Implementation of Geospatial Web Services for COMPS In-situ Observations

Vembu Subramanian, Mark Luther, Jeff Donovan and Robert Weisberg

College of Marine Science, University of South Florida
140 7th Avenue South, St. Petersburg, FL, 33701, USA, Email: vembu@marine.usf.edu

ABSTRACT

The University of South Florida (USF), College of Marine Science (CMS) has established a near real-time Coastal Ocean Monitoring and Prediction System (COMPS) for the West Florida Shelf. COMPS collects and disseminates near real-time marine observations to researchers, educators, students, local, state and federal emergency management agencies, and the public via Internet. COMPS is a sub-regional coastal ocean observing system, and a member of the Gulf of Mexico Coastal Ocean Observing System (GCOOS) Regional Association and the Southeast Atlantic Coastal Ocean Observing Regional Association (SECOORA), and the Florida Coastal Ocean Observing System Consortium (FLCOOS), all regional components of the US Integrated Ocean Observing System (IOOS). Realizing the importance of increasing data accessibility, enhancing data integration, and enabling interoperability between sub-regional, regional and federal coastal ocean observing systems, we have made significant improvements to our COMPS data management system. In this paper, we describe the implementation of Open Geospatial Consortium (OGC) compliant geospatial web services for in-situ observations to advance COMPS data system towards interoperability.

1. INTRODUCTION

The COMPS program consists of an array of coastal stations and offshore buoys located along the West Florida Shelf from the Florida Panhandle to the Dry Tortugas. A COMPS offshore buoy is outfitted with either Woods Hole Oceanographic Institution's Air-Sea Interaction Meteorological (ASIMET) sensors or Coastal Environmental Systems Weatherpak Meteorological sensors, a bridle mounted Acoustic Doppler Current Profiler (ADCP) and Seabird Electronics SBE-37 Microcat temperature/conductivity sensors mounted in the bridle and attached to the mooring cable. Data from all the sensors are acquired near real time by a data logger/transmitter built by USF/CMS Center for Ocean Technology (COT) and transmitted via GOES satellite once every hour. A COMPS coastal station consists of meteorological, acoustic water level/tide gage, and conductivity/temperature sensors. Data from a coastal station are acquired by a Campbell Scientific Data Logger and transmitted via GOES satellite (once every hour) as well as line-of-site radio (once every six minutes) where applicable. Sensors and data telemetry deployed on both types of platforms vary with location. On occasion, we have also mounted water quality sensors on some of our coastal and offshore stations in response to requests from other programs or projects. USF/CMS maintains a Local Readout Ground Station (LRGS) satellite receiving system, which allows us to receive and archive raw data transmitted from our stations via the GOES Direct Receiving Ground Station (GOES-DRGS) and Domestic Satellite (DOMSAT). The raw data received from the platforms are parsed or decoded and quality controlled using a suite of software, and made available on COMPS web site. Once every hour, the parsed data from all our COMPS platforms are disseminated to GCOOS and SECOORA Regional Associations (RAs) where it gets aggregated with data from other sub regional coastal ocean observing systems located within the southeast US and Gulf of Mexico coastal regions. The aggregated data are displayed and disseminated in a variety of data formats, including geospatial web services via GCOOS and SECOORA RAs web sites. COMPS data are also pushed to the National Data Buoy Center (NDBC), where it gets further quality controlled and distributed worldwide via the Global Telecommunication System (GTS).

2. COMPS DATA MANAGEMENT

2.1. Data Acquisition, Parsing, Storage and Visualization

USF/CMS maintains a Local Readout Ground Station (LRGS) Satellite Receiving system to collect data from remotely located COMPS marine monitoring stations. The LRGS system allows us to receive and archive raw data from GOES Direct Receiving Ground Station, DOMSAT and other LRGS systems (National Environmental Satellite, Data, and Information Service (NESDIS) DCP Data Service – Internet DDS). With the capability to acquire data from multiple sources, our LRGS system provides the necessary redundancy in acquiring our platforms raw data. For additional redundancy, we have added a second server with access to all of the services listed above. All of our platforms are equipped with a suite of sensors that collects marine observations, data logger computer, power source, transmitter, antenna, and they are programmed to transmit data once per hour. Data are received near real time at our base ground station located at the USF/CMS. The data then becomes available to the

decoding/parsing computers over the USF/CMS local area network.

The raw data received from the COMPS coastal and offshore platforms are either ASCII or Hexdecimel-ASCII format. The raw data format is dependent on the type of sensor packages, the data loggers and their set up. The sampling interval is six minutes for all sensors deployed on the coastal stations with the data being transmitted hourly. The sample interval for the offshore stations depends on the sensor package and the data is transmitted hourly as well. The raw data are parsed or decoded and quality controlled (by applying instrument and local range checks) using a suite of software written in PHP, Perl, Python and C. The parsed/decoded data are stored in PosgreSQL, an open source Relational Database Management System (RDBMS). This is a key improvement in COMPS data management that makes the web site a dynamic database-driven system, provides scalability necessary to meet the growth of the COMPS, and provides reliability (the comps database can be easily installable in other machines thus providing redundancy capability). We chose PostgreSQL because it is the most advanced open source RDBMS, offers the widest range of options for future development, provides a number of front-end applications that can access the database using SQL, and can be expanded to include geospatial data types using PostGIS extension. PHP, Java and JpGraph were used for the visualization of marine observations collected by our platforms and displayed on the COMPS web site. A Google Earth Map interface to display station locations and information, a dials display of the latest marine observations from each site, and time series graphics displays of data of each parameter for each site are made available on the COMPS web site (Figures 1 and 2)

2.2. Data Access and Delivery: Implementation of Geospatial Web Services

To make the Integrated Ocean Observing System (IOOS) vision (delivery of data and model products to address the seven societal goals – http://ioos.gov) a reality, sub-regional coastal ocean observing systems like COMPS have to implement data management technologies to provide seamless on-line access and delivery of the in-situ and high frequency radar observations as well as numerical model data and make their data systems interoperable (machine-to-machine). The conceptual framework of the IOOS Data Management and Communications (DMAC) plan document that addresses the core elements (interoperable metadata, data discovery, catalog, access, transport, on-line browse and archive) is available at IOOS web site (http://dmac.ocean.us/dmacPlan.html). Work is well underway at the sub-regional, regional and national and international levels as to the development of Data Management and Communications Standards

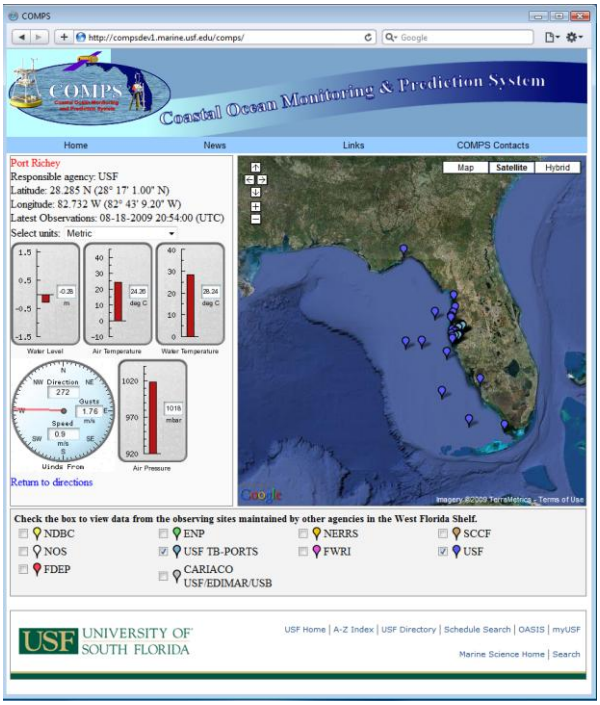

Figure 1. COMPS Home Page

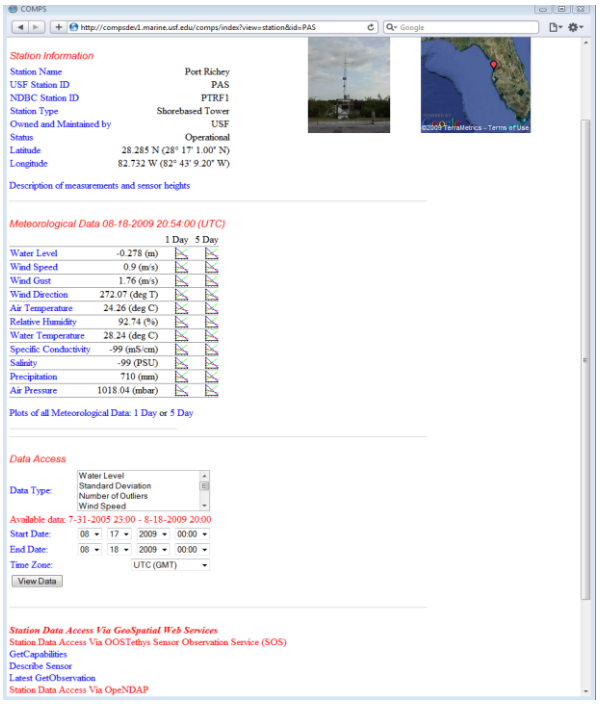

Figure 2. COMPS Port Richey Coastal Station Web Site

and best practices to advance data systems to interoperability. Guides and best practices documents related to implementing data management technology components for coastal ocean observing systems are being developed and made available. The ocean observing community, in partnership with Open Geospatial Consortium (OGC), has launched the Ocean Science Interoperability Experiment – OCEANS IE

(http://www.oostethys.org/ogc-oceans-interoperability-experiment) to advance the OGC Sensor Web Enablement (SWE) initiative. This initiative uses the OGC Web Feature Services (WFS) and OGC Sensor Observation Services (SOS) for representing and exchanging point data records from fixed in-situ marine platforms. It was concluded that the use of OGC SOS was better suited than the use of OGC WFS for this purpose.

With the improvements made to our COMPS data management and our active engagement in the GCOOS and SECOORA RAs funded data management projects, our observations and model data are now being made available via geospatial web services implementations. COMPS in-situ observations Sensor Observation Service offerings are available via COMPS web site. We used the OOSTethys (http://www.oostethys.org/) Sensor Observation Service version 1.0 Perl RDBMS Cook Book with some modifications to implement SOS on the COMPS server. As suggested by the OOSTethys-OCEANS IE, we also registered our SOS services at the Marine Metadata Interoperability developed SOS registry web site (http://score.itsc.uah.edu/MMI/), and became a part of the Ocean Sensor Web. Our services and data can be accessed and visualized via www.openioos.org, an integrated ocean observing system test bed. We will be working closely with OOSTethys developers to implement changes and updates when available.

The NOAA IOOS program has advanced the Data Integration Framework (DIF) to integrate data from the National Data Buoy Center (NDBC), National Ocean Service (NOS) and its partners and the RAs to provide access to these observations via IOOS-DIF Sensor Observation Services (http://ioos.gov/dif/). The IOOS-DIF is slightly different in presenting Observation and Measurements Model (O&M) results (XML Structure) compared to OOSTethys. The two development teams are working together to identify an approach to converge IOOS-DIF and OOSTethys regarding the presentation of O&M results. The IOOS-DIF SOS of COMPS in-situ observations are available via the GCOOS, SECOORA and NDBC web sites. Work is also underway in four focus areas (waves, in-situ currents, CTD and dissolved oxygen) to enable implementation of QA/QC standards into the OGC-SWE frameworks via an IOOS funded Q2O (Quality Assurance in Real Time Oceanographic Data – http://qartod.org to OGC- http://q2o.whoi.edu) program. As a sub-regional system we are participating in the Q2O project to encode COMPS observations QC flags in to SWE. The high frequency radar surface currents and numerical model data interoperability experiments are also well underway. OGC Web Coverage Service (WCS) is used by the ocean observing community to provide access to datasets currently available via technologies such as netCDF (Network Common Data Format), OPeNDAP (Open Project for a Network Data Access Protocol) and THREDDS (Thematic Real-Time Environmental Distributed Data Services). At USF/CMS we have installed the OpeNDAP netCDF server, and make available our in-situ observations, HF Radar data as well as our West Florida Shelf and Tampa Bay numerical ocean circulation model data. In addition to the above web services offering, we also have implemented a Google Maps Interface on our web site and provide our in-situ observations packaged using Keyhole Markup Language (KML), an OGC standard data sharing method that is currently very popular and widely used among the public and earth science communities. Other features that are offered on our web site include graphical dial display of latest marine observations from each site, individual station web pages that offer time series graphics display of data, and a description of sensors and measurements. Users can also download archived data from the PostgreSQL server in a variety of formats for a station of interest according to a chosen set of criteria.

3. CONCLUSIONS

We have described and demonstrated in this paper our experience in moving COMPS, one of the largest sub-regional coastal ocean observing system maintained by an academic institution, towards interoperability. With the improvements made to the COMPS data system and our active engagement/participation in the OpenIOOS interoperability experiment test bed as well as in NOAA IOOS funded data management projects via GCOOS and SECOORA regional associations, we have implemented community developed open source DMAC technologies to make COMPS interoperable. We have also implemented new data display and data access features to our web site, keeping in mind our local user community needs. We have begun the work on modifying our QA/QC algorithms and encoding these enhancements into the COMPS implementation of the OCG Sensor Web Enablement framework. In conclusion, COMPS is actively engaging in IOOS DMAC initiatives via regional associations and implementing DMAC technologies to provide seamless on-line access to its data collections.

4. ACKNOWLEDGEMENT

The authors would like to thank State of Florida and University of South Florida College of Marine Science for its support to the COMPS program. The authors wish to thank fellow associates of COMPS and Ocean Interoperability Experiment software team. Finally, the lead author (Vembu Subramanian) would like to thank Gulf of Mexico Coastal Ocean Observing System (GCOOS) Regional Association for their funding support to attend the OceanObs'09 conference.