P1.18 DATA SERVICES FROM NOAA'S PMEL/EPIC GROUP

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1. INTRODUCTION

This paper describes the suite of data services provided by NOAA's PMEL/EPIC group. Tools for backend data management include data archive, search, subset, and retrieval functions for large data collections. A suite of desktop tools include traditional analysis and graphics to modern desktop Java and Windows applications for intensive browsing of specific data types (such as ocean observations data sets), remote access, and desktop applications. Web-based services include toolkits for creating customized web interfaces providing data and graphics specific to individual projects or data sets (i.e., El Niño buoys, multi-beam bathymetric data, satellite analyses, etc).

Internet access services include OPeNDAP data servers and clients customized for specific data types (in situ, gridded), collaboration tools for data sharing with white boarding and session logging, web services for machine-to-machine access to data, XML and GIS tools, network tools to allow applications to detect and adjust to network availability parameters, and, most recently, planned development of Open Grid Services Architecture (OGSA) services for data access and graphics on the Grid.

2. EPIC: DATA MANAGEMENT, DISPLAY AND ANALYSIS (DESKTOP AND WEB)

The EPIC system (Denbo and Soreide 1997) has been developed for the management, display, and analysis of large collections of in situ oceanographic and meteorological observations. Developed over a period of years, it includes functions for data archival, search and retrieval (Zhu and Denbo 2001), and a large suite of traditional desktop display and analysis programs. Although EPIC has customarily been used for ocean observations data, new projects are being initiated to utilize EPIC software for atmospheric time series and profiles. The EPIC Web Browser is a web gateway (Zhu et al. 2001) that makes data selection, display, and download functions for large data collections available from the Web (e.g., http://www.epic.noaa.gov/epic/ewb/ and http://apdrc.soest.hawaii.edu/).

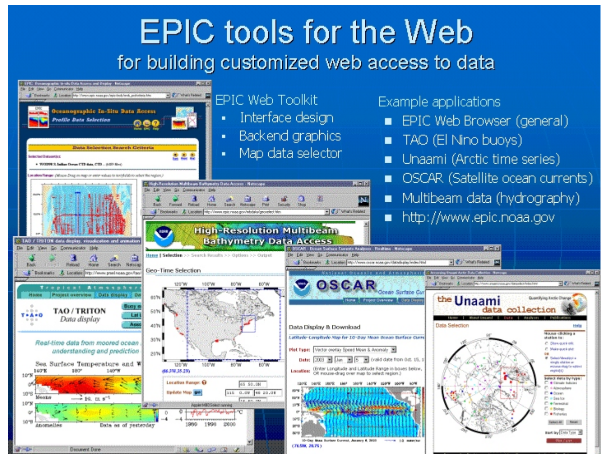

Fig. 1. Custom web applications built with EPIC utilities.

The suite of EPIC tools (Soreide et al. 2003) has been used to develop several customized (and popular) data-providing websites (Fig. 1). Examples include the TAO El Niño data site at http://www.pmel.noaa.gov/tao/jsdisplay/, the Bering Sea Climate and Ecosystem data site at http://www.beringclimate.noaa.gov/data/, the Arctic Unaami time series data collection, at http://www.unaami.noaa.gov/dataselect/index.html, and the OSCAR website providing near-realtime ocean surface currents derived from satellite data, at http://www.oscar.noaa.gov/.

3. ACCESSING, GRAPHING AND DOWNLOADING LOCAL AND REMOTE METADATA AND DATA

3.1 *Java OceanAtlas (JOA): Interactive Desktop Inspection of Multiple Data Collections*

The Java OceanAtlas (JOA) (Soreide et al. 2003) is a highly interactive Java application for in-depth viewing and manipulating of collections of oceanographic profile data (Fig. 2). Initially developed at Scripps Institute of Oceanography, JOA has been integrated into the PMEL EPIC environment. Since JOA also provides import capabilities for a wide variety of profile data formats, it is straightforward to work with one's own data. JOA is freely available for download from http://odf.ucsd.edu/joa/ and http://www.pmel.noaa.gov/epic/software/JavaJOA.htm.

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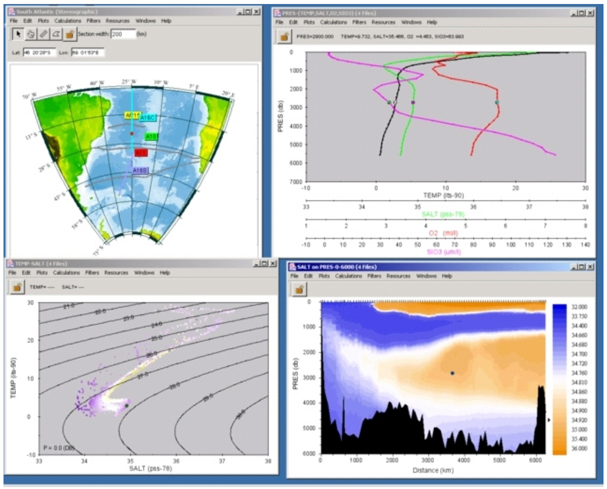

Fig. 2. Screen snapshot of Java OceanAtlas windows showing properties of ocean profile data sets.

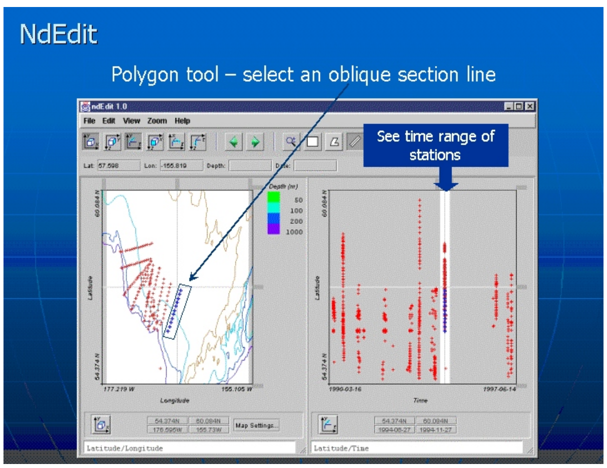

Fig. 3. Screen snapshot of "ndEdit", the Java data selection tool utilized in EPIC, the Climate Data Portal, OceanShare and Java OceanAtlas. Linked windows show two views of in-situ data locations (latitude-longitude map view and latitude-time view). The user can filter in the time window to subset the data or view the data locations.

A recent addition to JOA is the EPIC ndEdit tool (Osborne and Denbo 2002) for interactively browsing the time/space locations of individual observations and then subsetting the collections to select desired observed datasets in the same interactive environment (Fig. 3).

Most recently, work has begun to expand JOA's capabilities significantly to include the same sophisticated interactive browsing for a wide range of Ocean Observing System data types: ocean profiles, time series, drifting buoys, shipboard under-way measurements, ship-of-opportunity extensible bathythermograph (XBT) measurements, and inter-comparing these with one another and with gridded fields and model results. JOA development has always been driven by scientific researchers and these enhancements are being developed in the same manner.

3.2 *NcBrowse: OPeNDAP Desktop Client for 2D and 3D Graphics and Metadata Browsing of Data File Contents*

NcBrowse (Denbo and Osborne 2003) is a Java application that provides flexible, interactive graphical displays of data and metadata from a wide range of data file conventions. ncBrowse supports a wide variety of netCDF conventions, and allows viewing of netCDF attributes (metadata) as well as interactive desktop graphical browsing of multi-dimensional netCDF file data. Data can be displayed in 2D and as animations. Integration with VisAD allows interactive 3D displays and animations.

NcBrowse can be used to browse local or remote netCDF and OPeNDAP (formerly DODS) data files. Freely available for download from PMEL, at http://www.epic.noaa.gov/java/ncBrowse, ncBrowse is included in the Unidata site as a netCDF tool, and has proven quite popular amongst netCDF file users. It has been downloaded 10,496 times by 4151 sites in 61 countries in the past three years.

3.3 *Climate Data Portal: Access to Remote Distributed Data Collections*

The Climate Data Portal (Soreide et al. 2002) provides unified, networked access to geographically distributed data from ocean observing systems and historical data archives of in situ observed ocean data (Fig. 4). Data presently available through the portal includes:

- TAO El Niño buoy data (realtime)—PMEL
- Global sea level data (realtime)—University of Hawaii
- Global Temperature-Salinity Profile Program (GTSPP)—NODC
- International. Pacific Research Center in situ collection—University of Hawaii
- PMEL hydrographic data collection—PMEL
- WOCE Acoustic Doppler Current Profiler data—University of Hawaii

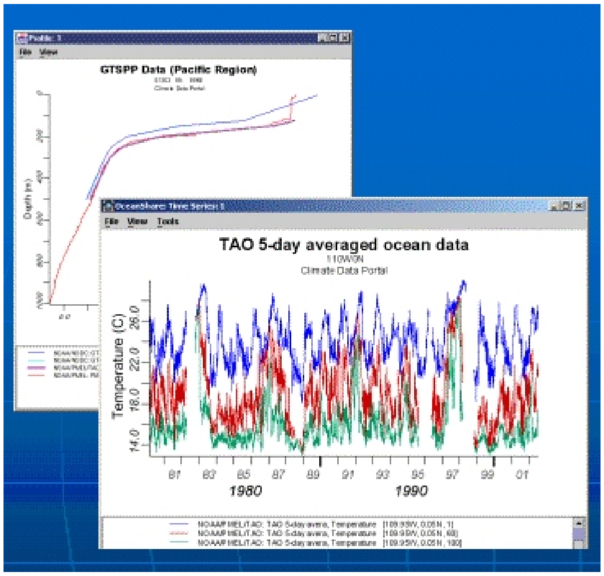

Fig. 4. Screen snapshot of Climate Data Portal windows showing in situ data access.

Data collections in progress or planned include a) WOCE hydrographic data—Scripps Institution of Oceanography and b) Marine Environmental Data Service (MEDS) Canada, c) ARGO profiling float data and d) WOCE/CLIVAR data.

Initially developed to utilize CORBA networking middleware, the Climate Data Portal is currently being integrated with OPeNDAP networking (Sirott et al. 2004). In the future, the Climate Data Portal will be extended to allow access to other types of data, such as gridded data, model results, and satellite data.

3.4 *OceanShare: Network Collaboration and Data Sharing by Multiple Scientists*

OceanShare (Denbo 2002) is a network collaborative tool that provides on-the-fly production of integrated browse images from in situ datasets stored at two or more geographically distributed data archives, and allows two or more scientists at different locations to view these images and have annotations simultaneously appear on all collaborating scientists desktops. All collaborating scientists can interactively post messages and change the data being displayed. OceanShare is based on Jini and JavaSpaces for collaborative functionality and uses the Climate Data Portal for remote data access. See http://www.epic.noaa.gov/collab/.

OceanShare is presently being enhanced to support NOAA Modeling Groups by providing a network collaboration environment for both in situ and gridded datasets, using OPeNDAP for remote file access, where individual participants may participate in a "networked conference session" to discuss a topic of interest, save the session, work off-line to investigate various aspects of this topic, and then rejoin the session later to post results for comment (Denbo 2004a). The science driver, and first testbed, will be the Carbon Modeling Consortium. When completed, this tool will be made freely available for use by others in the community.

3.5 *GIS integration*

Recent developments are helping to integrate oceanographic data sets and visualization services into the GIS environment. The EPIC group has long been working to integrate observed ocean data and gridded products with fisheries data in the GIS environment (Merati et al. 2002; Vance et al. 2004; Merati et al. 2003), and is presently working with ESRI, a world leader in the GIS software industry, to make realtime El Niño data from NOAA's TAO Ocean Observing System readily accessible, for the first time, through the Geography Network, an international GIS website reaching a large new community of users (Merati and Vance 2003).

Advanced 3D and stereographic virtual reality visualizations (Fig. 5) have also been implemented in the GIS environment (Vance et al. 2003).

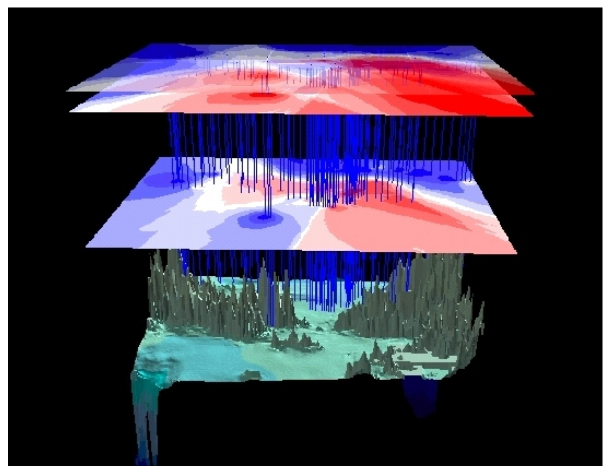

Fig. 5. Integration of virtual reality visualization of oceanographic profile data with bottom bathymetry into the GIS environment.

4. SERVERS AND UTILITIES

4.1 *Dapper: An OPeNDAP Server for In Situ Data Collections*

Dapper is a configurable web server that provides network access to thousands of in situ ocean observations by providing an OpenDAP interface to the EPIC-compatible Climate Data Portal from NOAA/PMEL. The first prototype Dapper installation is presently being tested. The capabilities of this new server as well as future design goals are discussed elsewhere in this conference (Sirott et al. 2004).

4.2 *SGT Java Graphics Toolkit*

The Scientific Graphics Toolkit (SGT) (Denbo 2003) facilitates easy development of platform independent, Java applications to produce highly interactive, flexible, publication quality, object oriented graphics of scientific data. Features include user settable or automatically scaled axes, sophisticated, automatically self-scaling time axes, labels as movable, customizable objects, automatic generation of legends to explain the data being displayed, and many more.

SGT JavaBeans (Denbo 2004b) provides an easy-to-use JavaBeans compatible interface to the Scientific Graphics Toolkit (SGT, http://www.epic.noaa.gov/java/sgt). With SGT Beans developers can create custom graphical displays for their data in a point-and-click environment. SGT Beans consists of three primary JavaBeans, Page, a graphical JavaBean upon which graphics, labels, axes, and legends are displayed, PanelModel, a non-graphical JavaBean that describes how the Panels, graphics, labels, axes, and legends are placed on the Page Bean, and DataModel, another non-graphical JavaBean which defines the connections between SGT data objects, Panels, axes, and legends. A netCDF data ingest example, along with other examples and tutorials, are included on the Web at http://www.epic.noaa.gov/java/sgt/ and http://www.epic.noaa.gov/talks/dwd/noaatech2004/SGTBeanTutorial.htm.

4.3 *3D Visualization and Virtual Reality*

The EPIC group at PMEL has served as a NOAA testbed for 3D stereographic and virtual reality presentations of data (http://www.noaanews.noaa.gov/magazine/stories/mag19.htm), beginning with the purchase of a large format projection platform (called an ImmersaDesk) that "immerses" the user in a virtual reality environment using stereo glasses. Pioneering the use of 3D and stereographic visualization techniques in oceanography and meteorology included taking the ImmersaDesk on a "road tour" of NOAA research facilities and conferences (http://www.pmel.noaa.gov/vrml/html/road.html), introducing research scientists to the use of desktop visualization software (Moore and Soreide 2001; Moore and Soreide 2002), and integrating 3D virtual reality techniques into the GIS environment (Vance et al. 2003). Most recently, a new GeoWall technology is being applied to provide an immersive virtual reality experience for science applications at one-tenth the cost of the earlier and bulkier ImmersaDesk technology (Hermann and Moore 2004). See the Virtual Reality website at http://www.pmel.noaa.gov/vrml/3DViz.html.

5. SUMMARY

EPIC data services begin with basic data archive/retrieval utilities for in situ ocean observations, and expand to include general purpose and customized utilities that provide search, retrieval, graphics, and data download functions for data files that reside locally and remotely. Although the EPIC group has long specialized in services for large collections of in situ ocean observations data, today the EPIC data services are expanding to include features for intercomparison of different types of ocean and atmospheric observations with one another and with gridded data products and model results.

EPIC data services can be utilized through general purpose or customized web pages or as interactive desktop Java clients or applications. The underlying technologies are standards-based and mainly OpenSource technologies, which are modern, robust, scalable and extensible. They include mySQL and PostgreSQL for database management, Java servlets, Java applets, and JavaScript for web pages, and Java and OPeNDAP applications for interactive desktop clients. Advanced, low-cost 3D stereographic visualization and virtual reality applications (Hermann and Moore 2004), GIS applications, and web services for ocean data (Burger et al. 2004) are also being developed.

Data services utilities are provided freely to others and can be customized for specific applications by the user or by the EPIC group. For more information, please see the EPIC website, http://www.epic.noaa.gov, the EPIC group's on-line presentations at http://www.epic.noaa.gov/talks, and contact the author of this poster at the following email address: Donald.W.Denbo@noaa.gov.

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