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1. INTRODUCTION

The National Ocean Service (NOS) Coast Survey Development Laboratory has developed and implemented a Web mapping portal called *nowCOAST* to allow the nation's coastal community to quickly display on-line, real-time weather and water observations and NOAA forecasts for any region in the coastal United States including the Great Lakes. The portal serves as a "one-stop shopping" solution for a user to locate and view real-time meteorological, oceanographic, river, and water quality observations as well as NOAA forecasts for a particular area of interest. The portal accomplishes this by providing spatially-referenced hyperlinks to thousands of Web pages within and outside of NOAA displaying this information.

NowCOAST is designed to be a planning aid for recreational and commercial mariners, coastal managers, HAZMAT responders, marine educators, and researchers. By merging information from many autonomous observing networks and NOAA forecast products via a user-controlled mapping environment, *nowCOAST* provides a new means for discovery of online information about the nation's coastal areas. The purpose of this paper is to describe a new version of the Web portal and discuss plans for future versions.

2. DESCRIPTION OF PORTAL

NowCOAST uses a Geographic Information System (GIS) to store geospatial information on observing network stations and NOAA point and zonal forecast products, including URLs of Web pages displaying real-time data from the observing systems and the NOAA forecasts. This information is exposed through the portal's interactive mapping interface that allows users to see as much or as little of this information as they choose. The mapping interface is custom designed to allow users to specify quickly the type of observations or forecasts they want for their geographic area of choice and also to provide an intuitive means of browsing through this information once it is located.



Fig. 1. *NowCOAST* Map Viewer

NowCOAST uses Arc Internet Map Server (ArcIMS) to create maps according to user specifications and to enable querying of *nowCOAST*'s geospatial data.

The first version of *nowCOAST*, released in August 2002, was adapted from a template HTML map viewer provided with the ArcIMS software. This viewer relied heavily on processing on the user's, or client's, machine. This reliance meant not only that a large amount of code had to be downloaded to the client, which can be a barrier to use on a slow Internet connection, but also that processing errors on the client could lead to irregular behavior or crashing of the viewer. In addition, customization of the map viewer was difficult under this model with the limitations inherent in client-side coding using JavaScript.

To overcome these limitations, Java Web programming technologies including Java Servlets and Java ServerPages (JSP) were combined with ArcIMS and Dynamic HTML (DHTML) to create a new custom mapping interface for *nowCOAST* Version 2. The Java language was selected since it is heavily used on the Web and a Java-based Application Programming Interface (API) is available for ArcIMS that exposes ArcIMS functionality in Java. The Java API for ArcIMS, called the ArcIMS Java Connector, has the added benefit that it can be integrated with the server utilities that must already be installed on the server to use ArcIMS. These include a Servlet Engine, such as Jakarta Tomcat, which executes all of the Java code running on the server. By using the Java Connector and Java code as the basis for viewer customizations, *nowCOAST* also benefits from the Java language's "write once run anywhere" portability, meaning that

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nowCOAST will not have to be modified if the operating system (OS) is changed on the server.

By eliminating much of the client-side processing that was necessary in the first version of *nowCOAST* and transitioning that processing to the Java language on the server using the Java Connector, the result is a much more stable and customizable map viewer with much greater functionality.

NowCOAST runs on a 2.2Ghz Intel Xeon server using the Apache 2.0.4x Web server, Jakarta Tomcat 4.1.x Servlet Engine, and Environmental System Research Institute's (ESRI's) ArcIMS 4.x software.

NowCOAST is located on the Web at the address <http://nowcoast.noaa.gov>.

3. DESIGN AND FUNCTIONALITY

NowCOAST is custom designed to allow users to specify quickly the type of observations or forecasts they want for their area of interest and also to provide an intuitive means of browsing this information once it is located. *NowCOAST*'s interface consists of two applications working in unison. The first is the map viewer, which allows users to see a map of observing station locations and forecast areas for their region of choice. The second is the *nowCOAST* 'Databrowser,' which is an interface allowing the user to navigate websites displaying observational data or forecast products that they locate through the map viewer. Each application is described below.

3.1. Map Viewer

NowCOAST's map viewer enables users to quickly locate and view observations or forecast information for any area of choice. The design is based on a combination of client-side programming in HTML and JavaScript and server-side programming in Java using the Java Connector. Communication between the client and server is handled by JSP, which captures information about user interaction with the map and submits it to the server, where it is translated by Java code into instructions for ArcIMS. Through the Java Connector, ArcIMS returns a map image or dataset to the client, depending on the request.

The instructions for ArcIMS that are created by server-side Java code are in the form of ArcXML, an XML standard developed by ESRI. Requests made to ArcIMS software must be in the form of a complete ArcXML request containing all of the information about the user's interaction with the map such as geographic extent, map layers visible, as well as any datasets requested from the database. In order for an ArcIMS map viewer to function, it must have the capability to create the necessary ArcXML according to user input. In *nowCOAST*'s map viewer, instead of constructing the ArcXML request on the user's computer with JavaScript,

this responsibility is given to the Java Connector on the server. This eliminates the need to download many large JavaScript libraries to the user's machine to create the ArcXML, and moves this computational responsibility to the server entirely, thus decreasing download times and lessening the chance for errors in creating the ArcXML.

Because *nowCOAST*'s map viewer was designed for a broad user base, users who are unfamiliar with GIS software are provided with a step-by-step process to specify the geographic area and type of information they are interested in viewing. This is accomplished via manipulation of four Web-standard 'pull-down' menus (Fig. 2) which allow the user to specify 1) the location (e.g. seaport, coastal state, estuary, marine sanctuary), 2) the information (i.e. specified type of observation, forecast guidance, or forecast), 3) the variable (e.g. water level, air temperature, wave height, etc.), and 4) the time (specific forecast time or time period). After selecting any or all of the four options, the user chooses 'Go' to create a map for their specified information and location. The user may then view live Web displays of observation stations or forecast points or zones by clicking anywhere on the resulting map.



Fig. 2. *nowCOAST* Pull-down Menu Bar

The *nowCOAST* map viewer also provides standard GIS tools for further interaction with the map and the database for users who have more GIS familiarity. Users may zoom and pan to any geographic area or extent, zoom to a specific latitude/longitude, use the Query, Select by Rectangle, and Identify tools to view underlying data for any observation station or forecast area, as well as use the Print tool to create a printable view of the map. To assist users with these tools, instructional messages appear below the map when a tool is selected, and a separate 'tool help' window with further instruction may also be opened.

The map viewer also gives the more advanced user the ability to overlay different GIS layers on top of one another to display several types of observations or forecasts on a single map. This ability is exposed by the 'Map Layers' list on the right of the map. The 'Map Layers' list (Fig. 3) provides the name of each GIS layer in *nowCOAST* along with the symbology used to represent it. The user may click on a check box for an individual layer to make it visible on the map, as well as click on the title of the layer to open a new window with a detailed description and photographs representative of the information found in that layer. The 'Map Layers' list is intended to show the user all of the information available in *nowCOAST*, to give the user the ability to directly work with the layers in addition to using the pull-down menus, and to introduce the inexperienced user to the GIS concept of layer overlay.

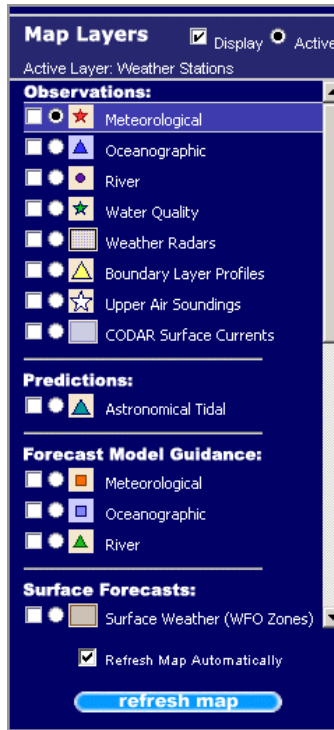


Fig. 3. View of nowCOAST Map Layers List

3.2. Databrowser

The Databrowser provides a means for users to navigate the websites displaying observations or forecasts they locate through the map viewer. This was a principal area of improvement needed in a new version of nowCOAST. Because of the greater flexibility to create add-on applications to the ArcIMS map viewer afforded by using the Java Connector and server-side Java code, a separate user session-based application to provide this ability was possible.

The nowCOAST 'Databrowser', based upon JSP, maintains a record of user interaction with nowCOAST throughout the duration of the user's session. Each time the user links to an observation station or forecast point or zone, a record is added to the Databrowser with this information. The Databrowser window contains buttons allowing the user to move forward and backward between each record in their session, delete a record, print any dataset returned from the nowCOAST database, or open a new window with the live forecast or observation Web page. These features give the user greater control over the information they obtain through nowCOAST.

A screenshot of the Databrowser interface is provided in Figure 4.



Fig. 4. Screenshot of the nowCOAST Databrowser Interface with NWS Web page displayed below

The Databrowser is displayed on the user's computer in a separate window from the map viewer. When the user first clicks on an observation station or forecast area on the map, the Databrowser will open with the corresponding Web page. Because of the proliferation of 'popup blocking' software on today's browsers, the Databrowser window may fail to open, in which case the user will be prompted to disable their popup blocking software for the nowCOAST site. Additionally, buttons are provided on both the map viewer and the Databrowser allowing the user to navigate from one to the other with a single click to help avoid this problem.

4. CONTENT

A list of nowCOAST links to federal, state, mesonet, and regional ocean observing networks and forecast products can be found in Figure 5 on the following page.

NowCOAST currently provides hyperlinks to existing Web pages that display real-time observations as well as text and numerical forecasts from the observation networks and forecast products, respectively, listed in Figure 5. The hyperlinks are prone to changes by the agencies and organizations operating the Web pages (e.g. new URLs) and problems due with the operation of Web servers. Thus, a Perl script was written to identify and log bad hyperlinks. This script is run once a week to identify the bad links and to make the appropriate changes in nowCOAST.

The Federal Geographic Data Committee (FGDC)-compliant metadata for nowCOAST's map layers are available at:
<http://nauticalcharts.noaa.gov/csdl/op/nowcoast.htm>.

nowCOAST's Database of Web Links to Observing Networks and Forecast Products

In-Situ Observing Networks:

<u>Agency</u>	<u>Type</u>	<u>Number</u>
NOS	Physical Oceanographic Real-Time System (PORTS)	54
	National Water Level Observing Network (NWLON)	155
National Data Buoy Center (NDBC)	Fixed Buoys	132
	Coastal Marine Automated Network (C-MAN)	56
NWS//FAA/Department of Defense (DOD)	Automated Surface Observing System (ASOS)	499
FAA	Automated Weather Observing System (AWOS)	82
NOAA	Climate Reference Network (CRN)	47
	Ground-Based GPS Meteorology Demonstration Network (GSOS)	72
	UrBANet	7
US Coast Guard	Manual Weather Observing Sites	7
EPA	Environmental Monitoring (EMPACT)	8
USGS	National Water Information System (NWIS)	7729
Non-Federal Regional Observing Networks	Carolinas Coastal Ocean Observing System (CaroCOOPS)	8
	Chesapeake Bay Observing System (CBOS)	3
	Coastal Ocean Monitoring and Prediction System (COMPS)	11
	CORIE	8
	Great Lakes Network (GLERL)	7
	Gulf of Maine Ocean Observing System (GoMOOS)	10
	Innovative Coastal-Ocean Observing Network (ICON)	2
	Long Island Shore Network (LIShore)	3
	Louisiana Universities Marine Consortium (LUMCON)	5
	Martha's Vineyard Coastal Ocean Observatory	2
	Maryland Dept. of Natural Resources	14
	Maryland Dept. of Transportation	37
	Prince William Sound Network (PWSN)	7
	South Atlantic Bight Synoptic Offshore Observational Network (SABSOON)	3
	Stevens Institute of Technology	3
Texas Automated Buoy System (TABS)	9	
Texas Coastal Ocean Observation Network (TCOON)	48	
Wave-Current-Surge Information System (WAVCIS)	7	

Remote Sensing Observing Platforms:

<u>Agency</u>	<u>Type</u>	<u>Number</u>
NWS/DOD	Radiosondes	31
NOAA	Boundary Layer Profilers	46
NWS	NEXRAD Weather Radar	158

Predictions:

<u>Agency</u>	<u>Type</u>	<u>Number</u>
NOS	Astronomical Tidal	277

Forecast Model Guidance:

<u>Agency</u>	<u>Type</u>	<u>Number</u>
NOS	Chesapeake Bay Operational Forecast System (CBOFS)	11
	New York Operational Forecast System (NYOFS)	8
	Galveston Bay Operational Forecast System (GBOFS)	6
NWS/Meteorological Development Laboratory (MDL)	Model Output Statistics (MOS)	1730
NWS/MDL	Extra-Tropical Storm Surge (ETSS)	77
NWS/National Center for Environmental Prediction (NCEP)	WaveWatch III	41

Surface Forecasts:

<u>Agency</u>	<u>Type</u>	<u>Number</u>
NWS/Weather Forecast Office (WFO)	County Weather Forecasts	3470
NWS/WFO	Surf Zone Forecasts	14
NWS/WFO	Coastal/Offshore Marine Forecasts	392
NWS/OPC/NHC	High Seas Forecasts	7

Fig. 5. Table of Observing Networks and Forecast Products in nowCOAST

5. FUTURE PLANS

Future enhancements to *nowCOAST* include additional data offerings and further improvements in viewer functionality. These include the acquisition and on-map display of observational data from selected networks, as well as graphical display of weather and oceanographic forecasts from selected NOAA forecast products.

NowCOAST will soon include graphical display of selected gridded meteorological and oceanographic fields from NWS' National Digital Forecast Database (NDFD) of interest to marine users (e.g. winds, waves, air temperature). NDFD will contain gridded fields of the following variables at a 5 km spatial resolution: maximum temperature, minimum temperature, hourly temperature, probability of precipitation, sky cover, dew point, heat indices, wind direction, wind speed, weather, and wave height. Temporal resolution of the variables is as follows: 24 hours (max-temp, min-temp), 12 hours (probability of precipitation), 3 hours out to 72 hours and 6 hours out to 168 hours (sky cover, temperature, dew point, heat indices, wind direction, wind speed). Initial fields maximum temperature, minimum temperature, and probability of precipitation will become operationally available on December 1, 2004. Other fields will become operational on a to-be-decided schedule in 2005. An example of a gridded 24-hr maximum temperature forecast as displayed by *nowCOAST* is shown in Fig. 6 below.

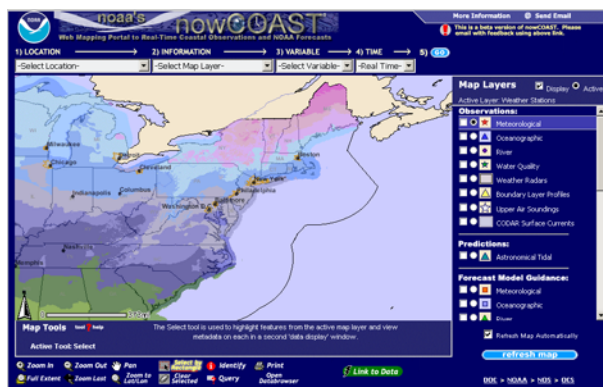


Fig. 6. Example of map depicting 24 hour maximum temperature forecast from the NDFD for the northeastern U.S.

NowCOAST will acquire and store data from NDFD in an Oracle database connected to ArcIMS via Arc Spatial Database Engine (ArcSDE). NDFD data in the database will be updated as needed, as often as hourly. In addition, other NOAA gridded fields may be included in *nowCOAST* once the NDFD implementation is complete, including the National Digital Guidance

Database (NGDG) and output from NOS estuarine forecast systems.

Improvements to the functionality and design of the viewer will be made to accommodate the inclusion of gridded fields. The user will be able to select individual fields for display using both the pulldown menu interface above the map as well as the 'Map Layers' list. Associated legend information for each field will be displayed on-map for easy viewing.

Plans also call for providing users with the capability to perform limited spatial analysis of gridded analyses and forecast fields, and to obtain a detailed display of results in the Databrowser. An example might be to select a specific location anywhere in the Conterminous U.S. to query for a forecast of selected variables from the NDFD. The user would click on a location on the map, select variables to display, specify a time window, and receive a graphical display or tabular data output in return. Additionally, comparisons of data from different NOAA forecast guidance products may also be possible for both a specific temporal or spatial domain.

Currently, *nowCOAST* is monitored on weekdays during regular business hours at NOS' Coast Survey Development Laboratory. It is anticipated that *nowCOAST* will be monitored 24 hours a day in the near future by NOS' Center for Operational Oceanographic Products and Services.

These planned enhancements to *nowCOAST*'s data offerings and user-interface will provide the nation's marine community and weather enthusiasts with a powerful, flexible, and reliable web-based mapping tool to access real-time environmental information for their geographic area.

6. ACKNOWLEDGMENTS

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