IOOS Coastal Ocean Modeling Testbed (COMT) Cyberinfrastructure

NOAA EDMC 2012

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INTEGRATED OCEAN OBSERVING SYSTEM

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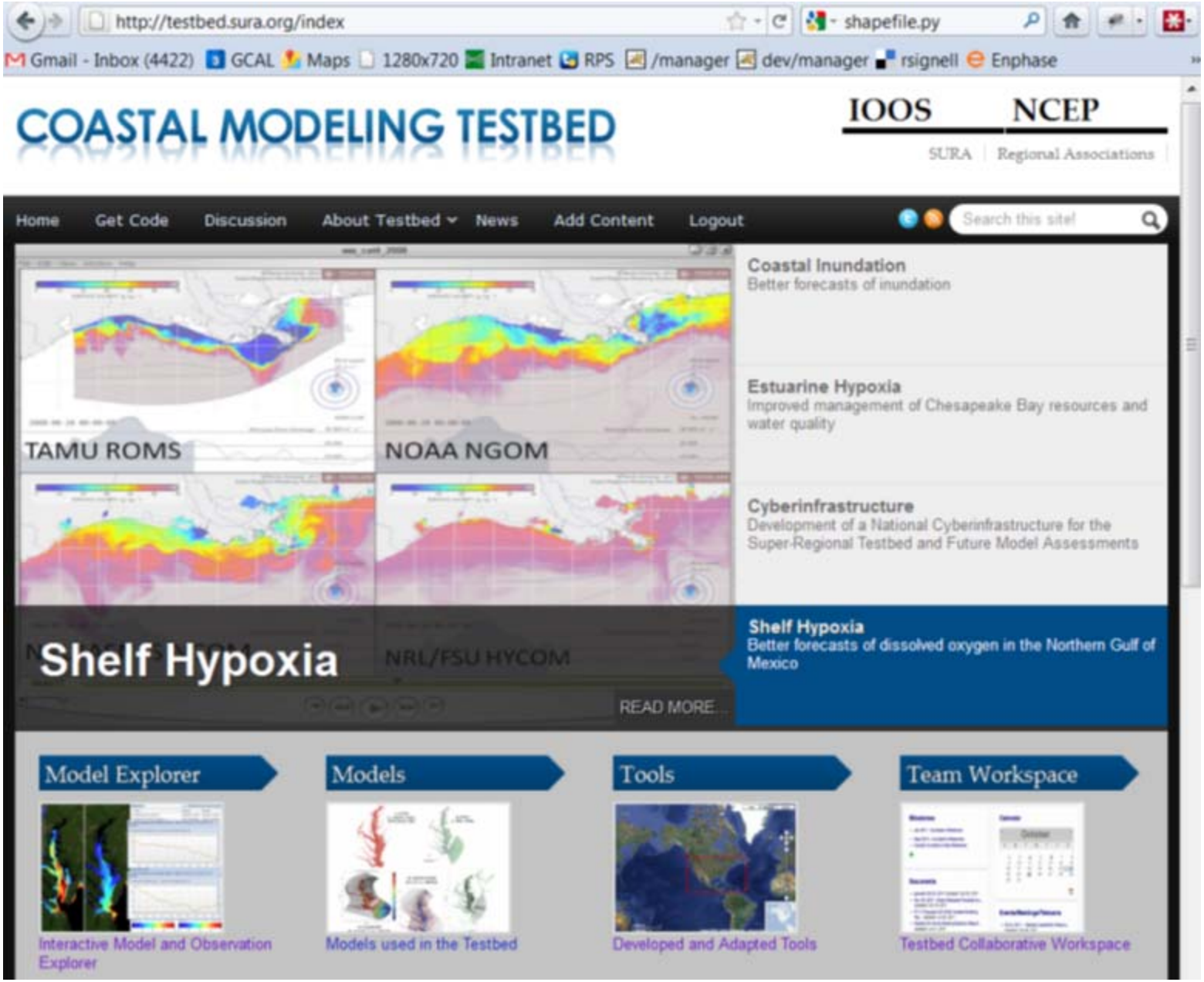

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How do I find and consume model and observation data easily?

INTEGRATED OCEAN OBSERVING SYSTEM

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CI Evaluations

TDS/OPeNDAP
NetCDF/Java
ncISO
ncWMS
RAMADDA
ERDDAP
OGC WMS
OGC SOS
OGC CS/W
OpenSearch
OGC WPS

Matlab (NCToolBox)
Python (pyWMS)
ncSOS
UGRID
CHPS
GI-CAT
ESRI GeoPortal

UGRID

Convention for storing Unstructured Grid data in NetCDF format

Implementation

- Support added to NetCDF-Java as a UGRID FeatureType
- NCTOOLBOX wraps the Java implementation
- Fast spatial lookups with RTree, overhead in loading the tree into memory
- More work to do on memory management handling large grids (>1m cells)
- “Simple” methods for common use cases
  - **Subset** – onto another Unstructured Grid, with topology included, by BBOX, Both entire dataset and specific variables
  - **Extract time-series** from a spatial location
    - Alleviates need for separate “point” output (space restrictions aside)

MATLAB Interoperability Tools : NCTOOLBOX

- **Merged njtbx functionality with nctoolbox's** (Brian Schlining) codebase (http://code.google.com/p/njtbx/)

- **Creating methods for SURA Testbed use case** (timeseries extraction, geographic bounding boxes, search api, unstructured grid support, comparisons/assessment…)

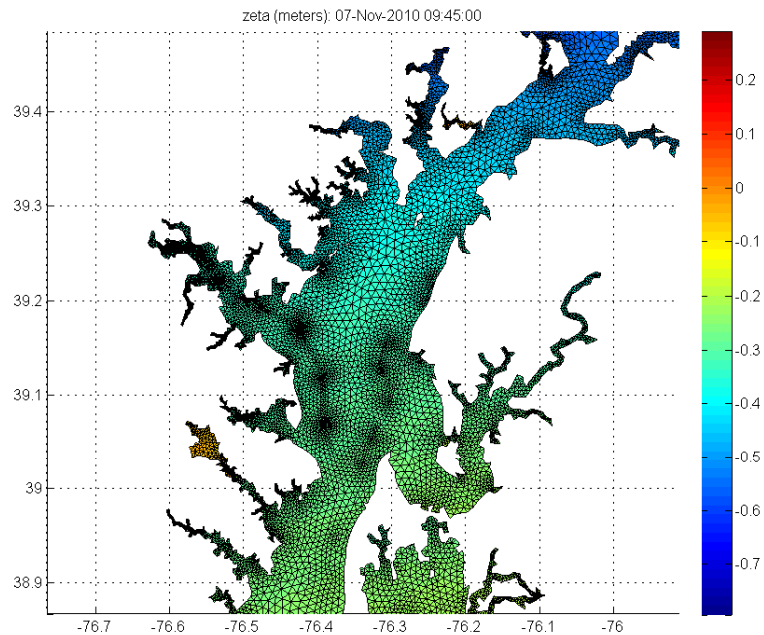
- **Merging changes with nctoolbox open source development** on Google Code (http://code.google.com/p/nctoolbox/)

NCTOOLBOX for Matlab

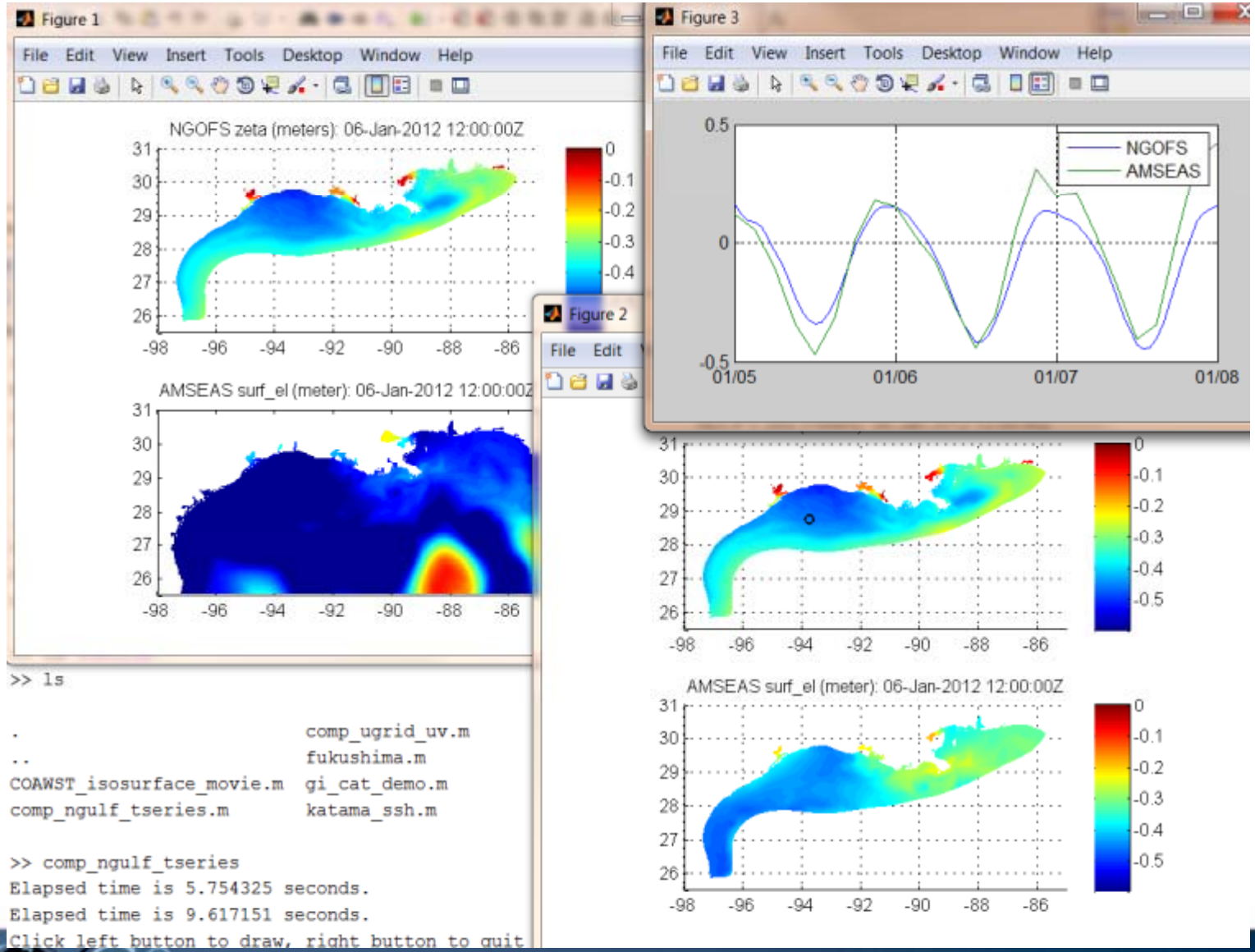
http://code.google.com/p/nctoolbox

```
links = opensearch(q)
nc = ncugrid(links.dap{1})
z  =  nc.data('zeta',…)
grid = nc.grid('zeta',…)
```

```
z = 26441x1 single
grid =
    lat: [26441x1 single]
    lon: [26441x1 single]
    time: 730970 (matlab datenum)
    connectivity: [52025x3 int32]
```

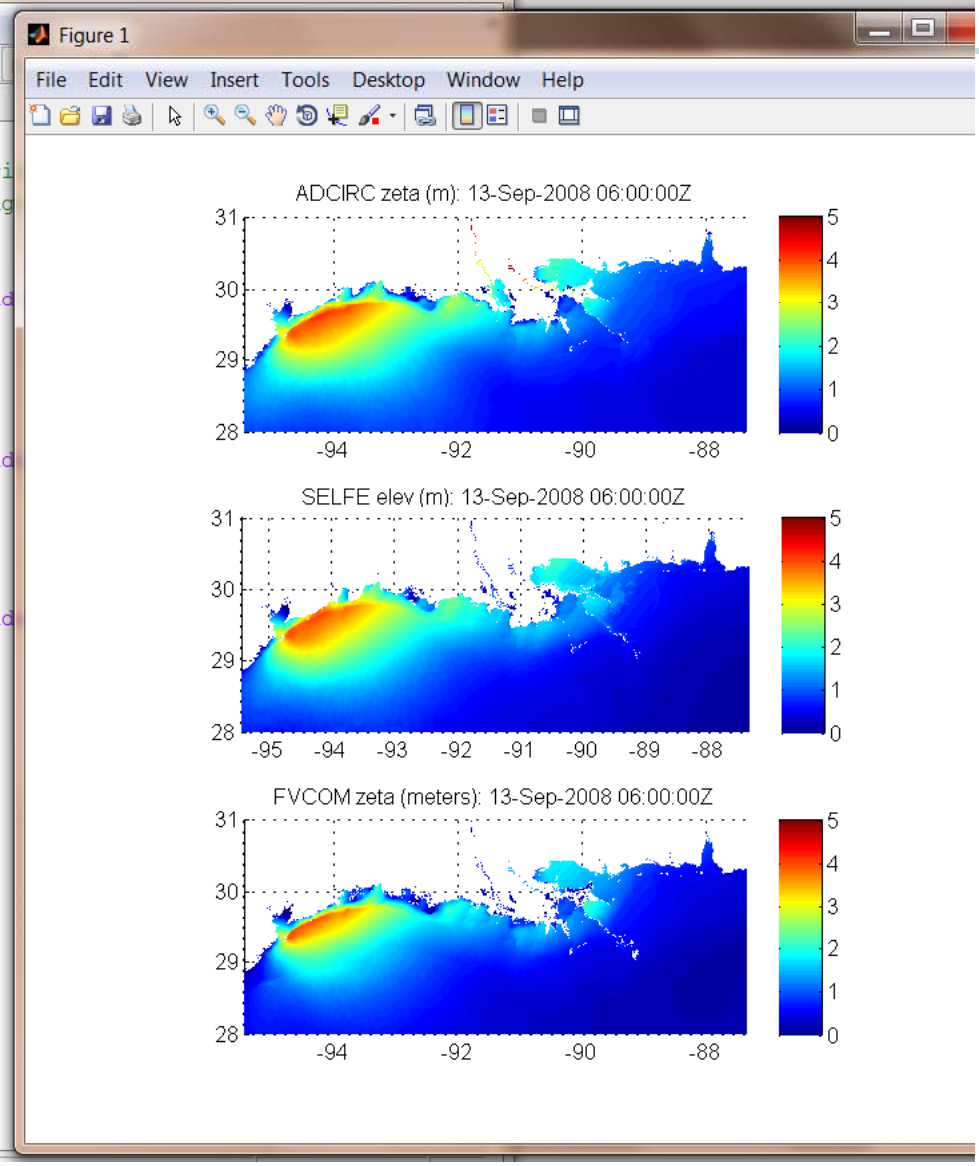


comp_ngulf_tseries.m

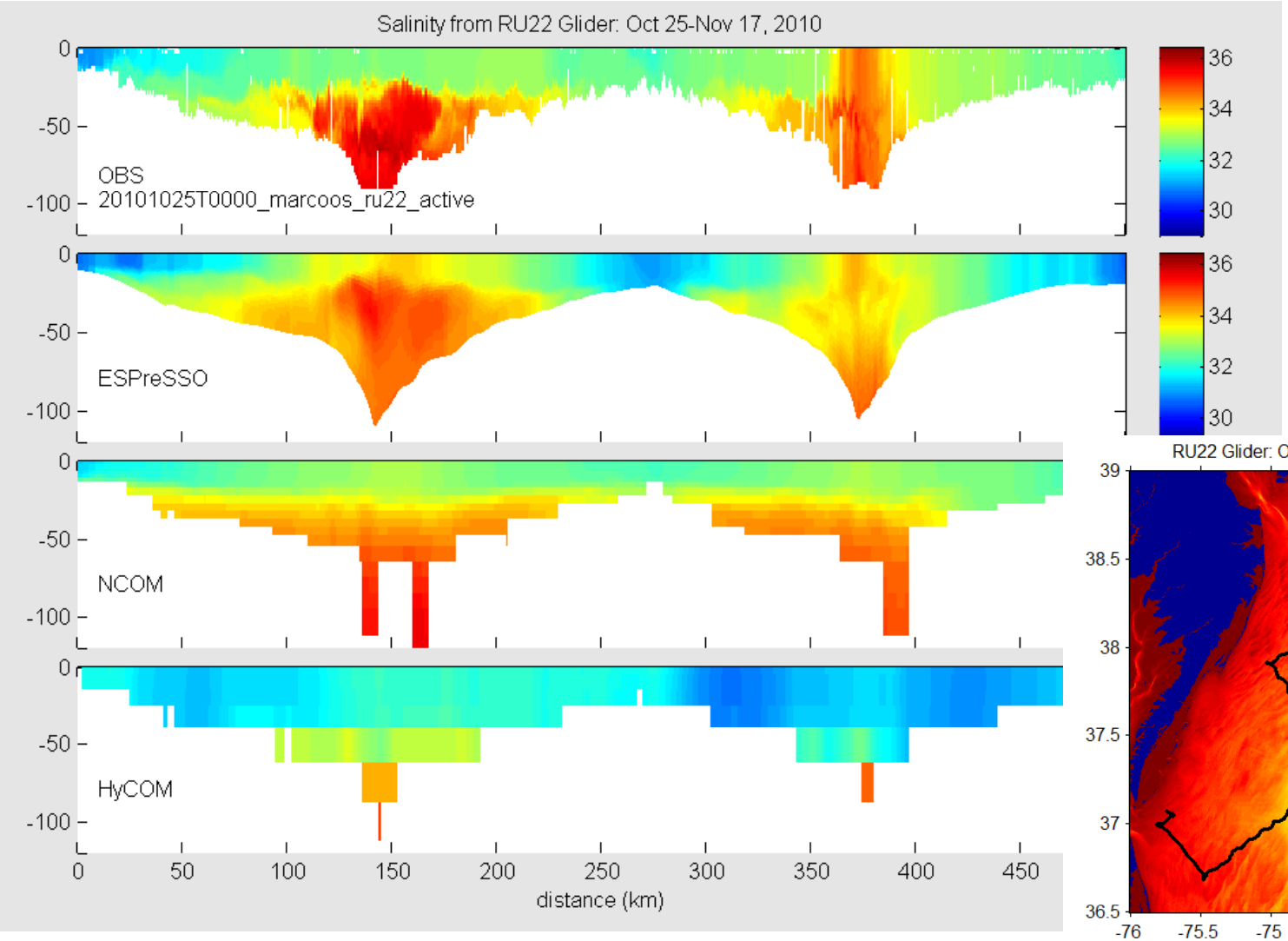


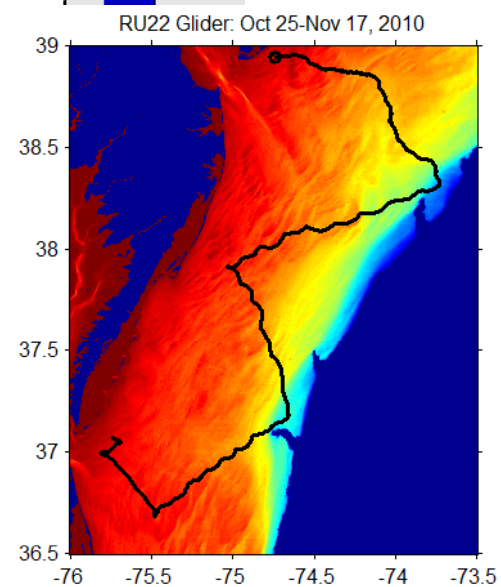
C:\cygwin\home\rsignell\distro\nctoolbox\demos\contrib\test_cf_ugrid3.m

```
% TEST_CF_UGRID3
% Compare water levels from 3 different unstructured gri
% models that use UGRID conventions (http://bit.ly/cf_ug
% comparison with no model specific code
titl{1}='ADCIRC';
uris{1}='http://testbedapps.sura.org/thredds/dodsC/inund
vars{1}='zeta';
times{1}=[2008 9 13 06 0 0];

titl{2}='SELFE';
uris{2}='http://testbedapps.sura.org/thredds/dodsC/inund
vars{2}='elev';
times{2}=[2008 9 13 06 0 0];

titl{3}='FVCOM';
uris{3}='http://testbedapps.sura.org/thredds/dodsC/inund
vars{3}='zeta';
times{3}=[2008 9 13 06 0 0];
% bounding box for figures
ax=[-95.4519  -87.3856   28.0   31.0]
% color range for figures
cax=[0 5];

% There is nothing model specific in the loop below!
for i=1:length(uris)
  tic
  % Initialize dataset object
  nc=ncgeodataset(uris{i});
  %get geovariable object
  zvar=nc.geovariable(vars{i});
  % Find the coordinate variables
  lon=zvar.getlondata(:);
```



Comparison to Glider





http://polar.ncep.noaa.gov/global/examples/usingmatlab2.shtml

Gmail - Inbox (4422) GCAL Maps 1280x720 Intranet RPS /manager dev/manager rsignell Enphase Rich Signell's Work Log...

www.nws.noaa.gov

National Weather Service

Environmental Modeling Center

Home News Organization Search Search

Local forecast by "City, St" or Zip Code

City, St Go

Text-only version

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RTOFS Global Data Analysis with MATLAB and NCTOOLBOX

Home Z-Levels Isopycnals Gulf Stream Metrics WOCE Data Access About

Go To RTOFS Atlantic Ocean Model

The following examples use MATLAB® to extract and visualize the sea surface temperature of the RTOFS Global model using the NOMADS data server and a downloaded NetCDF file.

Prerequisites

The examples make use of two free toolboxes,

1. NCTOOLBOX for MATLAB
2. M_MAP: A mapping package for MATLAB.

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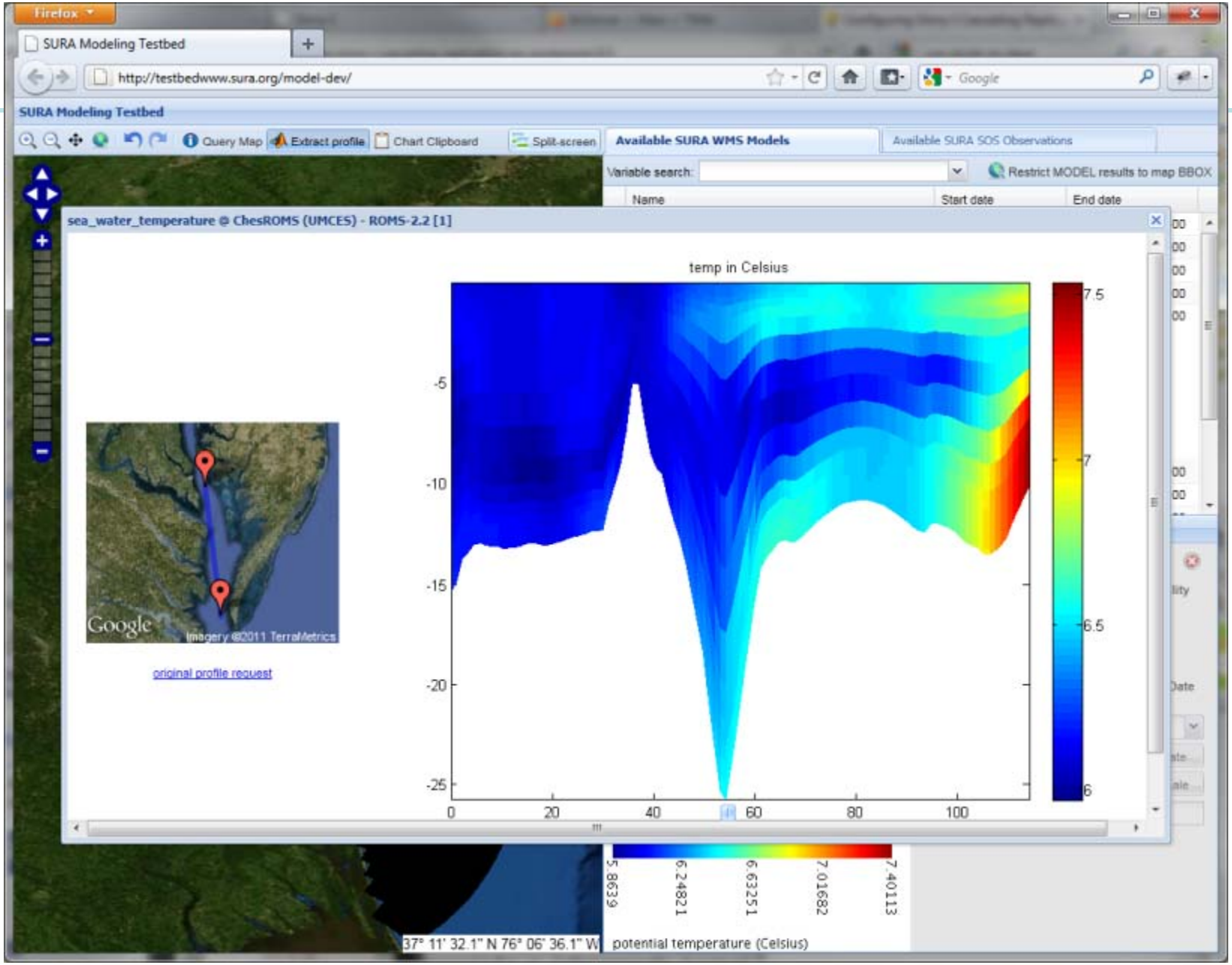
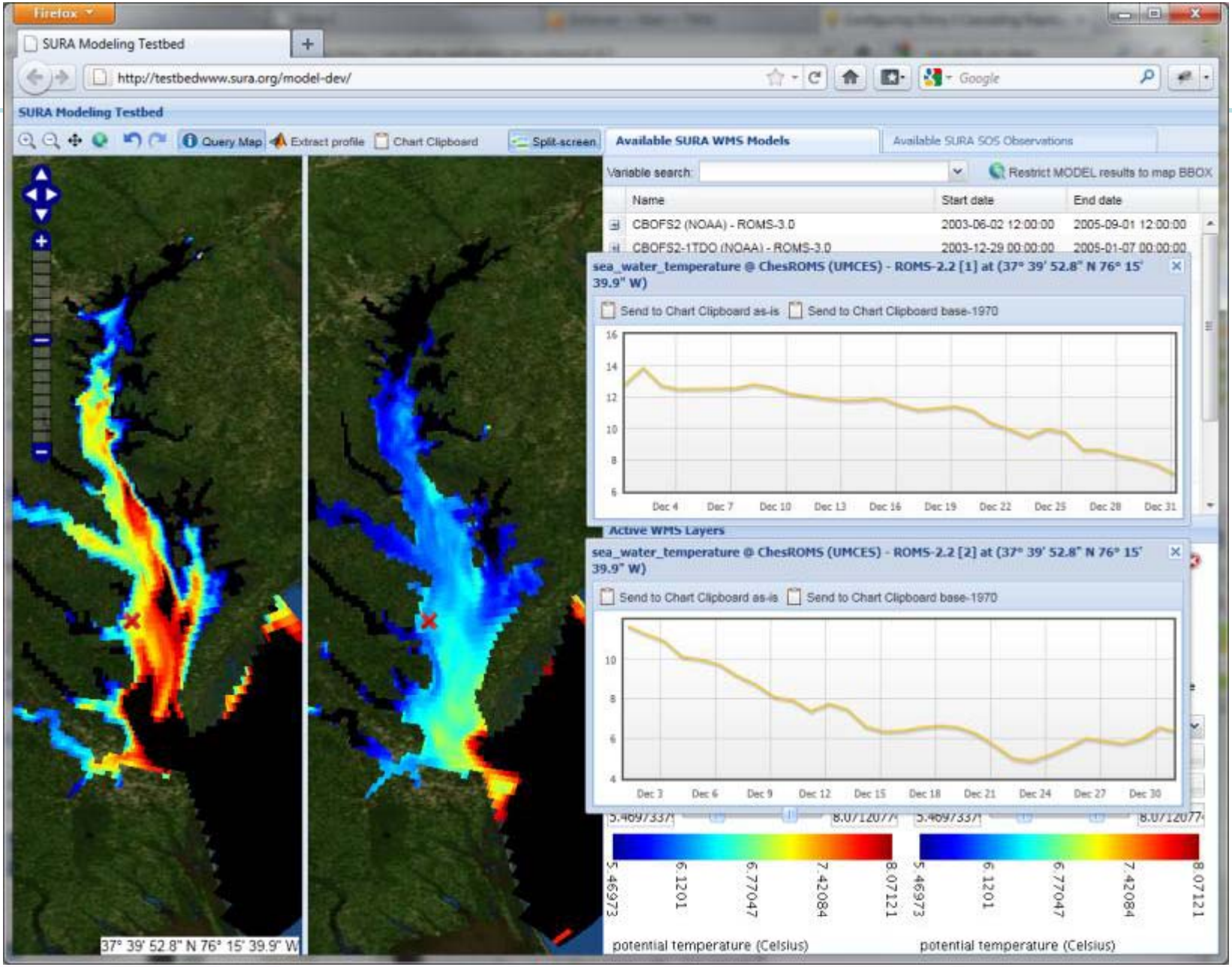
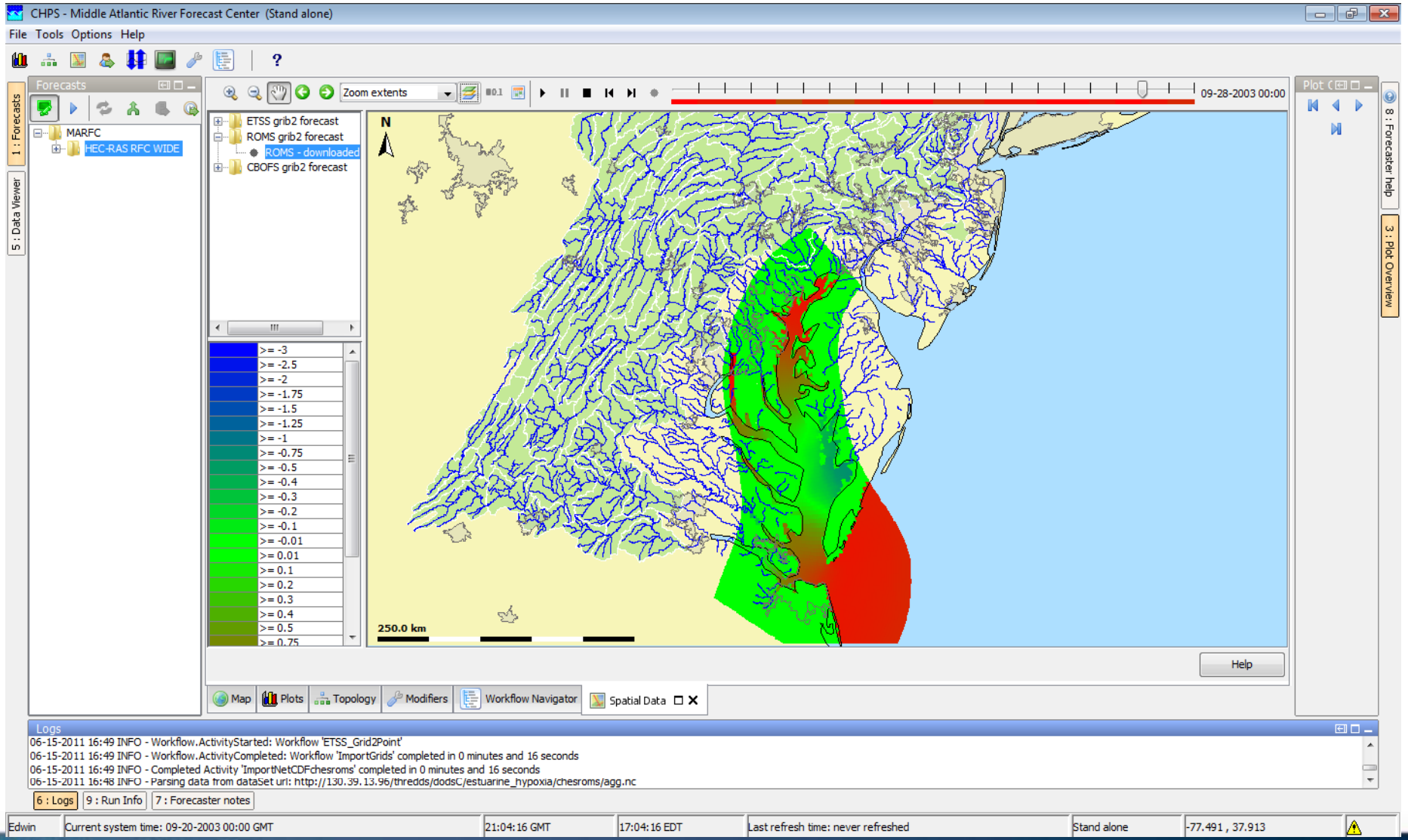


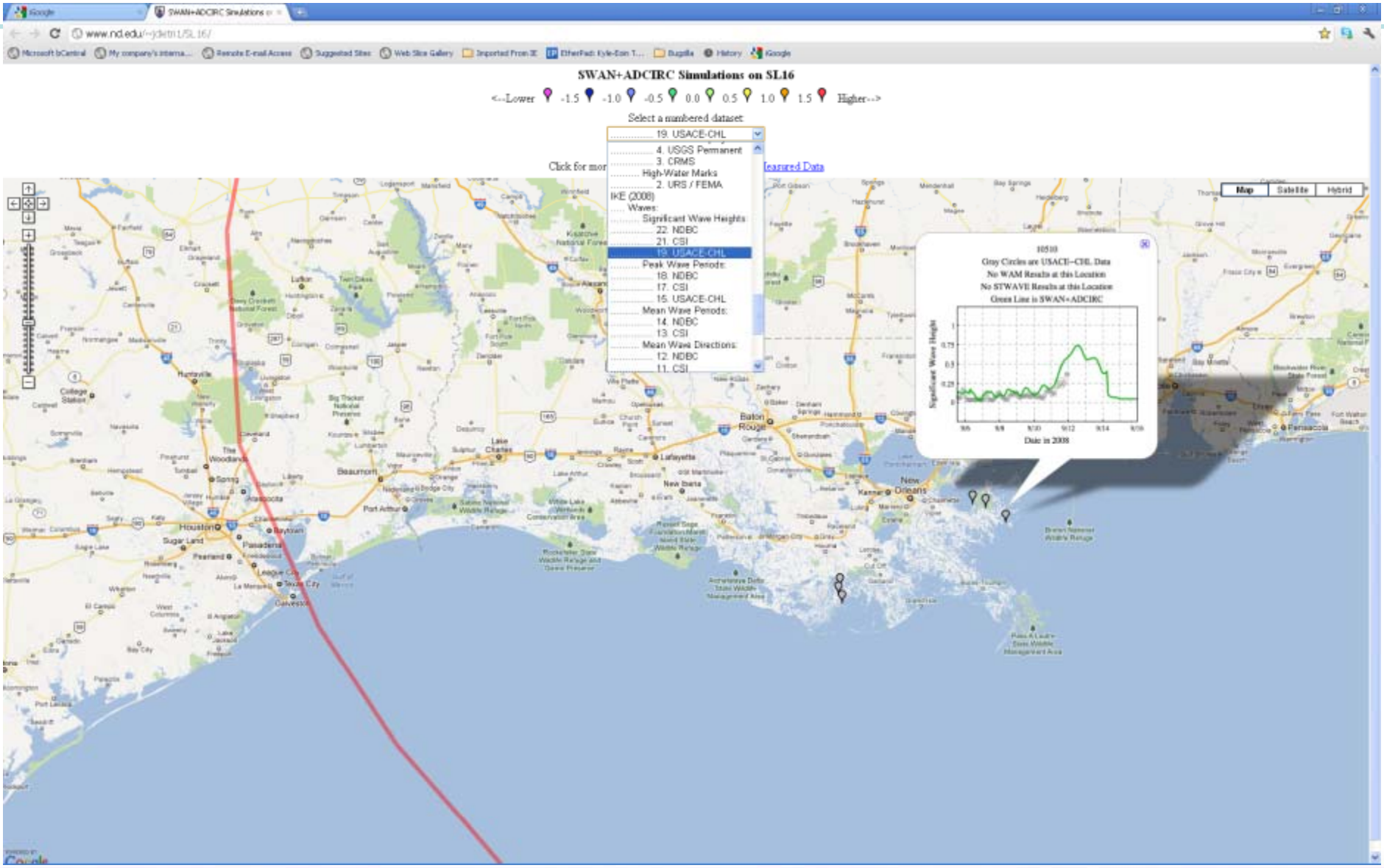
Matlab as a Web Service

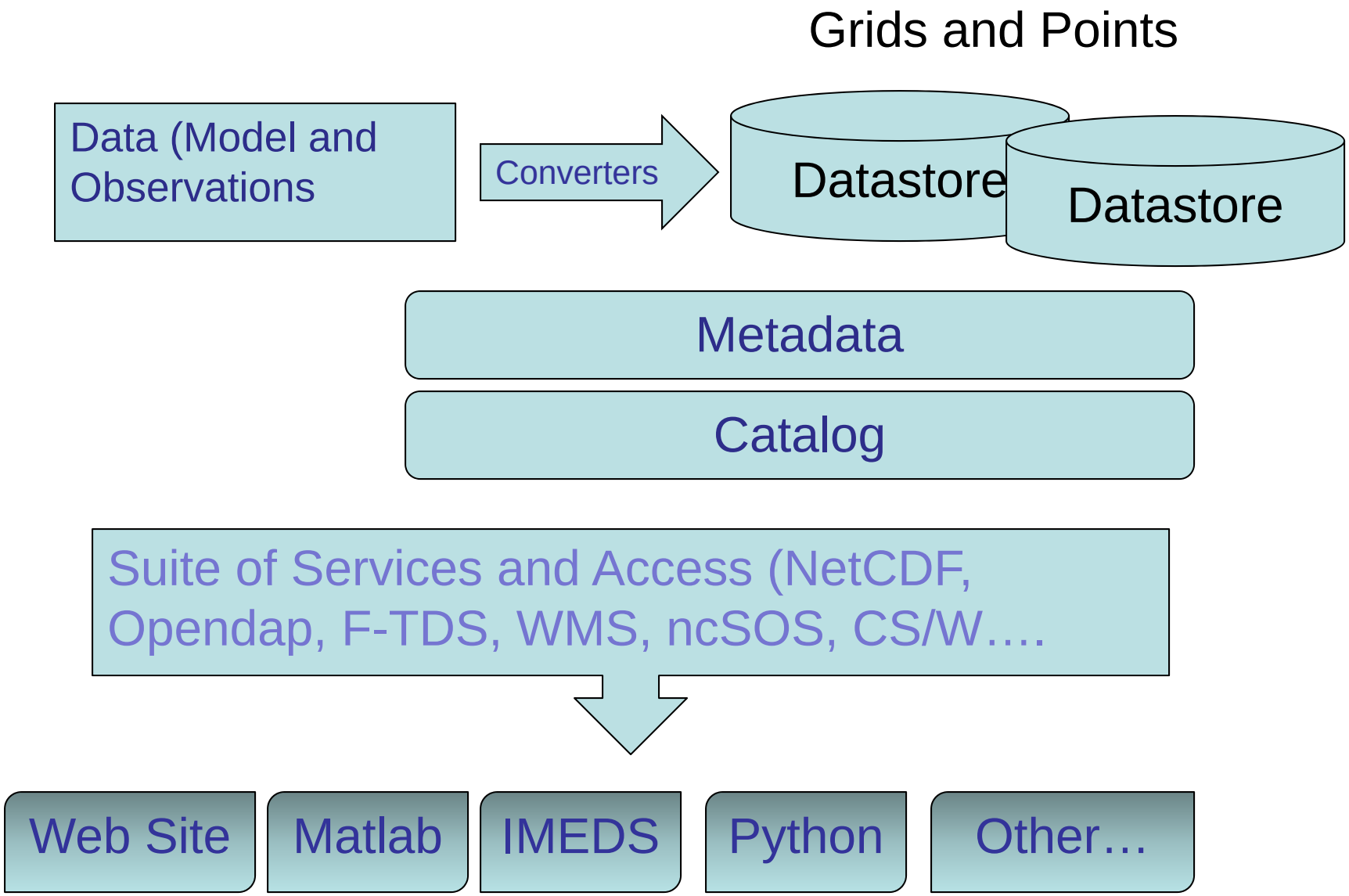

Firefox
SURA Modeling Testbed
http://testbedwww.sura.org/model-dev/
Google
SURA Modeling Testbed
Query Map
Extract profile
Chart Clipboard
Split-screen
Available SURA WMS Models
Available SURA SOS Observations
Variable search:
Restrict MODEL results to map BBOX
Name
Start date
End date
CBOFS2 (NOAA) - ROMS-3.0
2003-06-02 12:00:00
2005-09-01 12:00:00
CBOFS2-1TDO (NOAA) - ROMS-3.0
2003-12-29 00:00:00
2005-01-07 00:00:00
sea_water_temperature @ ChesROMS (UMCES) - ROMS-2.2 [1] at (37° 39' 52.8" N 76° 15' 39.9" W)
Send to Chart Clipboard as-is
Send to Chart Clipboard base-1970
Dec 4
Dec 7
Dec 10
Dec 13
Dec 16
Dec 19
Dec 22
Dec 25
Dec 28
Dec 31
Active WMS Layers
sea_water_temperature @ ChesROMS (UMCES) - ROMS-2.2 [2] at (37° 39' 52.8" N 76° 15' 39.9" W)
Send to Chart Clipboard as-is
Send to Chart Clipboard base-1970
Dec 3
Dec 6
Dec 9
Dec 12
Dec 15
Dec 18
Dec 21
Dec 24
Dec 27
Dec 30
5.46973
6.1201
6.77047
7.42084
8.07121
potential temperature (Celsius)
potential temperature (Celsius)
37° 39' 52.8" N 76° 15' 39.9" W

CHPS -Displaying the ROMS Elevation Grids



CI Workflow (UND)





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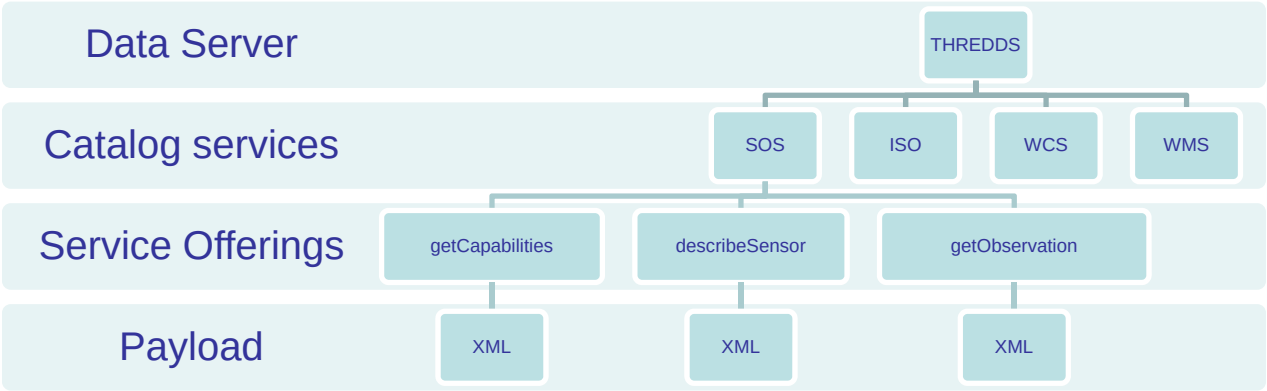
ncSOS

- Addition of SOS service capabilities to THREDDS server

–Get capabilities
–Describe sensor
–Get observation



- Single and Multi-station Netcdf datafiles:
  - EPA Netcdf datafiles
  - NOAA NDBC Station Netcdf datafiles
- XML payload designed to be compatible with existing SOS Parsers

CI Example

http://testbedwww.sura.org/sura2/

Metadata/Catalog Conversation

+ Tight integration with TDS

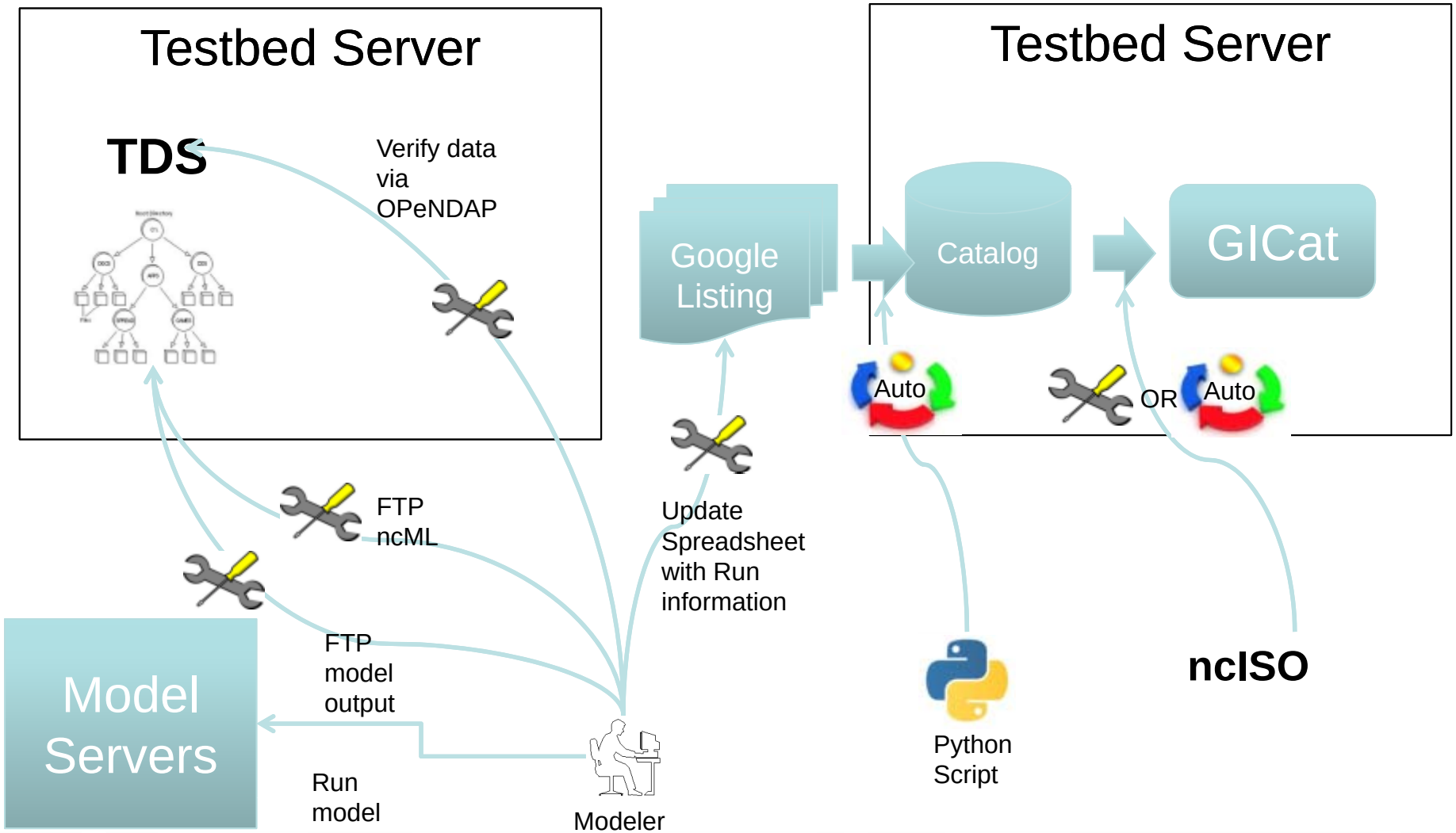
+ No need for intermediate metadata harvester like ncISO
    + Uses netcdf-java lib to access ncml and netcdf source metadata directly
    + Presents web service and portal catalog interfaces to data

- Little compliance with metadata or catalog standards
    - Arbitrary handling of global and variable attributes
    - Not all attributes are exposed in the same way
    - No automatic ingest of all service endpoints

- Adaptability only through code improvements by the (sole) developer

- Problems scaling to 100's and 1000's of cataloged datasets
    - Impossible to query or return all datasets

Current Steps for Ingest of Model Output and Metadata



Catalog

- Hosted document allows for easy access and editing. (Google Docs)

Unique Run Identifier	Run Title	Location of NcML on SURA Server
in.mdl.slosh.rita.gulf_of_mexico.slosh_wind.nowave.2d	SLOSH - RITA - Gulf of Mexico - Slosh Wind - No Waves - 2D	/data/ftp/upload/Inundation/MDL/Rita
in.usf.fvcom.ike.ultralite.vardrag.nowave.2d	FVCOM - IKE - Ultralite - Variable Drag - No Waves - 2D	/data/ftp/upload/Inundation/usf/fvcom_tropical/runs/Ike/2D_varied_manning_windstress

- Three key fields identify data stored on server: Unique Run Identifier, Run Title, Location of NcML on SURA Server

TDS Catalog

- Script reads from Google Table and hosted NcML to produce catalog XML
- Adds attributes to datasets, based on key fields.


```
</ns0:netcdf></dataset><dataset name="SLOSH - IKE - Gulf of Mexico - Slosh Wind - No Waves - 2D" ID="in.mdl.slosh.ike.gulf_of_mexico.slosh_wind.nowave.2d" urlPath=
"in/mdl/slosh/ike/gulf_of_mexico/slosh_wind/nowave/2d"> <serviceName>all</serviceName><ns0:netcdf xmlns:ns0="http://www.unidata.ucar.edu/namespaces/netcdf/ncml-2.2"
 location="/data/ftp/upload/Inundation/MDL/Ike/ike_gom.spatial.nc"><ns0:attribute name="id" value="in.mdl.slosh.ike.gulf_of_mexico.slosh_wind.nowave.2d" />
<ns0:attribute name="title" value="SLOSH - IKE - Gulf of Mexico - Slosh Wind - No Waves - 2D" /></ns0:netcdf></dataset><dataset name="SLOSH - RITA - Gulf of Mexico
- Slosh Wind - No Waves - 2D" ID="in.mdl.slosh.rita.gulf_of_mexico.slosh_wind.nowave.2d" urlPath="in/mdl/slosh/rita/gulf_of_mexico/slosh_wind/nowave/2d">
<serviceName>all</serviceName><ns0:netcdf xmlns:ns0="http://www.unidata.ucar.edu/namespaces/netcdf/ncml-2.2" location=
"/data/ftp/upload/Inundation/MDL/Rita/Rita_gom.spatial.nc"><ns0:attribute name="id" value="in.mdl.slosh.rita.gulf_of_mexico.slosh_wind.nowave.2d" /><ns0:attribute
name="title" value="SLOSH - RITA - Gulf of Mexico - Slosh Wind - No Waves - 2D" /></ns0:netcdf></dataset><dataset name="FVCOM - IKE - Ultralite - Variable Drag -
No Waves - 2D" ID="in.usf.fvcom.ike.ultralite.vardrag.nowave.2d" urlPath="in/usf/fvcom/ike/ultralite/vardrag/nowave/2d"> <serviceName>all</serviceName><ns0:netcdf
xmlns:ns0="http://www.unidata.ucar.edu/namespaces/netcdf/ncml-2.2" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation=
"http://www.unidata.ucar.edu/namespaces/netcdf/ncml-2.2 http://www.unidata.ucar.edu/schemas/thredds/InvCatalog.1.0.3.xsd">
<ns0:variable name="h" shape="node" type="float">
 <ns0:attribute name="mesh" value="fvcom_mesh" />
 <ns0:attribute name="coordinates" value="lat lon" />
 <ns0:attribute name="location" value="node" />
 <ns0:remove name="positive" type="attribute" />
 <ns0:remove name="grid" type="attribute" />
</ns0:variable>
<ns0:variable name="nv">
 <ns0:attribute name="standard_name" value="face_node_connectivity" />
 <ns0:attribute name="start_index" type="int" value="1" />
</ns0:variable>
<ns0:variable name="fvcom_mesh" shape="" type="int">
 <ns0:attribute name="standard_name" value="mesh_topology" />
```

ncISO Representation of Netcdf Metadata

```
<gmd:lineage>
        <gmd:LI_Lineage>
            <gmd:statement>
                <gco:CharacterString>Model started at 12:00 on 07/31/2008 and
finished at  12:00 on 09/17/2008</gco:CharacterString>
            </gmd:statement>
        </gmd:LI_Lineage>
      </gmd:lineage>
   </gmd:DQ_DataQuality>
</gmd:dataQualityInfo>
```

•ncISO pulls from the Thredds Data Server catalog (for things like service end points) and the source Netcdf/NCML files (for global and variable attributres).

•ISO metadata is also exposed as a service endpoint in Thredds Data Server

GI-CAT
(and other catalogs)

Identification Information	
Title	Imeds USGS-PERM watlev_USGS-PERM.F.C__IKE_VIMS_3D_WITHWAVE.IMEDS
Language	eng
Descriptive keyword	station_name
Descriptive keyword	latitude
Descriptive keyword	longitude
Descriptive keyword	time
Title	Imeds USGS-PERM watlev_USGS-PERM.F.C__IKE_VIMS_3D_WITHWAVE.IMEDS THREDDS OPeNDAP
Endpoint	http://testbedapps-dev.sura.org/thredds/dodsC/imeds/simulation/watlev_USGS-PERM.F.C__IKE_VIMS_3D_WITHWAVE.nc
Title	Imeds USGS-PERM watlev_USGS-PERM.F.C__IKE_VIMS_3D_WITHWAVE.IMEDS Open Geospatial Consortium Sensor Observation Service (SOS)
Endpoint	http://testbedapps-dev.sura.org/thredds/sos/imeds/simulation/watlev_USGS-PERM.F.C__IKE_VIMS_3D_WITHWAVE.nc?service=SOS&version=1.0.0&request=GetCapabilities

These are actually variable names, not descriptive keywords…

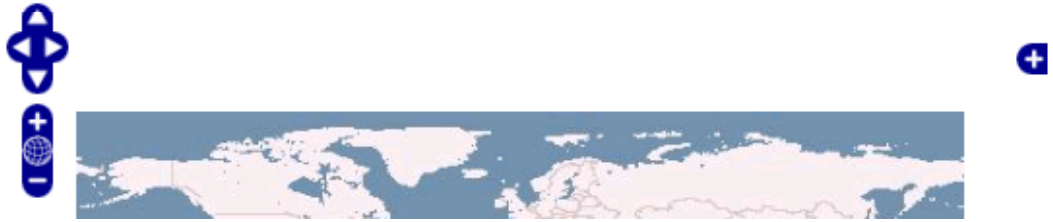
We know from the title that this dataset has a water level variable: Where is it?

Geographic Extent	
South	29.389999389648438
West	-450.61802673339844
North	30.406389236450195
East	-87.73694610595703

Is this a problem with netcdf library, ncISO, source metadata?

End points appear in GI-CAT data model, but are not mapped to catalog CSW response?

Searching on specific ISO metadata elements limited to only some attributes? Which ones?



http://testbed.sura.org/catalog-browser

http://72.44.60.22/edc/

Accomplishments and Lessons Learned

- Testbeds are incredible framework to allow multi-disciplinary collaboration

- NcToolbox allows for one stop access to model (unstructured) and obs data
- UGRID implementation
- ncSOS – already in use and evolving
- pyWMS – in development
- Advances in ncISO and Catalog integration
- Advancing NetCDF implementation for observations
- Supporting modeling teams to generate compliant NetCDF
- CHPS integration (R2O)

- Interoperability can be powerful, but can make for slow development