

9A.1 COAMPS-OS® DASHBOARD: MERGING GIS TECHNOLOGIES WITH ENVIRONMENTAL PREDICTION

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ABSTRACT

The Coupled Ocean/Atmosphere Mesoscale Prediction System (COAMPS®) – On-Demand System (COAMPS-OS®) is software developed at the United States Naval Research Laboratory (NRL) that the US Navy uses to run the COAMPS operational mesoscale numerical weather prediction system. In 2011, the NRL team released the first version of the COAMPS-OS Dashboard Viewer into operations at the US Navy's Fleet Numerical Meteorology and Oceanography Center (FNMOC) to meet the goal of integrating Geographic Information Systems (GIS) technologies into the system. The Dashboard is an advanced AJAX-based (Asynchronous JavaScript and Extensible Markup Language [XML]) web interface for creating, viewing, and exporting model visualizations, radar, satellite, model verification, and other standard GIS products in a properly geospatially-registered display. The Dashboard utilizes several open source tools such as MapServer, OpenLayers, and Google Web Toolkit (GWT) to provide an accessible, tailored, easy to use GIS interface in a web browser. With these new tools in COAMPS-OS, users have the ability to create their own map product layers, integrate other model forecast data (e.g., ocean models), overlay radar and other remote sensing observation layers, and add other geospatial intelligence information into a single application. A new version of the Dashboard client is currently in development, which will incorporate a completely new interface design using Sencha Inc.'s Ext GWT® framework, new features including live spatial data querying and user sessions. It is scheduled to be included with the next major release of the COAMPS-OS software sometime in 2012.

1. INTRODUCTION

Since 2001, the Coupled Ocean/Atmosphere Mesoscale Prediction System (COAMPS®) – On-Demand System (COAMPS-OS®) has provided United States Naval forces with web based interfaces for setting up and executing COAMPS mesoscale forecasts and for displaying and disseminating COAMPS model output.

While these technologies are very useful, they do not easily allow integration with other meteorological and support information.

As part of a COAMPS-OS enhancement to integrate Geographic Information Systems (GIS) technologies into the system, the software development team at the Naval Research Laboratory (NRL) has created the COAMPS-OS Dashboard Viewer (CDV).

2. CDV APPLICATION

The CDV is more of a system than just a data viewer. This system is comprised of an advanced web browser based viewer, the CDV client, and a powerful web services suite, the CDV server (Figure 1). The CDV client and server utilize several open source technologies which leverage the power of many developers and users around the world to bring the best and latest features to military operators and scientists.

The CDV client has been built using two major open source web technologies: the Google Web Toolkit (GWT) [1] and OpenLayers [2]. GWT enables NRL scientists to develop the CDV in the Java programming language. Then the GWT compiler produces Asynchronous JavaScript and XML (AJAX). The AJAX code produced by GWT is optimized for all major web browsers allowing the CDV to reach many users regardless of platform and no additional system software.

At the heart of the CDV client is its GIS web map, powered by OpenLayers. OpenLayers is an open source software package which provides an interactive web map similar to Google Maps®. OpenLayers also provides the necessary tools to communicate with servers using standard GIS protocols. For the CDV, the standard GIS communication protocol is the Web Mapping Service (WMS) [3].

While the client is the most apparent part of the system, the server is the workhorse by supplying the necessary services to support the CDV client as well as other GIS clients. Some of these services are used to: a) Provide information about available data from COAMPS-OS, b) Convert model raw data files into standard GIS formats, and c) Expose data via the WMS protocol to the CDV client and other GIS software applications. The CDV server is comprised of several different open source software packages and also software written at NRL. One of the most important open source software packages on the server is

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MapServer [4]. MapServer is used to expose COAMPS-OS data via the WMS protocol. It supports many different geospatial projections and allows styling to be applied to raw GIS features (points, lines, polygons). Through options available in the CDV client, a user has the power to customize their products. For example, users are able to select colors, symbols (wind barbs vs. arrows), and density of point data. These user options are made possible by the styling support in MapServer.

In addition to supporting feature data (points, lines, and polygons), MapServer also supports 'raster' data. This allows for very high resolution imagery (satellite, radar, topography) to be served via WMS to all the GIS clients. A NASA Blue Marble background layer is made available to the clients through the use of this feature in MapServer.

Custom software was also developed for the CDV server that performs various functions such as: contouring, generating point features (for wind barbs and arrows), generating Keyhole Markup Language (KML) [5] files for import into Google Earth®, and providing meta-data to the clients. The services are provided via a Java Servlet application hosted in an application server (Tomcat). This allows the system to be easily expanded or scaled to support more clients as it becomes necessary. The server does not currently utilize any sort of database, but rather manages its data through the file system. This allows for easy installation/configuration and less software dependencies.

One of the powerful features of the CDV server is that it allows for custom GIS data to be easily integrated and hosted for all the clients. This allows for COAMPS-OS administrators to easily integrate their own GIS data without any modifications to the CDV software. For example, an administrator may want to add a custom feature set (cities, roads, and other geospatial information) alongside the available COAMPS-OS data. Or an administrator may want to customize the client to display data from a remotely hosted WMS server that provides radar or satellite imagery. This can easily be done through simple configuration files on the CDV server, without any modification to the software. All CDV clients will then be able to access the custom data.

3. FEATURES

There are many features in the CDV for both military operators and scientists. This section will discuss major features of the CDV including data access, product customization, information integration and data export.

The CDV system provides access to more than 60 COAMPS forecast products and ocean products from the Navy Coastal Ocean Model (NCOM) and WAVEWATCH III® (WW3) models. Data querying and layer requests are made using Representational State Transfer (REST). The CDV REST is implemented using the Java based open source framework Jersey [6]. CDV also provides the ability for a user to create several different type of products with these data sources

including contour lines, color filled polygons, points, wind barbs and arrows. The CDV can also display remote sensing data from radar and satellite sources (Figure 2). A prominent feature for scientists is the ability to display model verification data provided by COAMPS-OS with actual COAMPS forecast products (Figure 3). The client also can display these products in different geographic projections. Current projections offered are tiled and un-tiled spherical Mercator (EPSG: 4326) and two versions of polar stereographic for the north and south poles with 8 different rotations.

Another major feature of the CDV is the ability for the client and server to communicate with other GIS servers to provide a powerful GIS integration tool as shown in Figure 4. For example, other WMS supported applications, like ArcGIS Explorer®, can communicate with the CDV server and display COAMPS-OS data on its map interface. For military operators, any geospatial intelligence information exposed as a standard WMS service can be viewed by the CDV enhancing their environmental situational awareness.

Perhaps one of the best features is the system's ability to convert products created in the CDV and export them into three common formats: PNG image, Shapefile, and KML. PNG export takes a "snapshot" of what is visible on the CDV client's web map and converts it into an image using MapServer and ImageMagick® [7]. The user is also given the ability to add a title, classification markings, adjust orientation of legends, and image size. PNG export is very useful for military operators as they often give briefings using Microsoft PowerPoint®. Shapefile is a very popular GIS file format for users wanting to perform complex spatial analysis. As stated in the previous section, data requested from the CDV is automatically converted to Shapefile and the Shapefile export feature is provided as a convenience to users not wanting to connect to the CDV server. By far the most popular format of the three is KML, the file format of choice in Google Earth. Using software developed by NRL and the open source software tools GeoTools [8] and JTS Topology Suite [9], Shapefiles of the data requested from the CDV are converted to Open Geospatial Consortium (OGC) standard KML 2.2 files. These KML files contain full vector information from the Shapefiles and are queryable in GIS software packages that read standard KML and highly interactive in Google Earth (Figure 5).

4. FUTURE

The CDV client is currently undergoing a complete rewrite using Sencha Inc.'s Ext GWT® framework. This new framework will allow NRL scientists to address user feedback on ease of use and speed while incorporating new features. The next version of the CDV is scheduled to be delivered within COAMPS-OS version 2.3 in fiscal year 2012.

5. LINKS

1. Google Web Toolkit
Website: <http://code.google.com/webtoolkit/>

2. OpenLayers Website: <http://openlayers.org/>
3. OpenGIS Web Map Service Implementation Specification
Website: <http://www.opengeospatial.org/standards/wms>
4. MapServer Website: <http://mapserver.org/>
5. Google's KML Documentation
Website: <http://code.google.com/apis/kml/documentation/>
6. Jersey REST Website: <http://jersey.java.net/>
7. ImageMagick
Website: <http://www.imagemagick.org/script/index.php>
8. GeoTools Website: <http://geotools.org/>
9. JTS Topology Suite
Website: <http://tsusiatsoftware.net/jts/main.html>

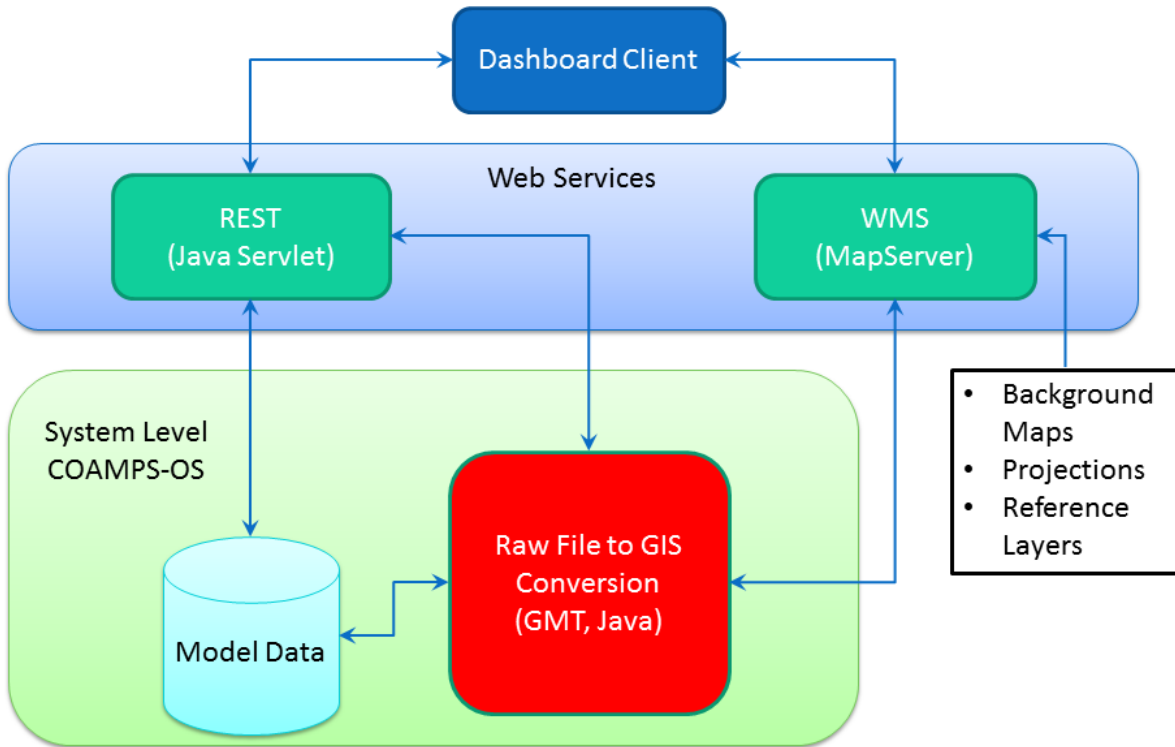


Figure 1. A Flow Diagram Showing How Information is Transmitted Throughout the CDV System.

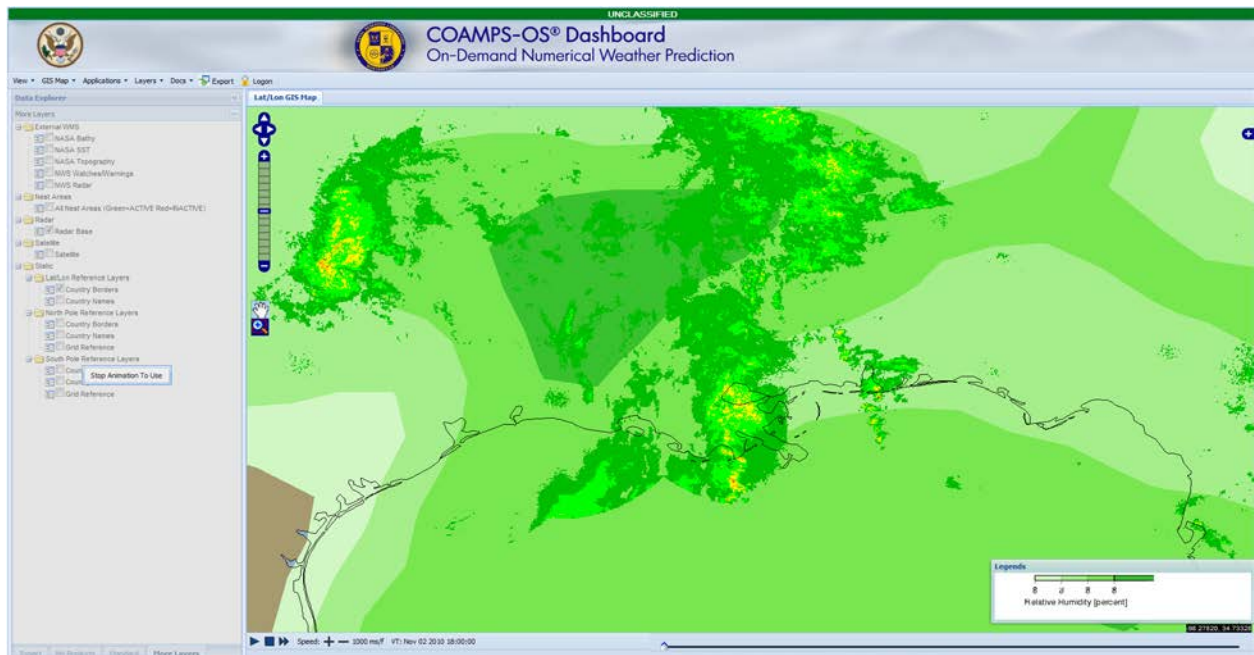


Figure 2. NEXRAD Radar Reflectivity with COAMPS Forecasted Relative Humidity.

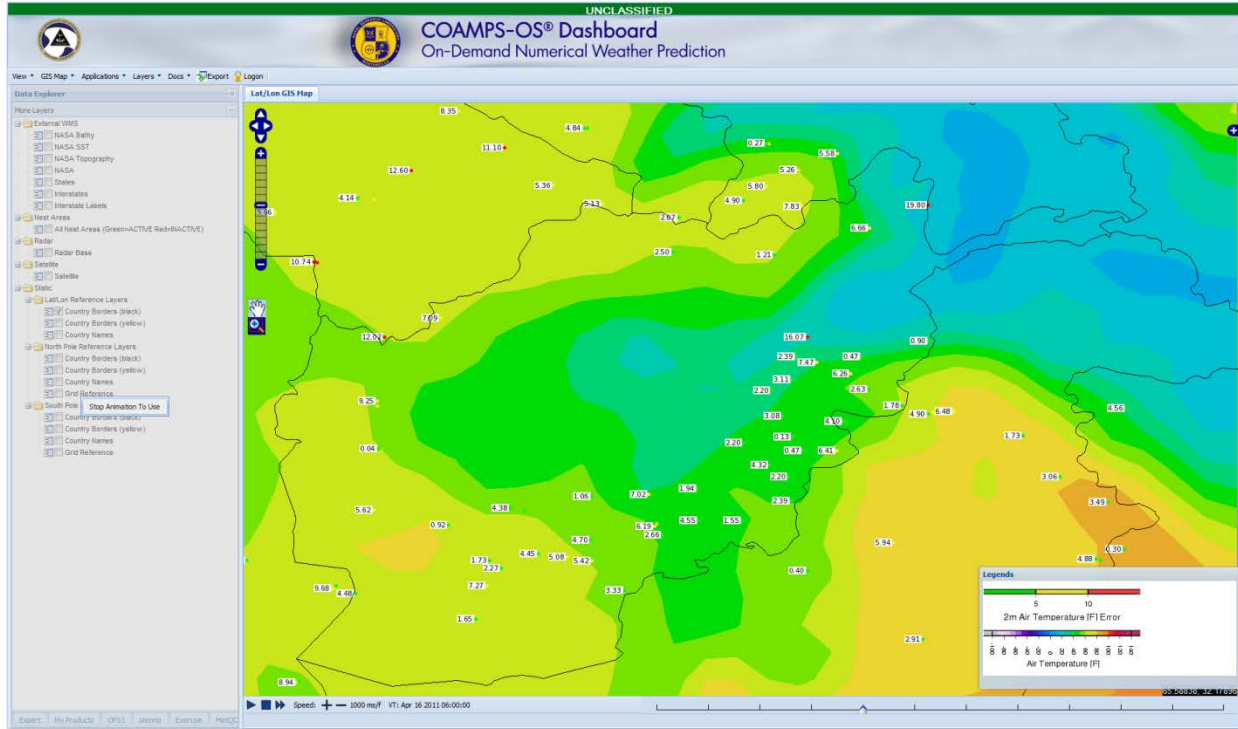


Figure 3. COAMPS Forecasted Surface Air Temperature (Color Filled) Overlaid with Quality Control Analysis Points Provided by COAMPS-OS' MetQC.

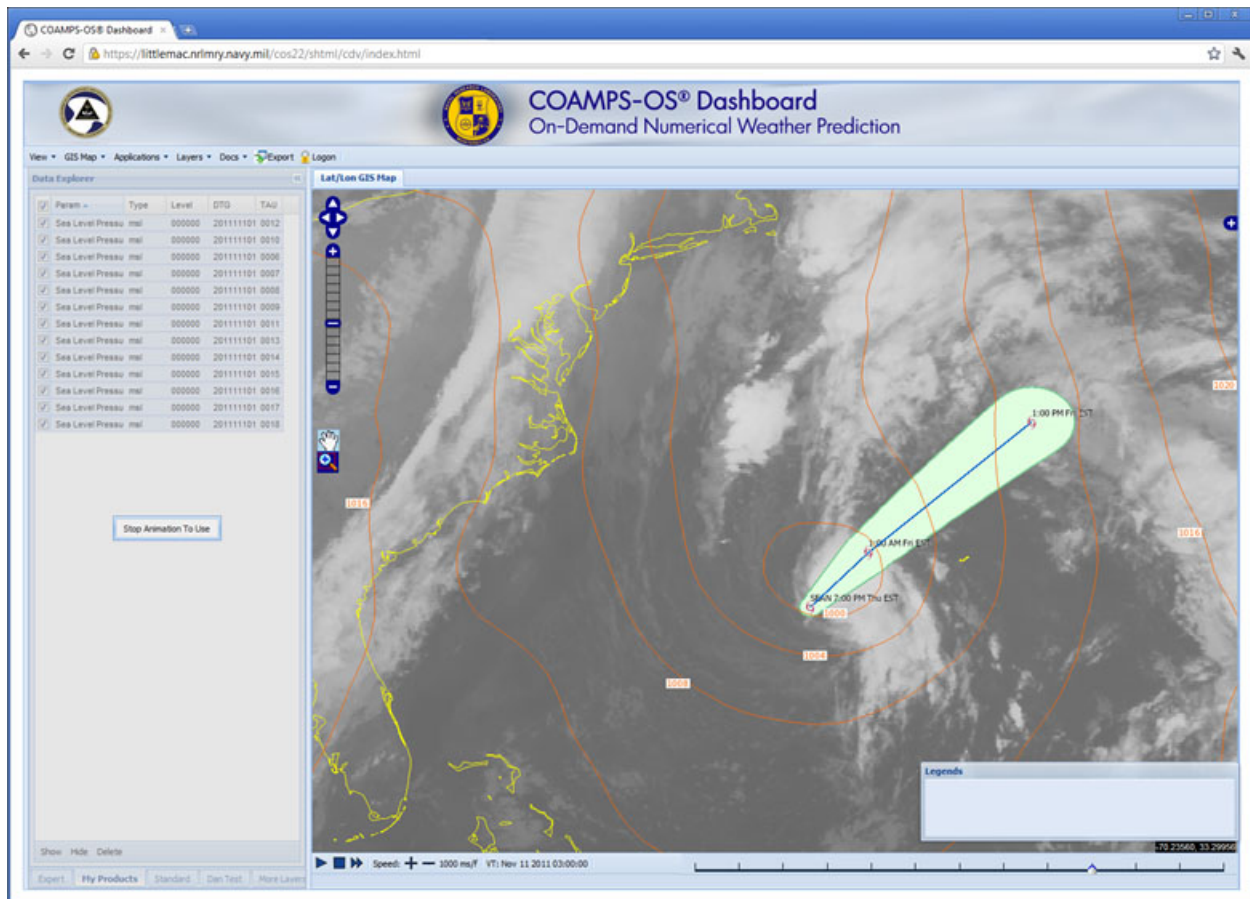


Figure 4. Infrared Satellite Imagery and National Hurricane Center (NHC) Forecast of an Atlantic Tropical System Integrated with COAMPS Forecasted Sea Level Pressure. NHC and Satellite Data Provided by the National Oceanic and Atmospheric Administration's National Ocean Service nowCOAST WMS Service.

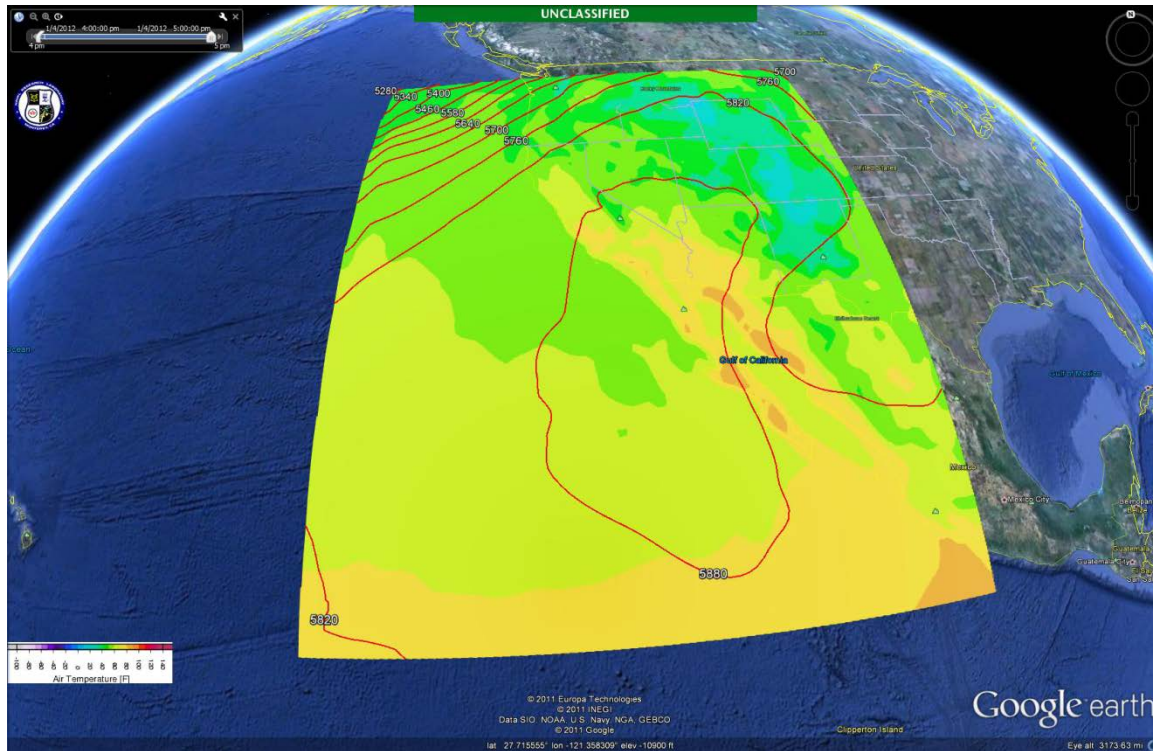


Figure 5. COAMPS Surface Air Temperature with 500 Millibar Geopotential Height Contours Exported to KML Using the CDV and Displayed in Google Earth.

APPENDIX A

1. ESRI Shapefile: From the ESRI Shapefile Technical Description 1998 “A shapefile stores nontopological geometry and attribute information for the spatial features in a data set. The geometry for a feature is stored as a shape comprising a set of vector coordinates.” ESRI Shapefile Technical Description: <http://www.esri.com/library/whitepapers/pdfs/shapefile.pdf>