
and Public Safety. This reorganization is intended to promote coordination of State, County, and local relief
efforts. All acts and parts of act inconsistent with this reorganization plan are superceded to the extent of
such inconsistencies.

Executive Order 101, 1980 Transfer of Emergency Management to the NJ State Police
Established an Office of Emergency Management in the Division of State Police, Department of Law and
Public Safety. The Office of Emergency Management shall be under the supervision, direction and control
of the State Director of Emergency Management.

Executive Directive No. 1978-1 - Establishment of the Emergency Management Section
The functions, power and duties of the Office of Civilian Defense Director are hereby established in the
Bureau of Emergency Services in the Division of State Police under the authority of William F. Hyland
Attorney General.

EXECUTIVE ORDERS
Executive Order 39, 1954 - Functions and Duties of the State Director - The Office of Emergency
Management is the lead State agency in disaster recovery operations and it is responsible for coordinating
State preparedness plans for major disasters.

Executive Order 12, 1970 - Directs each Department to Develop Emergency Plans - Directs State
Departments to develop, coordinate and keep current a workable plan for the effective utilization of
manpower and resources. Copies of these plans shall be forwarded to the Director of Emergency
Management. The Director of Emergency Management is authorized to call upon any department, office,
division or agency of the State to supply such statistical data, program reports and other information as he
deems necessary.

Executive Order 115, 1994 - Established an-Interagency State Hazard Mitigation Team - A representative of
the office of the Governor will chair the team and the State Hazard Mitigation officer appointed by the
Governor will serve as Deputy Chair. Lists other members of the team, their roles and responsibilities.

Executive Order 161, 1987 - Implementation of the Federal Emergency Planning and Community Right-to-
Know Act - Implementation of the State Emergency Response Commission who shall perform all duties and
acts prescribed by the federal "Superfund Amendments and Reauthorization Act of 1986."
OTHER RELEVANT STATE STATUTES PERTAINING TO EMERGENCY MANAGEMENT

No volunteer fire company, volunteer first aid, rescue or emergency squad, civil defense unit, which provides services for the control and extinguishment of fires or emergency public first aid and rescue services shall be liable in any civil action to respond in damages as a result of any acts of commission arising out of the rendition in good faith of any such services.

**N.J.S.A. 2A:62A-7-Liability of Volunteer Fire Company and Civil Defense Unit**
No individual, partnership, corporation, association, or other entity shall be liable for civil damages as a result of acts taken in the course of rendering care, assistance, or advise with respect to an incident creating a danger to persons or property.

**N.J.S.A. 2C:17-2**
A person who purposely or knowingly, unlawfully causes an explosion, flood, collapse of a building, release or abandonment of poison gas, radioactive materials or any other harmful substance will be charged with a crime in the second degree.

**N.J.S.A. 13:1E-80**
All major hazardous waste facilities shall, for the purpose of local property taxation, be assessed and taxed in the same manner as other property.

**N.J.S.A. 13:1K-17**
When the Department of Environmental Protection obtains information which leads it to suspect that hazardous discharge has occurred, they shall immediately notify the governing body and local Board of Health of the municipality in which the hazardous discharge has occurred and shall take appropriate action to verify that discharge has occurred. Within six months of the effective date of this act the department shall notify the governing body of each municipality in the State with a list of all hazardous discharges reported to the department.

**N.J.S.A. 13:1K-33-35**
The Division of State Police in the Department of Law and Public Safety and the Department of Environmental Protection shall establish and operate a hazardous material discharge initial emergency response training program for municipal and county agents involved in investigating suspected hazardous material discharge.

**N.J.S.A. 26:2D-37-et seq**
The Division of State Police and the Department of Environmental Protection shall prepare or cause to be prepared and adopt a State Radiation Emergency Response Plan. This statute covers local response plans, county response plans, the powers and duties of DEEP and the powers and duties of the Division of State Police. The statute also provides guidelines for other relevant agencies needed for radiation response.

**N.J.S.A. 38A:2-3 et seq.**
Whenever the militia, or any part thereof, is employed in aid of civil authority, the Governor, if in his/her judgement the maintenance of law and order will thereby be promoted, may by proclamation, declare any county or municipality, or part thereof, which the troops are serving to be subject to martial law.

**N.J.S.A. 38A:3-6.1**
The Governor shall have the authority to order to active duty, with or without pay, in State service, such
members of the New Jersey National Guard that in their judgement are necessary to provide aid in circumstances which threaten or are a danger to the public health, safety or welfare.

**N.J.S.A. 38A: 20-3**
The purpose of this compact is to provide mutual aid among the states in meeting any emergency or disaster from enemy attack or other cause (natural or otherwise) including sabotage and subversive acts and direct attacks by bombs, shellfire, and atomic, radiological, chemical, bacteriological means, and other weapons. The prompt, full and effective utilization of the resources of respective states, including such resources as may be available from the United States Government or any other source, are essential to the safety, care and welfare of the people.

**N.J.S.A. 39:4-213**
The Attorney General is authorized to erect directional signals or signs, and assign such police personnel as may be necessary for the manual direction of traffic during an emergency.

**N.J.S.A. 40A:14-156.4**
Suspension of acts to provide emergency assistance. The county emergency management coordinator may by express order suspend operation of the provisions upon declaration of a State of Emergency.

**N.J.S.A. 48:23-11**
In order to qualify for funding pursuant to section 4 of this act, the New Jersey Public Broadcasting Authority shall, upon notification by the Director of the State Office of Emergency Management in the Division of State Police that an emergency condition exists, immediately operate its television stations in order to broadcast news and information concerning the emergency condition.

**N.J.S.A. 52:14A-4 et seq.**
In the event that the Governor, for any reason is not able to exercise and discharge their duties, this statute provides for emergency executive succession.

**N.J.S.A. 52:14-4 et seq.**
The Governor's Advisory Council for Emergency Services and guidance for its operation.

**N.J.S.A. 52:27D-222**
Directs certain entities which store, manufacture, distribute or warehouse unusually hazardous substances to develop an emergency response plan along with the county or municipal fire officials.

**N.J.S.A. 53:1-21.6**
The Director of the State Office of Emergency Management in the Division of State Police shall notify the New Jersey Public Broadcasting Authority when an emergency condition exists or is imminent. The Director shall give the authority all information necessary for the authority to operate its television stations in order to alert and inform the public about the emergency condition.

**N.J.S.A. 55:13C-1**
Need for emergency shelters for victims of fire, natural disasters, domestic violence and other causes of homelessness. Directs the Department of Community Affairs and Human Services to develop regulations for implementation of the Rooming and Boarding Housing Act of 1979.

**N.J.S.A. 58:16A-66 et seq**
The Commissioner of the Department of Environmental Protection shall in consultation with the United States Army Corps of Engineers and in coordination with the Office of Emergency Management in the Division of State Police, develop a flood early warning system.

**N.J.S.A. 58:16a-101**
The office of Emergency Management shall notify the emergency management organization in the counties, which shall then notify the local police departments in the event of a flood situation.
New Jersey Administrative Code - Summary

NJAC 7:19 et seq
The Water Supply Management Act, NASA 58:1A-1 et seq constitutes the rules governing the management of the waters of the State during drought warning and water supply emergencies.

N.J.A.C. 7:26-9.7-212-216 –
Standards and requirements for all persons treating, storing or disposing of hazardous waste.

N.J.A.C. 8:39 41.2-42.2
Guidelines for fire regulations in long-term health care.

N.J.A.C. 8:436-24.13
Guidelines for fire and emergency preparedness for hospital facilities.

N.J.A.C. 12:100-4.2
Hazardous materials and occupational safety and health standards for public employees engaging in general operations.

N.J.A.C. 12:100- 4.3
The purpose of this subchapter is to set forth procedures to protect employees from the hazards of entry into and work within a confined space.

N.J.A.C. Chapter 17
The Governor is authorized to enter into agreements with the governors of any of the states bordering on New Jersey for the protection in the event of emergency of any or all interstate bridges, tunnels, ferries and other communications facilities.

N.J.A.C. Chapter 18
With the prior or subsequent consent of the congress of the United States, the Governor, on behalf of this State, is authorized to enter into, amend, supplement and implement agreements or compacts with the executive authorities of other states, providing for mutual military aid, and matters incidental thereto, in an emergency.

NJ ATTORNEY GENERAL POLICY MEMOS

Memorandum October 8, 1980
The Superintendent of the State Police is the point of authority in emergency situations which are beyond local control when the cabinet officers are not present it must be known that the representative of the State Police is the person in charge.

Memorandum October 29, 1985
The Attorney General opinion regarding the statutory authority of municipal plans.

Memorandum August 10, 1990
Fire chiefs do not have any powers of supersession by virtue of the Statute 40A:14-54, with respect to any members of the New Jersey State Police while acting in their official capacities.

Memorandum January 6, 1992
Economic Responsibilities of Municipalities in periods of emergencies. It is the opinion of the Attorney General that a municipality will bear appropriate costs in dealing with an emergency within its boundaries.

Memorandum January 29, 1993
Procedures for inclement weather and their effect on State operations.

Memorandum June 10, 1993
Any amount of material discharged into a waterway, storm drain or sewer requires immediate notification to
the New Jersey State Police.

**Memorandum June 22 1993**
State Police notification of Hazardous Materials Incident and the procedures to be followed.
Appendix 4: CODAR Ranges

Figure 3: An example of the coverage expanse of one long range CODAR station

Figure 4: An example of the coverage expanse of one short range CODAR station
Appendix 5: Brief Biographies and Contact Information of the Research Team

**John Toniolo** (Manager)
Email: jrt2111@columbia.edu
Bio: A native of New Jersey, John received his B.A. in economics from the University of Maryland. He then worked for the Maryland Department of Natural Resources on wetland restoration around the Chesapeake Bay before returning to the New York area to work for Rockefeller University Press’ Journal of Experimental Medicine. His interests are now turned towards emergency management and planning.

**Kathleen Szleper** (Deputy Manager)
Email: kls2141@columbia.edu
Bio: Born and raised in France, Kathleen came to the US in 1998 where she got her B.A. in Marine Biology from Boston University. She then went on to work as a wild fisheries expert, conservation associate and official translator for NGOs in the Boston area. She has experience managing teams of environmental experts to improve environmental sustainability, and enjoys fostering communication between policy-makers, managers and scientists. She is interested in finding new ways of making sure that the best scientific data is consistently used when making coastal management decisions, especially for the preservation of coastal ecosystems. She is also interested in media and outreach.

**Amanda Gambill**
Email: aag2134@columbia.edu
Bio: With a background in environmental conservation and ecology, Amanda has experience working on marine biodiversity issues, specifically with coral reef habitats and marine protected areas. She spent several months in the British West Indies doing field work and writing a general management plan for marine resources in and around the island of South Caicos. Her interests include storm patterns, impacts on marine life, and ways in which the environment is represented in the psychology of society.

**Ashley Mercer**
Email: amm2205@columbia.edu
Bio: Born in the United States and raised in Canada, Ashley has background in liberal arts and ecology. She is interested in ocean conservation issues, particularly Arctic Ocean policy. She is also interested in storm surge research and its increased prevalence due to climate change in the Arctic, as well as emergency management in urban centers.

**Jeb Berman**
Email: jeb2154@columbia.edu
Bio: Jeb grew up just north of San Francisco. After earning his degree in geology-biology from Brown University, he moved to Washington, DC to help connect marine scientists to policymakers at the Communication Partnership for Science and the Sea (COMPASS). He is interested in pursuing his career in marine policy, thus applying for a Knauss Marine Policy Fellowship through NY Sea Grant.

**Shu Wang**
Email: sw2404@columbia.edu
Bio: Born and raised in Xiamen, China, an island regularly hit by typhoons, Shu learned first hand about the importance of emergency management. With a law degree in political science from
China, she held the position of legislative administrator in an aluminum manufacturing company for a year, overseeing compliance with ISO 14001 (the international environmental standard). Having worked on marine issues throughout her Columbia degree, she is interested in U.S. ocean governance issues.

Jannel Gabriel
Email: jrg2135@columbia.edu
Bio: Raised on the tropical island of St. Lucia with its own unique environmental problems, Jannel's background is in environmental science and natural resource management. Her research experiences include the environmental applications of GIS tools in wetland management and poverty alleviation strategies. Her interests include environmental science and conservation and natural resource management issues.

Erik Jorgensen
Email: ehj2105@columbia.edu
Bio: Erik has a BS in Environmental Engineering, and has worked for the US Bureau of Reclamation in the water treatment field prior to coming to Columbia University. While at the Bureau of Reclamation he assisted in the Department of the Interior’s ESF-3 coordination center during Hurricane Katrina. He is interested in learning how to incorporate and communicate information about technologies to various levels of decision makers to better manage water resources.

Lauren Grochmal
Email: lmg2145@columbia.edu
Bio: Originally from Hampton, VA, Lauren grew up on the Chesapeake Bay and has experienced first hand the impacts of hurricanes and emergency response. She has a background in advertising, marketing and communication, as well as environmental policy and planning. Her interests are primarily in the impacts of agriculture on marine ecosystems as well as environmental and ethical issues of the meat and dairy industry.

Larron Win
Email: ayw2105@columbia.edu
Bio: Larron is originally from New York City. Before earning his Bachelor degree in Environmental Studies and a minor in Biology from St. John’s University, he worked for UNICEF headquarters for 2 years and served in the United States Army for 5 years. He has almost 2 years experience working in a laboratory researching the reproduction of hard clams (Mercenaria mercenaria). Currently his interests include finding innovative ways for corporations and government/s to work towards a sustainable growth in urban areas, as well as coastal resource management.

Rebekah Hamed
Email: ryh2104@columbia.edu
Bio: Rebekah earned her Bachelor degrees in Science (Resource and Environmental Management) and Law from the Australian National University. She went on to work as a researcher at the Australian Conservation Foundation (an environmental NGO) and later, as a sustainability policy analyst for the Victorian State Government. Her main policy interests are in multi-sectoral approaches to decision-making and implementation, and legal frameworks for cross-boundary environmental issues.