STOQS: The Spatial Temporal Oceanographic Query System

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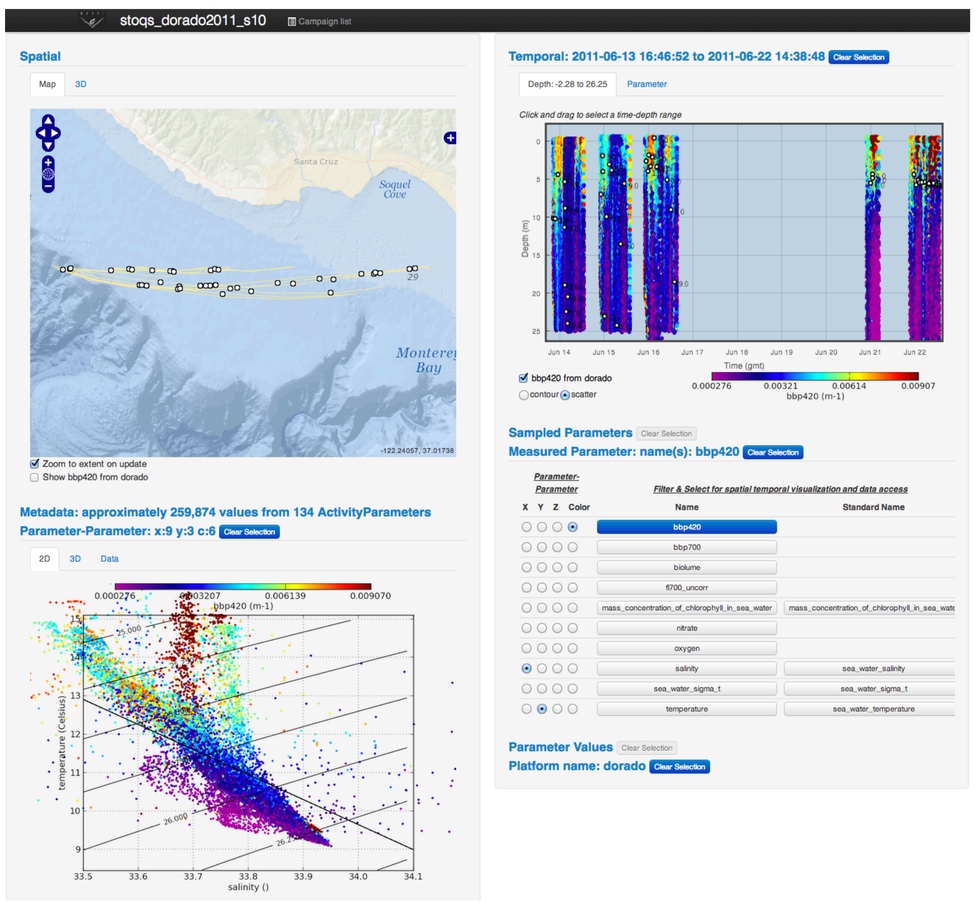
Multi-parameter spatial temporal data

With increased ability to acquire measurements from platforms such as ships, moorings, drifters, gliders and autonomous underwater vehicles, the need to efficiently access and visualize the data they collect is growing. The Monterey Bay Aquarium Research Institute has designed and built the Spatial Temporal Oceanographic Query System (STOQS) specifically to address this issue. The fundamental issue of providing efficient management and access to multidisciplinary data is addressed by embracing existing standards and employing geospatial relational database technology along with modern web frameworks to build a tool that enables deep exploration of complex data sets.

User Interface

The STOQS user interface displays a map of the vehicle tracks and a time series of depth profiles of the vehicles. The screen capture below shows data from five days of Autonomous Underwater Vehicle runs across an evolving upwelling front in Monterey Bay California. A T/S diagram colored with optical backscatter at 420 nm has been interactively generated by selecting radio buttons in the Measured Parameter section.



Technology

STOQS consists of a PostgreSQL/PostGIS database, Mapserver, and Python-Django running on a server and client-side technology (jQuery, OpenLayers, Twitter Bootstrap) running in a modern web browser. The web application provides faceted search capabilities allowing a user to quickly drill into data of interest. Data selection can be constrained by spatial, temporal, and depth selections as well as by parameter values and platform names. The web application layer also provides a REST (Representational State Transfer) Application Programming Interface allowing tools such as the Matlab stoqstoolbox to retrieve data directly from the database. New capabilities provided by X3DOM are being explored for providing interactive 3D views of the data in browsers that support WebGL.

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Operation

The STOQS software and its prerequisites are free to use under standard open source licenses. A capable Unix system administrator can have a system up and running within a day. The specific steps of operation include :

1. Install the STOQS software on a Linux server
2. Conduct oceanographic missions that produce in situ measurement data
3. Create files of the data using the CF-NetCDF DSG featureTypes
4. Make those files available via OPeNDAP, create a PostgreSQL database
5. Construct simple load script to load data from OPeNDAP into the database
6. Explore and access the data through the STOQS web user interface

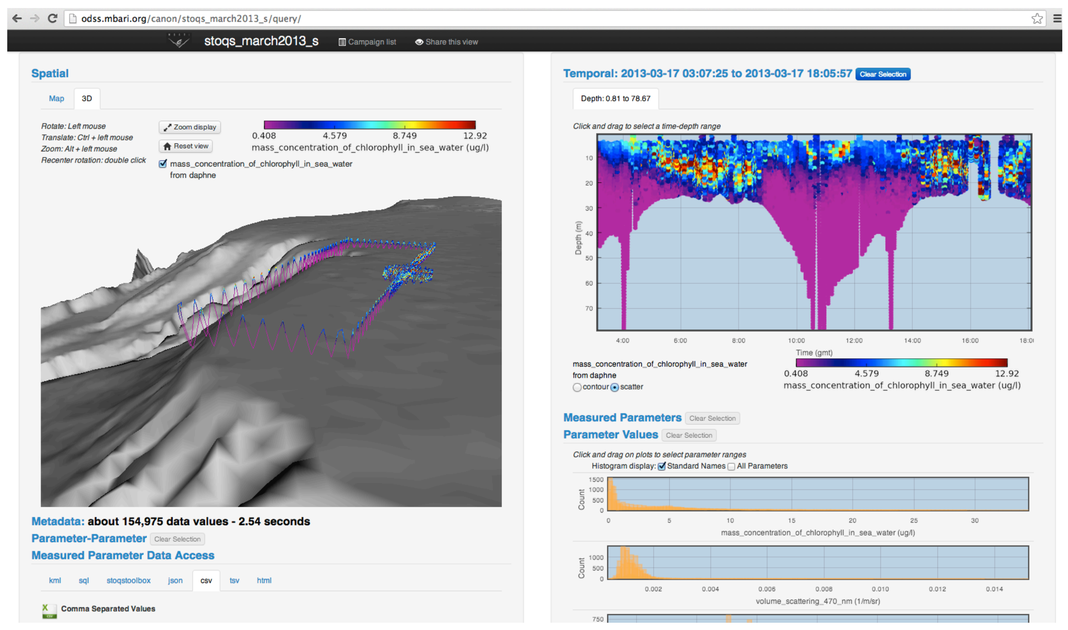
Within the user interface measurement data are retrieved directly from the database and transformed to products and formats for further visualization and analysis. A typical campaign produces dozens of NetCDF files containing millions of measurement values. Performing comparable data access without STOQS would require reading all of the NetCDF files, sub-selecting the data and creating desired products within the client tool, an intractable proposition for certain queries.

Data Exploration

With data access and subselection performed on a high performance data server (rather than within the client software), new ways of exploring relationships amongst the data are enabled. A typical oceanographic campaign produces a few million *in situ* electronic measurements and about 100 water samples. The water samples are subsampled and subjected to further examination ranging from simple chemical analysis and microscopy to more complex genetic assays. Numeric values resulting from these analyses can be loaded and linked to electronic sensor measuement data, permitting easy comparisons and exploration.
The web application allows immediate association of any parameter with any other parameter in a visual way such that an investigator can quickly form hypotheses and test them by making appropriate selections and associations.

X3DOM

Interactive 3D Web display of chlorophyll measurements from an autonomous underwater vehicle in San Pedro Bay, California. ISO standard X3D Geospatial used with X3DOM JavaScript library used for rendering in browsers that support WebGL.



Acknowledgments

Development of STOQS has been supported by the David and Lucile Packard Foundation at the Monterey Bay Aquarium Research Institute. STOQS is an open source software project built upon a framework of free and open source software and is available for anyone to use.

For more information please see: http://code.google.com/p/stoqs/