An Overview of the Coastal Ocean Monitoring and Prediction System (COMPS)

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***Abstract*- Florida is the United States' fourth most populous state, with 80% of the population living in a coastal county. Several recent storms have brought large, unpredicted flooding to Florida's West Coast. The coastal sea level response to tropical and extra-tropical storms results from wind forcing over the entire continental shelf. For example, during the March 1993 no-name "Storm of the Century", residents of West Florida's Pasco County experienced storm surge flooding of 6-9 feet along the coast in the early morning hours when most people were asleep. 8,009 units received some level of damage. 2,266 homes received minor damage, 5,506 received major damage and storm surge flooding destroyed 237 homes. In contrast, local response may actually be due to storm winds quite distant from the local area of concern; a case in point being Tropical Storm Josephine, a modest storm that nevertheless brought large, unpredicted flooding in the spatially distant Tampa Bay, Florida area.**

This overview briefly describes the University of South Florida/College of Marine Science's (USF/CMS) Coastal Ocean Monitoring and Prediction System (COMPS). COMPS operates along the Gulf of Mexico's west Florida coast and was implemented in 1997 as a State of Florida legislative initiative. Data and model products are disseminated in real-time to federal, state, and local emergency management officials by various means including the Internet (URL http://comps.marine.usf.edu). The COMPS overall program goal is to provide real-time data for emergency management use and to improve description and understanding of the relevant physical processes that control shelf circulation, hydrography, and coastal flooding caused by storm surges. COMPS provides an example of the practical value of university research.

I. INTRODUCTION

A. PROGRAM HISTORY

Coastal Flooding and high winds are major problems along the West Coast of Florida. Tropical storms, hurricanes, extra-tropical winter storms like the March 13, 1993 "Storm of the Century", and squall lines hit frequently. The coastal sea level response to tropical and extra-tropical storms results from wind forcing over the entire continental shelf. For example, during the March 1993 "Storm of the Century", residents of West Florida's Pasco County experienced storm surge flooding of 6-9 feet along the coast in the early morning hours when most people were asleep. 8,009 units received some level of damage. 2,266 homes received minor damage, 5,506 received major damage and storm surge flooding destroyed 237 homes. In contrast, local response may actually be due to storm winds quite distant from the local area of concern; a case in point being Tropical Storm Josephine, a modest storm that nevertheless brought large, unpredicted flooding in the spatially distant Tampa Bay Florida area.

As a response to these events, Drs. Peter Betzer, Mark Luther, and Robert Weisberg (University of South Florida's College of Marine Science (USF/CMS) approached the Florida state legislature with the idea of establishing a real-time Coastal Ocean Monitoring Prediction System (COMPS) for the West Florida Shelf (WFS) region. In 1997, COMPS was implemented as a legislative initiative with continuing support to date. Drs. Luther and Weisberg remain COMPS Co-Principal Investigators with Dr Luther's focus centered on the onshore installations and Dr. Weisberg's focus centered on the offshore installations and numerical ocean circulation modeling.

B. BACKGROUND

The State of Florida's coastline is both a popular place to live and a major destination for tourists. Unfortunately, the average elevation of the coast makes it extremely vulnerable to the intense and rapidly moving storms that sweep across the shoreline from the Atlantic and Gulf of Mexico, particularly in the warmer seasons. As a result, Florida's economy and the lives and property of its residents are increasingly at risk. COMPS data is providing an important new focus on ocean storms and coastal flooding produced by storm surges and has lead to improved forecasts and flood warnings; previously unavailable because of a lack of timely knowledge of oceanic conditions.

Understanding the circulation on the west Florida shelf is also important for a variety of other reasons. Knowledge of currents and sea level is necessary to monitor coastal erosion. This information is also useful for recreational and commercial navigation and for search and rescue operations. Similarly, prediction of the movements and dispersal of hazardous material spills is dependent on knowing the currents and how they respond to tides, winds, and seasonal heating and cooling. The coastal ocean circulation and its interaction with the deeper Gulf of Mexico affects the distribution of biological and chemical properties that determine fisheries and Harmful Algal Blooms (e.g. red-tides). COMPS data is helping to provide insight into all these areas.

II. COMPS ARRAY SYSTEM DESCRIPTION

COMPS consists of an array of instrumentation both along the west Florida coast and offshore, combined with numerical circulation models, and builds upon existing in-situ measurements and modeling programs funded by various state and federal agencies. In addition, COMPS links to the USF/CMS Remote Sensing Laboratory, which collects real-time satellite imagery via its' HRPT and X-Band receivers. This observing system fulfills all of the requirements of the Coastal Module of the Global Ocean Observing System (CGOOS). Data and model products are disseminated in real-time to federal, state, and local management officials, as well as the general public, via the Internet. COMPS is designed to support a variety of operational and research efforts, including storm surge prediction, environmental protection, coastal erosion and sediment transport, red tide research (ECOHAB - Ecology of Harmful Algal Blooms), and Hyperspectral satellite remote sensing of Coastal Ocean Dynamics (HyCODE).

The majority of COMPS stations are fully operational, with additional stations planned for the near future. At present, the COMPS array consists of 3 offshore buoys and 6 land based coastal stations. These USF/CMS installations augment other sites maintained by federal, state, and local agencies, thus enhancing or adding to existing stations operated by partner agencies. For example, work is currently on going to build and install two complete coastal tide stations and a fully outfitted air-sea interaction buoy in support of the Pasco County, Florida's Office of Emergency Management. These stations are a result of cooperative agreements between USF/CMS and the National Weather Service (NWS) and USF/CMS and the State of Florida's Emergency Management Division via a competitive grant award.

Low-power, microprocessor-based electronic payloads on the buoys and coastal stations perform data sampling and processing, and transmit the resulting data message to shore via NOAA's Geostationary Operational Environmental Satellite (GOES) network. The data acquisition, processing, and transmission cycle is once per hour. After being received on shore, the buoy message undergoes further processing; including a "first line" automated data quality control, and is made available via the Internet and to the NWS for national and regional use in forecasts and warnings.

The COMPS web home page is presented in Fig. 1. Via this site, individual COMPS measurement locations (as well as all GOES WFS sites) can be accessed and the disseminated data obtained. These data consist of the most recent observations as well as plots of one and five day duration. In addition, data products, such as five-day progressive vector plots are displayed real-time (Fig. 2).

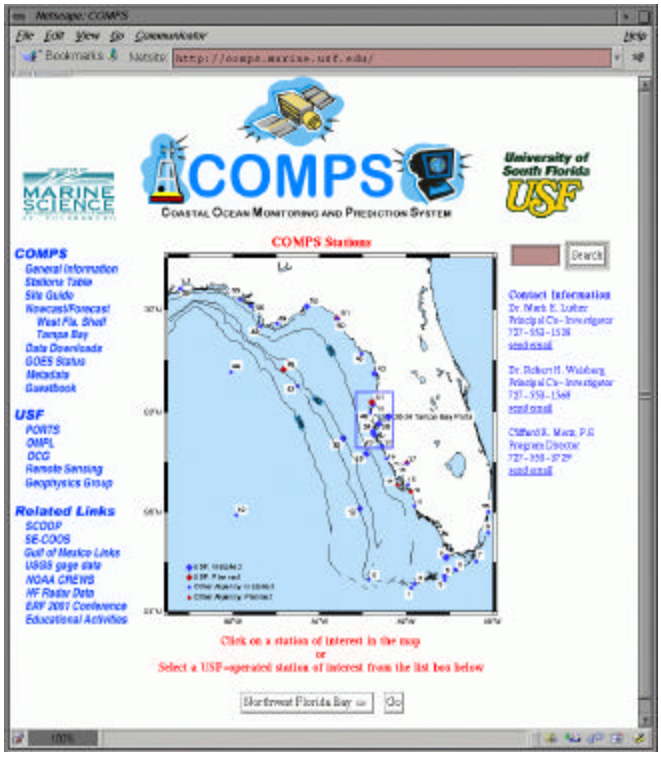

Fig. 1. COMPS Home Page

An offshore buoy configuration consists of a surface float with a full suite of Woods Hole Oceanographic Institution's Air Sea Interaction - METeorological (ASIMET) sensors; a bridal mounted, downward looking, acoustic Doppler current profiler (ADCP); and multiple temperature/salinity sensors inductively coupled to the mooring cable. Data from all sensors are gathered by a custom data logger/transmitter, built by USF/CMS's Center for Ocean Technology (COT), for transmission via the GOES satellite. An example of such a COMPS buoy is presented in Fig. 3. The typical coastal tower tide station consists of tower mounted surface meteorological sensors, an acoustic water level tide gauge, and a seawater temperature and salinity sensor. An example of the COMPS Cape Sable (Northwest Florida Bay) coastal tower

station is presented in Fig. 4. The data is collected by a Vitel data logger for transmission via the GOES satellite as well as direct communication via a spread spectrum radio transceiver pair to each remote site. The site set-up and instrument selection conform to established National Ocean Service (NOS) guidelines.

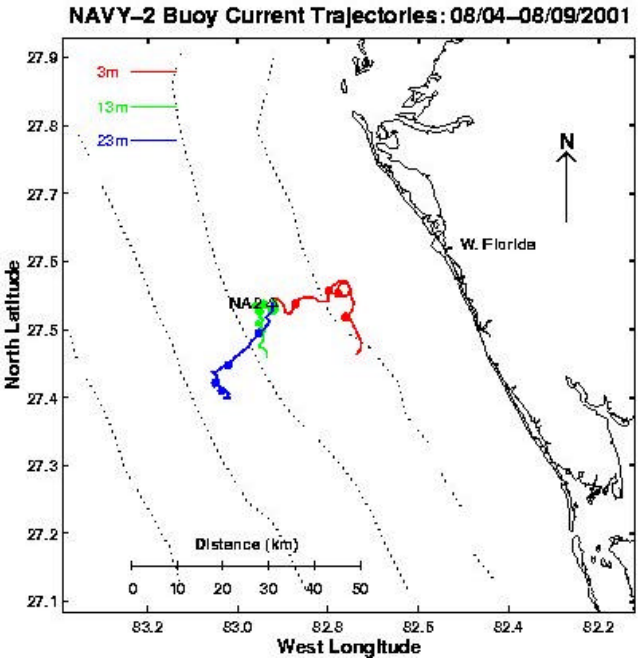

Fig. 2. Sample Progressive Vector Plot

Fig. 3. Typical COMPS Air-Sea Interaction Buoy

Fig. 4. Coastal Tower off Cape Sable, FL

III. MODELING/PREDICTION CAPABILITIES

A numerical ocean circulation model, based on the Princeton Ocean Model (POM), has been developed for the entire WFS, with an offshore boundary stretching from the Mississippi Delta to the Florida Keys. By using the curvilinear grid (the grid size varies from 2-km at the coast to 6-km along the open boundary), this model is capable of resolving the detail of the complex geometry of the coastline (Fig. 5). Driven by NCEP/NOAA ETA winds, the model is run in a nowcast/forecast mode and has been successful in simulating past storm surge events such as sea level (Fig. 6) and ocean currents (Fig. 7). Sea surface temperature and ocean color data collected by our Remote Sensing laboratory can be combined with *in-situ* data and model output to provide a comprehensive analysis of oceanic conditions.

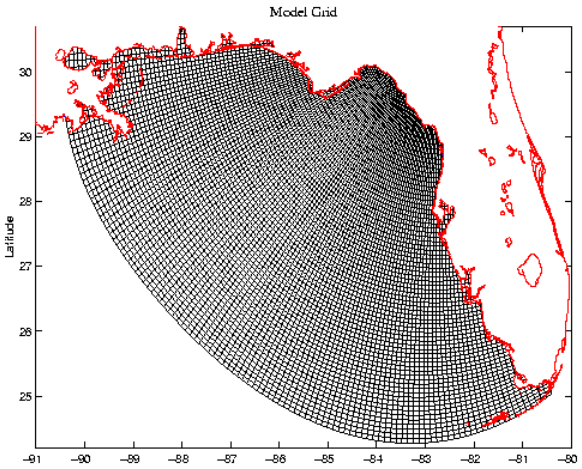

Fig. 5. Model Grid Layout

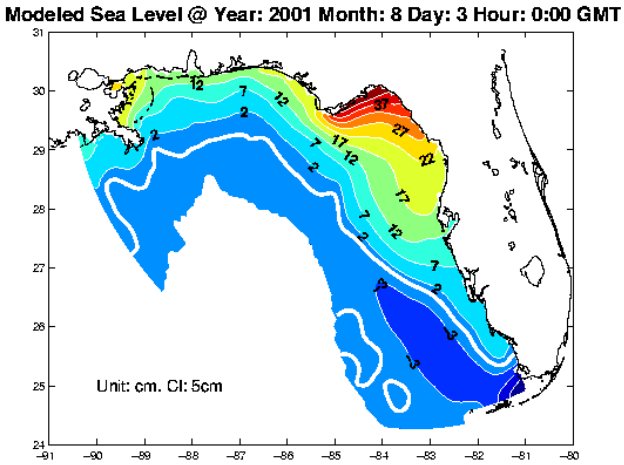

Fig. 6. Sample Modeled Sea Level

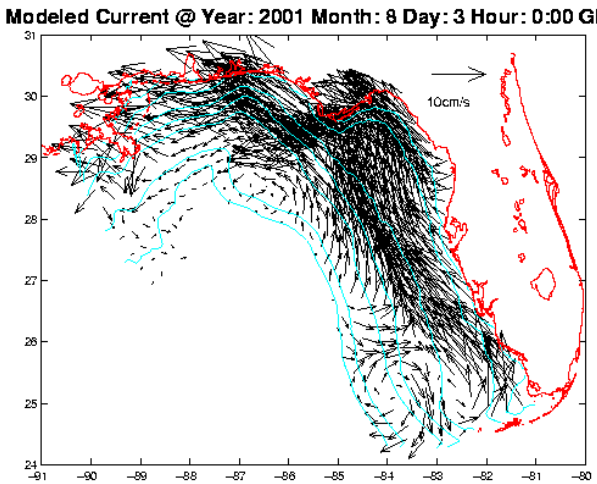

Fig. 7. Sample Modeled Current

IV. DATA ARCHIVAL AND DELIVERY

The COMPS data archival and distribution system collates data streams from the USF/CMS operated sites with those from sites operated by other agencies into a seamless web-based interface. We have redundant GOES satellite downlinks (both a Digital Direct Reading Ground Station and Domestic Satellite [DOMSAT] rebroadcast) for receiving data telemetry from remote locations. USF/CMS is collaborating with the NOAA National Ocean Data Center, the National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center, and the National Ocean Service (NOS) to develop a comprehensive database management system for the acquisition, archival, quality assurance, and distribution of these data.

Data and model products are disseminated in real time to federal, state and local emergency management officials via the Internet (http://comps.marine.usf.edu/). In addition, the data collected is available via FTP by the NWS West Florida regional forecast office for ingestion into the NWS Advanced Weather Interactive Processing System (AWIPS) for access by all NWS activities. All data is provided to county emergency management agencies (CEMA) and to the Florida Division of Emergency Management (DEM) via Internet from NWS. This will increase safety to the public through NWS watches and warnings and from county actions taken in response to those watches, warnings and actual readings from coastal sensors. These sensors will provide accurate measurements in areas where no records exist. This will allow a database to be compiled and for improved computer modeling to provide even more accurate forecasts. Data are also available via the Internet from the COMPS web site.

V. COLLABORATING AGENCIES

Since COMPS was established in response to several major coastal flooding events, the program remains committed to establishing and maintaining a regional connection with the constituents that it serves. The offshore weather buoys, coastal tide stations, and the provision of data from these sources for warning and modeling is consistent with the general purpose of the Florida State Comprehensive Emergency Management Plan (CEMP) as described below:

1) Reduce the vulnerability of people and communities of this state to damage, injury, and loss of life and property resulting from natural, technological or manmade emergencies, catastrophes, or hostile military or paramilitary action;
2) Prepare for prompt and efficient response and recovery to protect lives and property affected by emergencies, and;

3) Respond to emergencies using all systems, plans and resources necessary to preserve the health, safety and welfare of persons affected by the emergency.

In support of this, COMPS has worked closely with the following collaborating agencies in support of the CEMP: Florida Division of Emergency Management, Florida Institute of Oceanography, Citrus County Emergency Management, Pasco County Emergency Management, City of Tarpon Springs Emergency Management, NOAA, NOS, United States Coast Guard, Office of Naval Research, U.S. Environmental Protection Agency, Southwest Florida Water Management District, The National Data Buoy Center, and The United States Geological Survey.

VI. CONCLUSION

COMPS is an evolving network of oceanographic and meteorological monitoring systems located along the WFS and fulfills all of the requirements of the Coastal Module of the Global Ocean Observing System (CGOOS). It provides real-time access to both offshore and coastal conditions, thereby, providing additional warning of potential flooding conditions to emergency management personnel. During its brief history, it has assisted federal, state, and emergency management personnel in dealing with severe weather events. Also, as the modeling efforts continue, the model products will be of increased use for search and rescue, hazardarous material tracking, fisheries resource studies, and the prediction of Harmful Algal Blooms.

ACKNOWLEDGMENTS

The author would like to thank the State of Florida and USF/CMS for its support of this program. In addition, the author wishes to thank to Drs. Weisberg and Luther; fellow COMPS associates: Rick Cole, Jeff Donovan, Vembu Subramanian, Ruoying He, and Dr. David Burwell; Randy Russell and the USF/CMS Center for Ocean Technology (COT); The Florida Institute of Oceanography (FIO) and the captains and crew of the R/V SUNCOASTER and R/V BELLOWS; Dr. Al Hine and the captains and crew of the R/V SUBCHASER and R/V PRICE; The United States Geological Survey (USGS) and the captain and crew of the R/V GILBERT; The Harbor Branch Oceanographic Institution (HBOI) and the captain and crew of the R/V EDWIN LINK; The National Data Buoy Center; and the numerous graduate students and divers involved in COMPS WFS projects.