Using STOQS and stoqstoolbox for *in situ* Measurement Data Access in Matlab

Francisco López Castejón (francisco.lopez@upct.es) Department of Chemical & Environmental Engineering, Technical University of Cartagena (UPCT), Cartagena, Spain
Brian Schlining (brian@mbari.org) and Michael P. McCann (mccann@mbari.org) Monterey Bay Aquarium Research Institute, Moss Landing, CA

Abstract

This poster presents the stoqstoolbox, an extension to Matlab that simplifies the loading of in situ measurement data directly from STOQS databases. STOQS (Spatial Temporal Oceanographic Query System) is a geospatial database tool designed to provide efficient access to data following the CF-NetCDF Discrete Samples Geometries convention. Data are loaded from CF-NetCDF files into a STOQS database where indexes are created on depth, spatial coordinates and other parameters, e.g. platform type. STOQS provides consistent, simple and efficient methods to query for data. For example, we can request all measurements with a standard_name of sea_water_temperature between two times and from between two depths. Data access is simpler because the data are retrieved by parameter irrespective of platform or mission file names. Access is more efficient because data are retrieved via the index on depth and only the requested data are retrieved from the database and transferred into the Matlab workspace. Applications in the stoqstoolbox query the STOQS database via an HTTP REST application programming interface; they follow the Data Access Object pattern, enabling highly customizable query construction. Data are loaded into Matlab structures that clearly indicate latitude, longitude, depth, measurement data value, and platform name. The stoqstoolbox is designed to be used in concert with other tools, such as nctoolbox, which can load data from any OPeNDAP data source. With these two toolboxes a user can easily work with in situ and other gridded data, such as from numerical models and remote sensing platforms. In order to show the capability of stoqstoolbox we will show an example of model validation using data collected during the May-June 2012 field experiment conducted by the Monterey Bay Aquarium Research Institute (MBARI) in Monterey Bay, California. The data are available from the STOQS server at http://odss.mbari.org/canon/stoqs_may2012/query/. About a half-million measurements of 18 parameters from 6 platforms acquired over a 3-week period are available on this server. The model used for comparison is the Regional Ocean Modeling System developed by Jet Propulsion Laboratory for the Monterey Bay. The model output are loaded into Matlab using nctoolbox from the JPL server at http://ourocean.jpl.nasa.gov:8080/thredds/dodsC/MBNowcast. Model validation with in situ measurements can be difficult because of different file formats and because data may be spread across individual data systems for each platform. With stoqstoolbox the researcher must know only the URL of the STOQS server and the OPeNDAP URL of the model output. With selected depth and time constraints a user's Matlab program searches for all in situ measurements available for the same time, depth and variable of the model. STOQS and stoqstoolbox are open source software projects supported by MBARI and the David and Lucile Packard Foundation. For more information please see http://code.google.com/p/stoqs.

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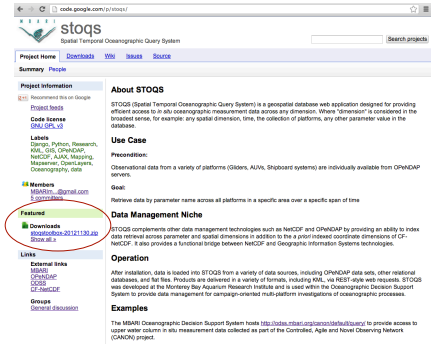
The STOQS Project

STOQS is a free and open source geospatial web database project that is designed to work with *in situ* oceanographic data. Anyone may install it and use the system for their data management, access and visualization.

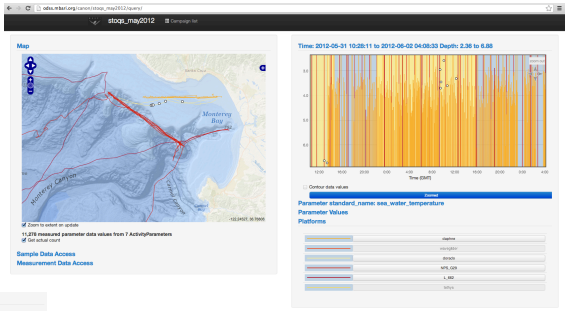
The stoqstoolbox Matlab toolbox is available for download from the STOQS project web site: http://code.google.com/p/stoqs.

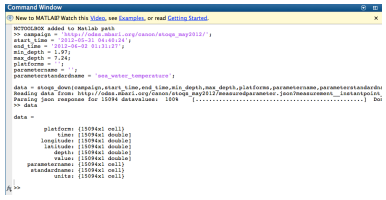


Example 1

A. Using the STOQS web application, select Parameter standard_name "sea_water_temperature" and a depth and time range.

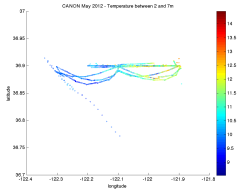
B. Select the stoqstoolbox" tab under Measurement Data Access and copy and paste the text into a Matlab session.





After the data are loaded, work with them as you please. For example, to create the scatter map at the right execute the commands:

```
scatter(data.longitude, data.latitude, 5, data.value)
axis([-122.4, -121.8, 36.7, 37])
xlabel('longitude')
ylabel('latitude')
title('CANON May 2012 - Temperature between 2 and 7m')
colorbar()
```



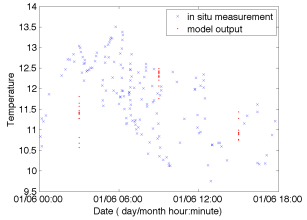
Example 2

Included as a demo in the stoqstoolbox download, this example is an execution of a Matlab script that starts with a model output file and then examines a STOQS server for *in situ* measurement data. Data from STOQS are retrieved from within tight bounds around the model's time and depth coordinates.

```
>> canon_may2012_validation
------------------------------------------------------------
Model time 01-Jun-2012 03:00:00
Using NCTOOLBOX to read model data from http://ourocean.jpl.nasa.gov:8080/thredds/dodsC/MBNowcast/mb_das_2012060103.nc
Using STOQSTOOLBOX to look for data at http://odss.mbari.org/canon
Opening http://odss.mbari.org/canon/campaigns.json
Parsing json response for 26 datavalues:  27%     [.............                                      ]  Done.
Reading data from: http://odss.mbari.org/canon/stoqs_may2012/measuredparameter.json?
measurement__instantpoint__timevalue__gte=2012-06-01+00:00:00&measurement__instantpoint__timevalue__lte=2012-06-01+06:00:00&measurement__depth__gte=4.9&m
easurement__depth__lte=5.1&parameter__name=sea_water_temperature&
Parsing json response for 48 datavalues:  98%     [.................................................. ]  Done.
Downloaded 48 measurements
------------------------------------------------------------
Model time 01-Jun-2012 09:00:00
Using NCTOOLBOX to read model data from http://ourocean.jpl.nasa.gov:8080/thredds/dodsC/MBNowcast/mb_das_2012060109.nc
Using STOQSTOOLBOX to look for data at http://odss.mbari.org/canon
Opening http://odss.mbari.org/canon/campaigns.json
Parsing json response for 48 datavalues:  15%     [.......                                           ]  Done.
Reading data from: http://odss.mbari.org/canon/stoqs_may2012/measuredparameter.json?
measurement__instantpoint__timevalue__gte=2012-06-01+06:00:00&measurement__instantpoint__timevalue__lte=2012-06-01+12:00:00&measurement__depth__gte=4.9&m
easurement__depth__lte=5.1&parameter__name=sea_water_temperature&
Parsing json response for 88 datavalues:  99%     [.................................................. ]  Done.
Downloaded 88 measurements
------------------------------------------------------------
Model time 01-Jun-2012 15:00:00
Using NCTOOLBOX to read model data from http://ourocean.jpl.nasa.gov:8080/thredds/dodsC/MBNowcast/mb_das_2012060115.nc
Using STOQSTOOLBOX to look for data at http://odss.mbari.org/canon
Opening http://odss.mbari.org/canon/campaigns.json
Parsing json response for 88 datavalues:  8%      [....                                              ]  Done.
Reading data from: http://odss.mbari.org/canon/stoqs_may2012/measuredparameter.json?
measurement__instantpoint__timevalue__gte=2012-06-01+12:00:00&measurement__instantpoint__timevalue__lte=2012-06-01+18:00:00&measurement__depth__gte=4.9&m
easurement__depth__lte=5.1&parameter__name=sea_water_temperature&
Parsing json response for 26 datavalues:  96%     [.................................................. ]  Done.
Downloaded 26 measurements
```

Image produced by the demo `canon_may2012_validation` script.

A simple comparison of model and *in situ* data plotted together.



Future Work and Acknowledgements

Matlab's parsing of the strings in the JSON response is very time consuming, taking several minutes to retrieve the 15,094 measurements in example 1. A technique that would generate a metadata-enhanced binary data response would be much more efficient. STOQS does not yet support requesting data given a geographical constraint. Once that is implemented (Issue #13 of the project) in the server-side REST code, it would be an easy step to add the capability to stoqstoolbox.

STOQS and stoqstoolbox are licensed under GPL3 and are built upon other free and open source software. For more information please see the project web site at http://code.google.com/p/stoqs/. Development of STOQS is supported by the David and Lucile Packard Foundation at the Monterey Bay Aquarium Research Institute.

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