NOAA MODEL EXTENDED TO USE NOWCAST/FORECAST CURRENTS

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ABSTRACT: *GNOME (General NOAA Oil Modeling Environment) is a publicly available oil spill trajectory model used by the National Oceanic and Atmospheric Administration (NOAA) Hazardous Materials Response Division (HAZMAT) for oil spill response. In order to leverage work being done within and outside NOAA to develop detailed circulation models, GNOME has been extended to accept currents in a number of formats (ASCII, netCDF) from different types of models (time dependent triangular, rectangular, or curvilinear grids). In particular, HAZMAT is interested in connections with nowcast/forecast models. The NOAA Live Access Server (LAS), using the Unidata Distributed Oceanographic Data System (DODS), has been extended to support several nowcast/forecast models in the U.S. DODS provides the tools to make local data accessible to the outside through the Internet, regardless of internal format. LAS is a highly configurable server that allows on-the-fly graphics for data visualization, custom subsetting, and different output formats (from files to graphics). Providers of nowcast/forecast data need only set up a DODS server at their site for their data to be available to LAS. Once LAS is made aware of the new data, HAZMAT responders have 24-hour access to model generated fields. With the GNOME/LAS/DODS combination, other circulation models can be used to quickly create new spill trajectory forecasts.*

Discussion

Background and Motivation. The computer revolution over the past several decades has enabled researchers and private citizens to have desktop computing ability with orders of magnitude more memory and calculation speed than that of larger machines housed in special air conditioned spaces 20 years ago. Fluid dynamicists have taken advantage of their access to greater computing power, data assimilation techniques (using realtime measurements of environmental conditions), and public interest in forecasts to create nowcast/forecast models. HAZMAT modelers have developed their latest trajectory model, GNOME (Beegle-Krause, 2001), with an architecture that allows them to utilize the circulation fields of an increasing variety of circulation models. To enable HAZMAT to access these off-site nowcast/forecast models, HAZMAT has partnered with NOAA Pacific Marine Environmental Laboratory (PMEL) to use LAS and DODS to create the 24-hour connection. Both of these technologies are publicly available. The schematic shown in Figure 1, below, illustrates how HAZMAT can connect to a variety of nowcast/forecast models through a single LAS implementation.

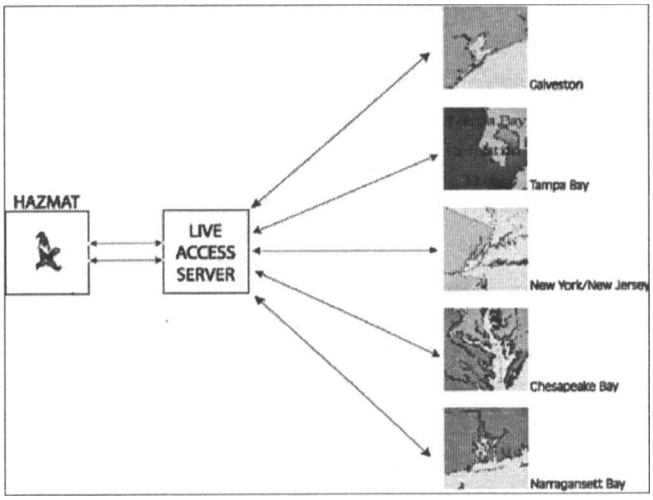

Figure 1. Connecting HAZMAT to a variety of nowcast/forecast models through a single LAS implementation.

The key to the success of this project is the LAS/DODS combination that disassociates the user from complex details of data conversion. LAS allows HAZMAT to download custom subsets of these models in a data format used by GNOME through a simple graphical user interface without any interaction with the original model's specific data structure (see Figure 2, below). The DODS server, located with the desired data, understands the native format and subsets and reformats the data as requested by LAS. Once LAS receives data from DODS, LAS performs any user-requested alterations, such as regridding, and the user-requested data formatting (gif image, ASCII text,

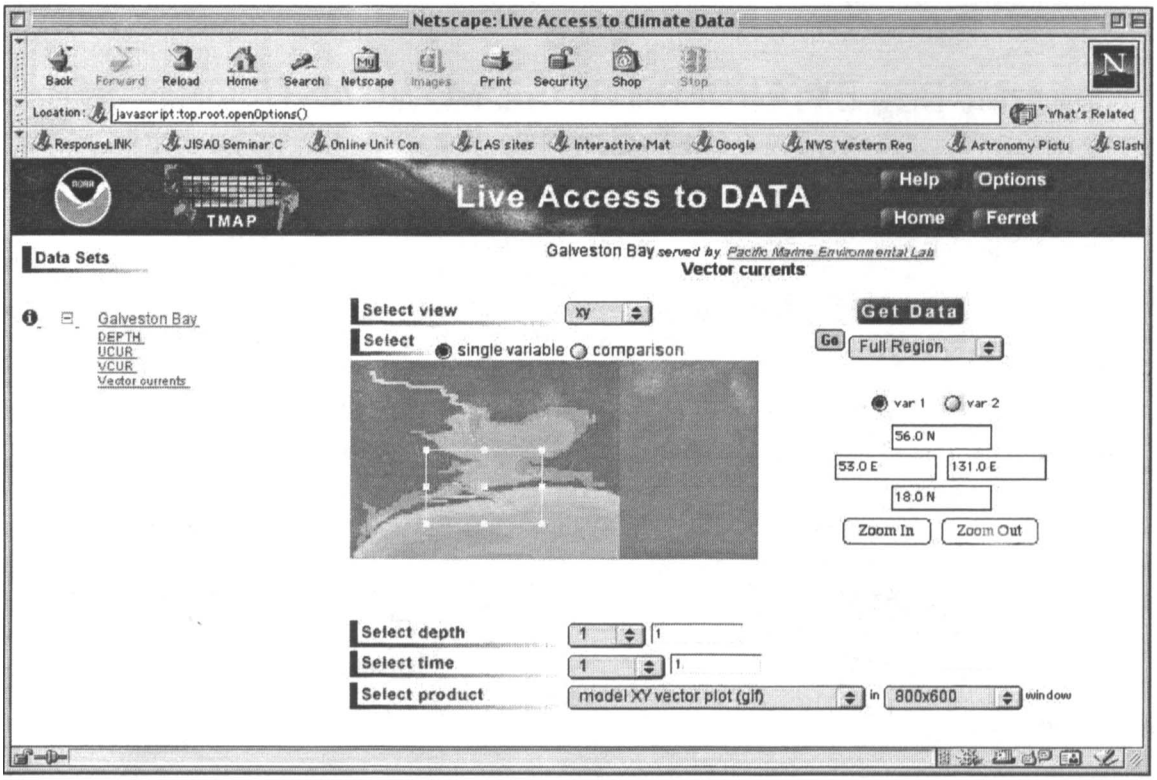

Figure 2. Live access server interface.

netCDF). With a high-speed Internet connection, HAZMAT can request and receive these custom data subsets in seconds.

How the Connection Happens

The details of how the system works are outlined in Figure 3, below. HAZMAT receives notification of a spill by phone in an area where a nowcast/forecast model exists. Using an internet browser, a HAZMAT modeler opens the HAZMAT LAS website, selects a particular model, the model fields, subset characteristics, and output format, then requests the data from LAS. LAS generates a DODS request and sends it to the DODS server with the nowcast/forecast model. DODS subsets the local data and sends the data back to LAS. LAS then formats the DATA using the NOAA Ferret application (http://ferret.wrc.noaa.gov/Ferret/) to perform any requested regridding, analysis, or reformatting, then sends the data on to the HAZMAT modeler. Finally, the HAZMAT modeler loads the data into GNOME and runs the spill trajectory.

DODS

The Unidata Distributed Oceanographic Data System (DODS) (http://unidata.ucar.edu/packages/dods/) is a system designed to make access to remote data transparent for the user. Data is available to the user without their knowledge of the internal data format. DODS is the protocol for connecting a DODS-enabled computer application to external data and uses http for requests. Thus any application that uses URLs, ranging from LAS to MATLAB® to Microsoft® Excel, can use DODS data. The idea is that the data creator offers the best distribution format, and users use their favorite analysis software, rather than learning or developing custom software. In addition, users only need to store the specific subset of data they choose to download.

LAS

The Live Access Server (LAS) (http://ferret.wrc.noaa.gov/Ferret/LAS/ferret_LAS.html) is a highly configurable Web server designed to provide flexible access to geo-referenced scientific data. It can present distributed data sets as a unified virtual database through the use of DODS networking. LAS allows a user to visualize data with on-the-fly graphics and request custom subsets of variables in a choice of file formats. Various links in the LAS interface enable the user to access background reference material about the data (metadata).

Additional capabilities have been added to LAS to address the needs of HAZMAT. Many of the data sources needed by HAZMAT include output from models on curvilinear grids. The HAZMAT LAS interface allows users to create visualizations in both the model grid and in standard world coordinate (lat-long) space. Visual inspection is vital for quality control checks before data is ingested into GNOME. Data can then be downloaded to the model grid or can be run through an objective analysis algorithm with user-set parameters to generate a lat-long gridded representation of the model data. (Although it would be preferable to have each data provider generate an "official" lat-long version of their model output, it is unreasonable to expect this to happen in the near future.)

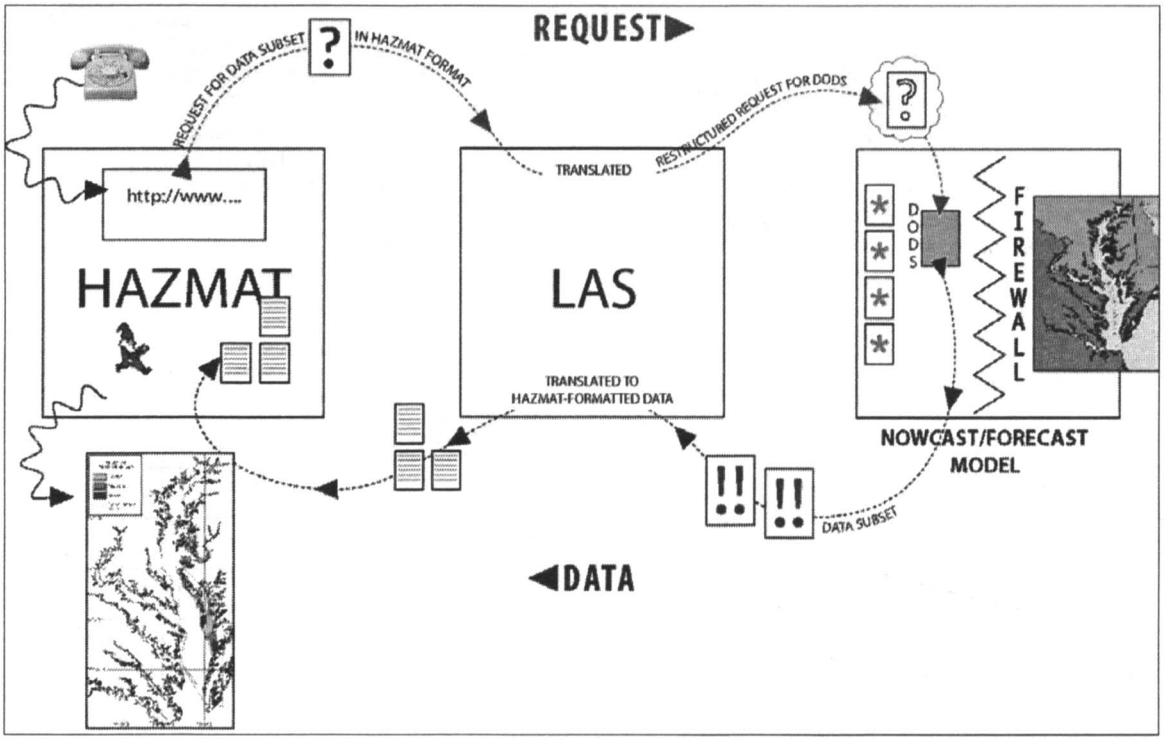

Figure 3. Pathway of information flow during a spill, from notification (by phone, upper left) to trajectory forecast (lower left), using LAS to retrieve custom-formatted data.

GNOME

The General NOAA Oil Modeling Environment (GNOME) trajectory model uses the LAS current files as one would expect: the model grid domain is the land/water boundary for oil beaching and flow-through calculations as GNOME computes the trajectory. In GNOME's Diagnostic Mode, the LAS-derived fields are loaded as a map that includes a current mover. GNOME understands netCDF (http://www.unidata.ucar.edu/packages/netcdf/) with particular keywords and attributes (keywords and attributes are available upon request, and in the future, via Internet download). Currently, development is concentrated on the curvilinear grids used in the Princeton Ocean Model (POM) (Mellor, 1996; http://www.aos.princeton.edu/WWWPUBLIC/htdocs.pom/) and finite element models, such as QUODDY (Ip and Lynch, 1995) and RMA10 (http://chl.wes.army.mil/software/tabs/). In particular, we are working to create a finite number of data output standards with the U.S. Navy and NOAA Coast Survey Development Laboratory (CSDL). Our goal is that new models will be easily added to LAS and function on appropriate conversion from model coordinates (i,j,k,l) to world coordinates (x,y,z,t). The end result is that a modeler's fields are well represented in subsequent use.

Conclusions

The HAZMAT LAS has been prototyped and will expand as connections are made with more modelers and their nowcast/forecast models. LAS/DODS technology allows the responder to quickly leverage available nowcast/forecast current fields for use during emergency response. Because the technology is publicly available, the DODS/LAS technology will allow the nowcast/forecast modeler to share their model fields with a wide range of users who require different types of information without extra investment. The modeler can control access or distribute data freely, and the user can format or otherwise alter the data to meet their needs without contacting the modeler directly. Under ideal conditions, an unconnected nowcast/forecast modeler could download and install a DODS server and have his or her data available to emergency responders via LAS in one hour.

Biography of presenting author

"CJ" Beegle-Krause is a physical oceanographer specializing in modeling chemical transport in the ocean. She has been associated with HAZMAT for five years as part of the GNOME development team and as a response trajectory analyst. CJ is also a member of the Scientific Advisory Panel for the Alaska Cruise Ship Initiative.

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