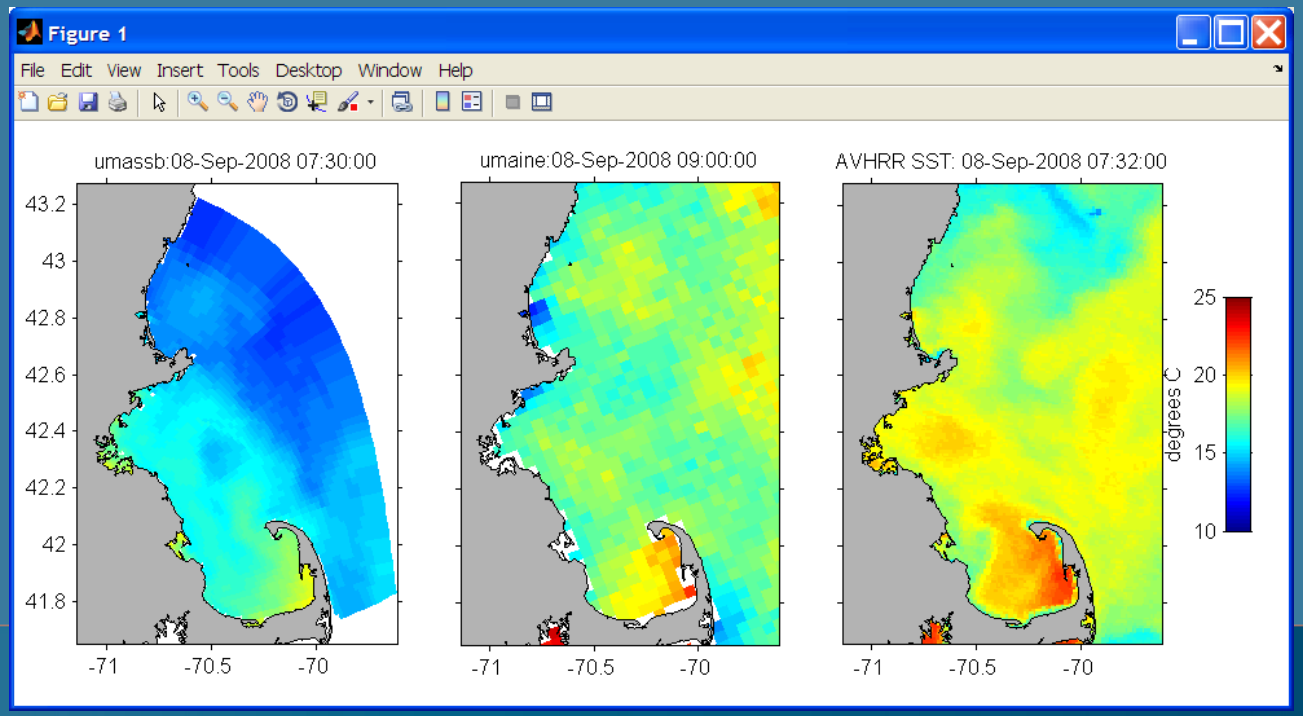
Ocean, Atmosphere & Climate Model Assessment for Everyone

Rich Signell
USGS Woods Hole, MA

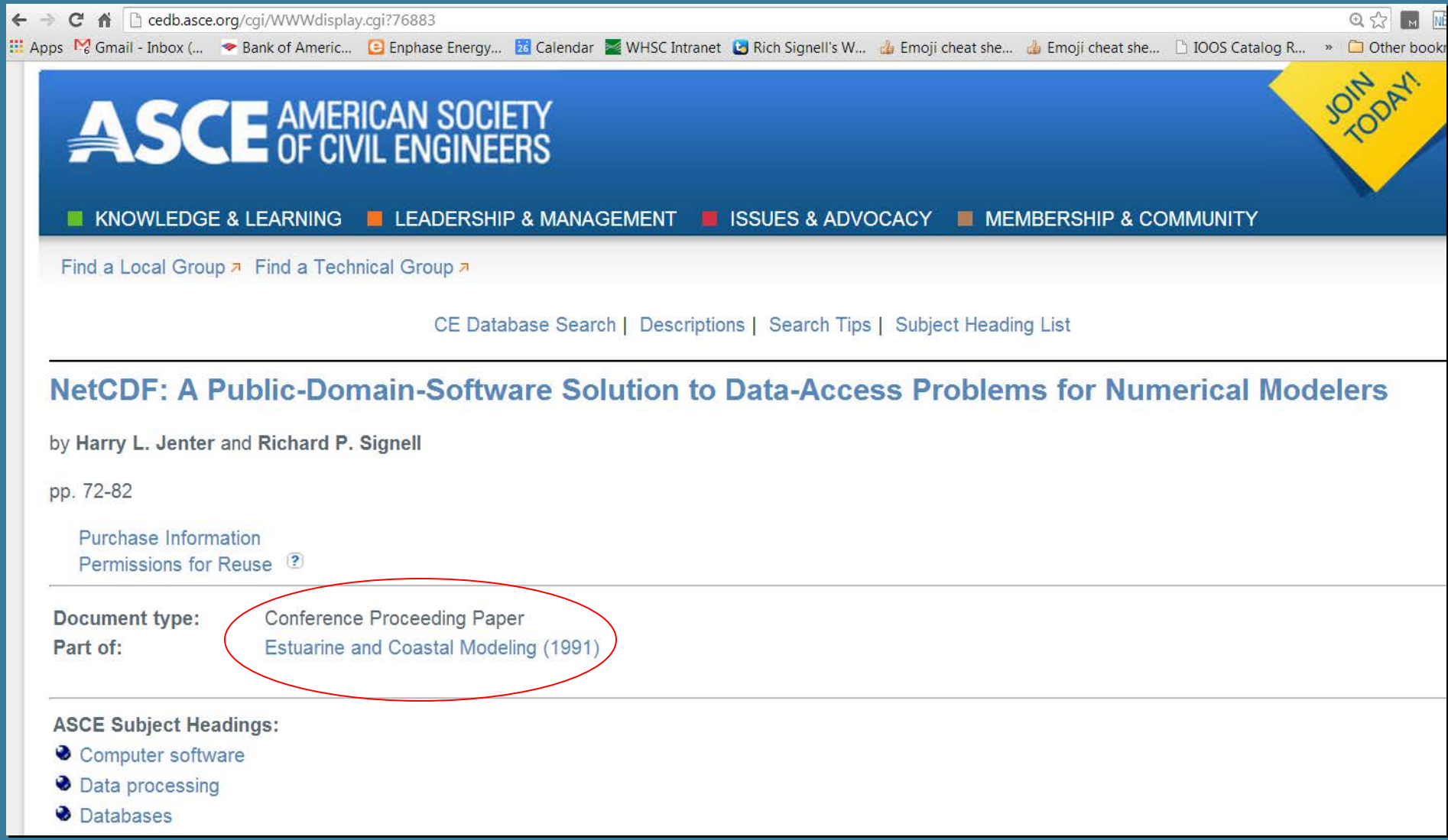
Unidata 2014 DeSouza Award Presentation

Boulder, CO : Sep 15, 2014



INTEGRATED OCEAN OBSERVING SYSTEM

IOOS


cedb.asce.org/cgi/WWWdisplay.cgi?76883
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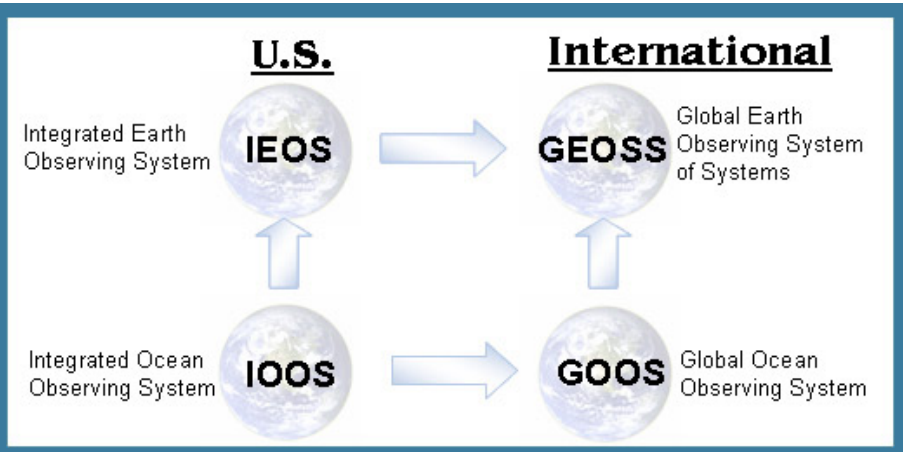
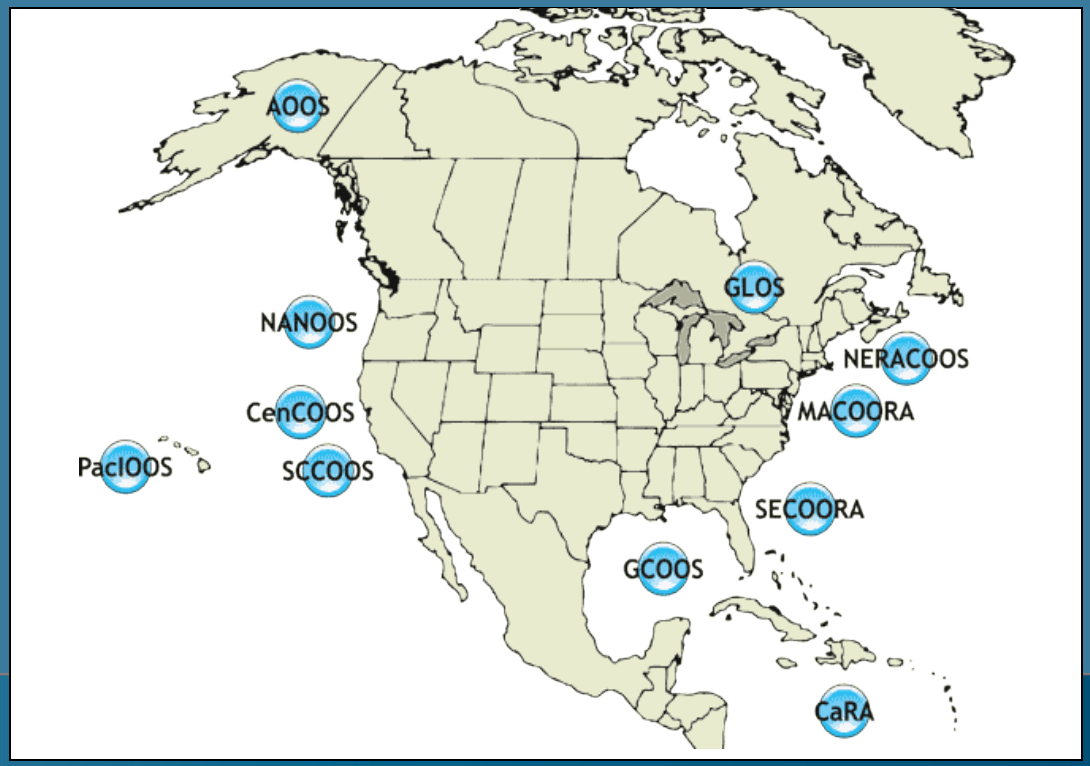
NetCDF: A Public-Domain-Software Solution to Data-Access Problems for Numerical Modelers
by Harry L. Jenter and Richard P. Signell
pp. 72-82
Purchase Information
Permissions for Reuse
Document type: Conference Proceeding Paper
Part of: Estuarine and Coastal Modeling (1991)
ASCE Subject Headings:
Computer software
Data processing
Databases

US Integrated Ocean Observing System (IOOS®)

IOOS® Plan defines:

- **Global Component**
- **Coastal Component**
  - **17 Federal Agencies**
  - **11 Regional Associations**





How well do models simulate events?

Hurricane Sandy, Ocean Grove Pier - New Jersey, October 29, 2012 - Photograph by Bob Bowné

Deepwater Horizon Oil Spill, Northern Gulf of Mexico, May 24, 2010. Image from MODIS on NASA's Terra Satellite.

IOOS Core Principles

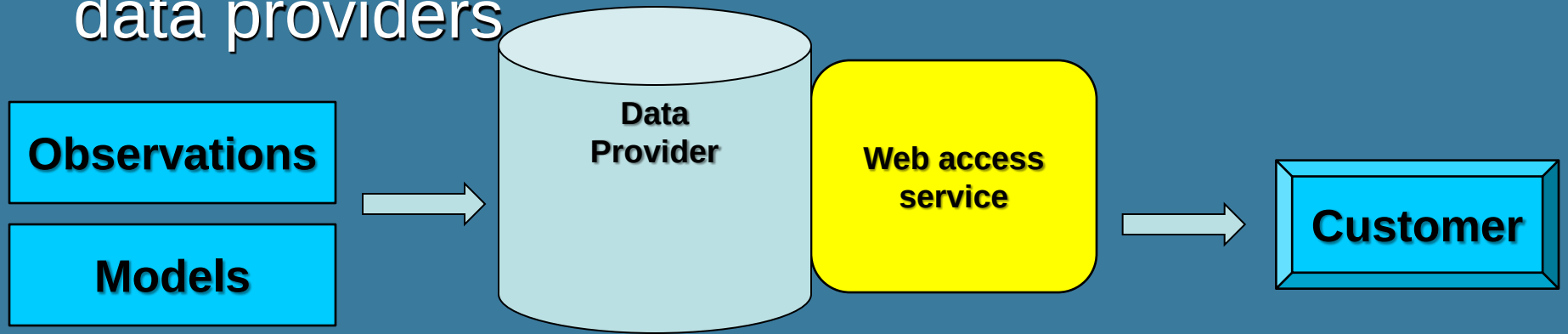
- Adopt open standards & practices

OGC® Open Geospatial Consortium, Inc.

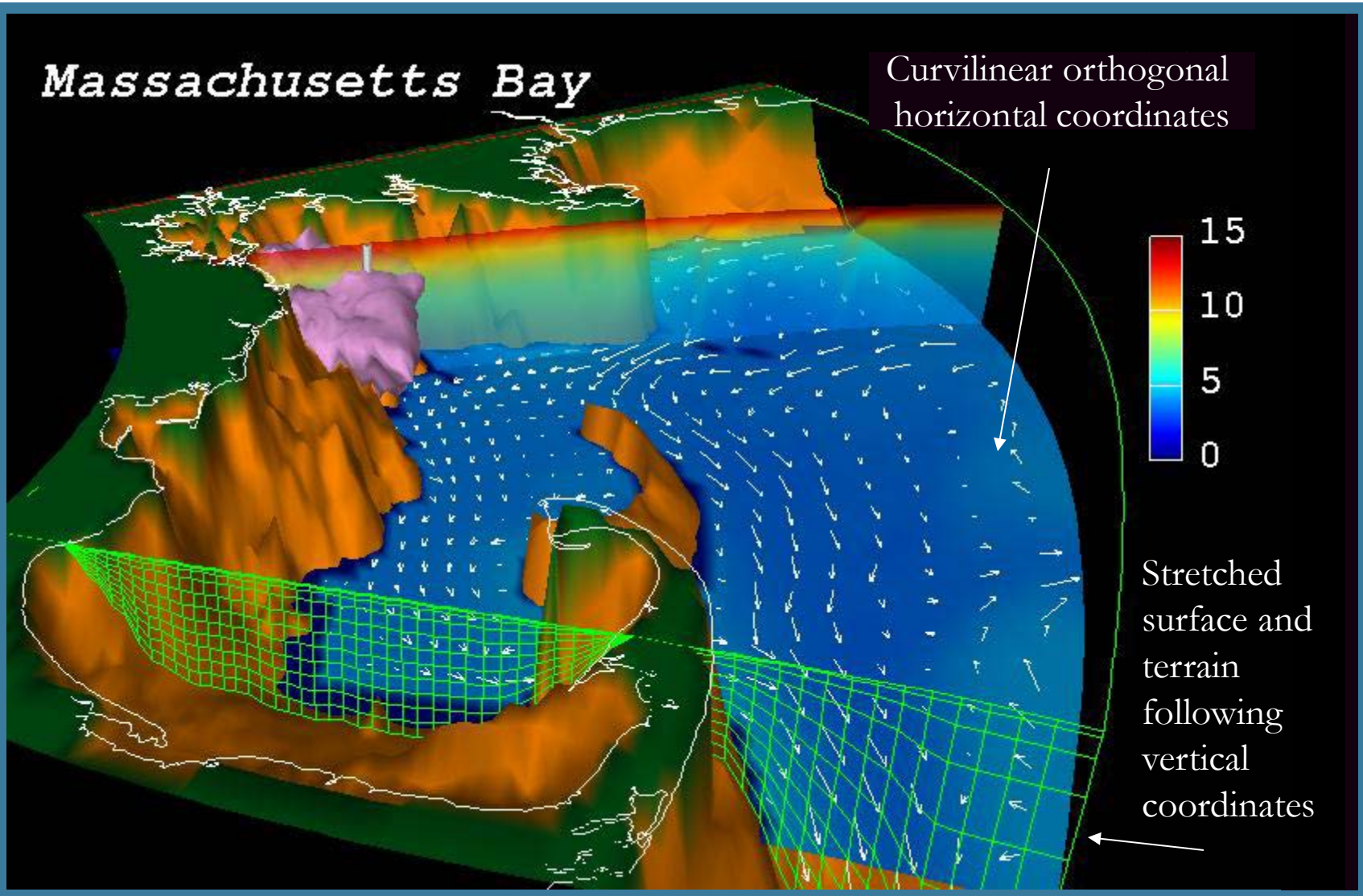
ISO International Organization for Standardization

unidata

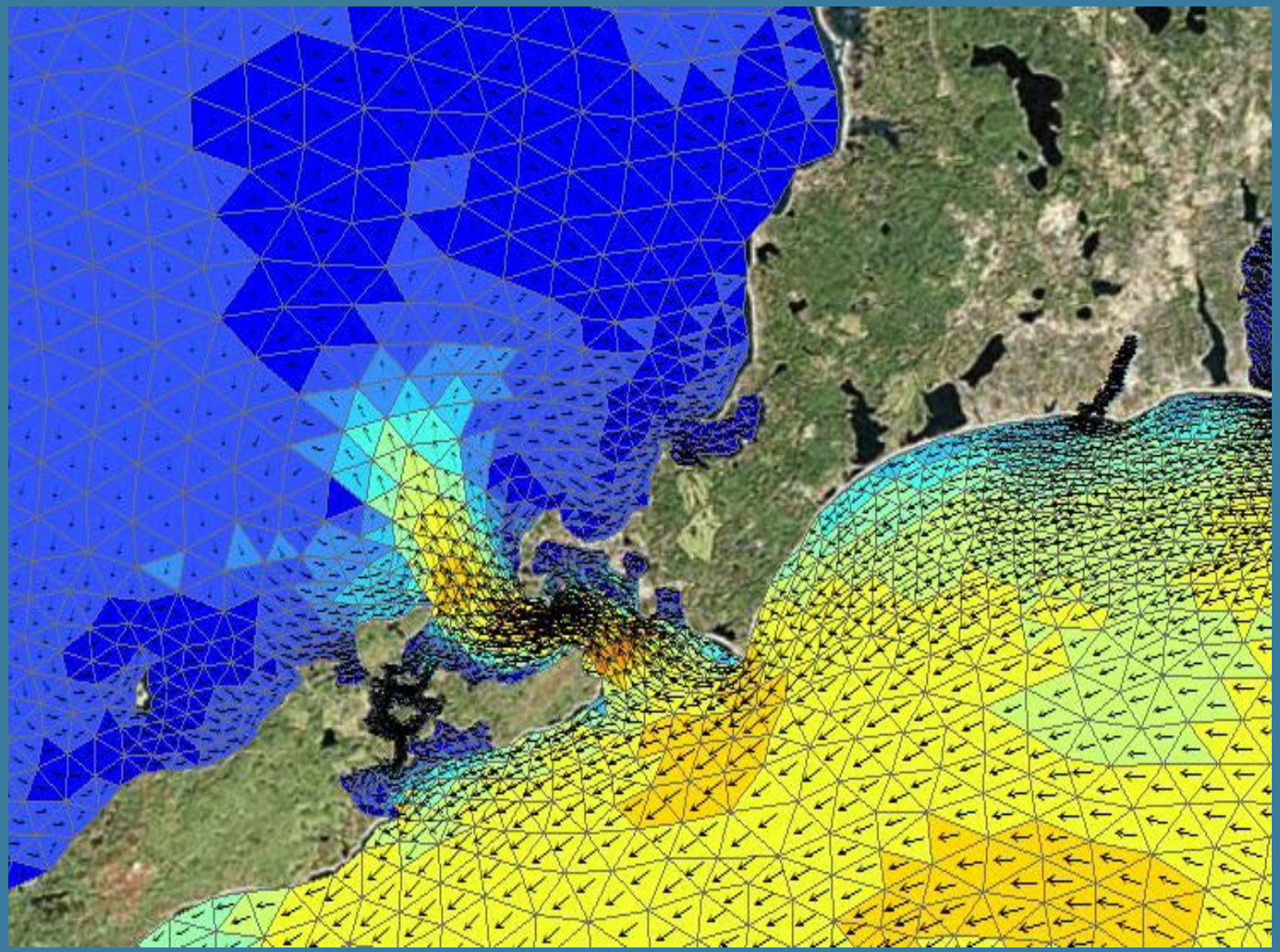
- Avoid customer-specific stovepipes
- Standardized access services implemented at data providers



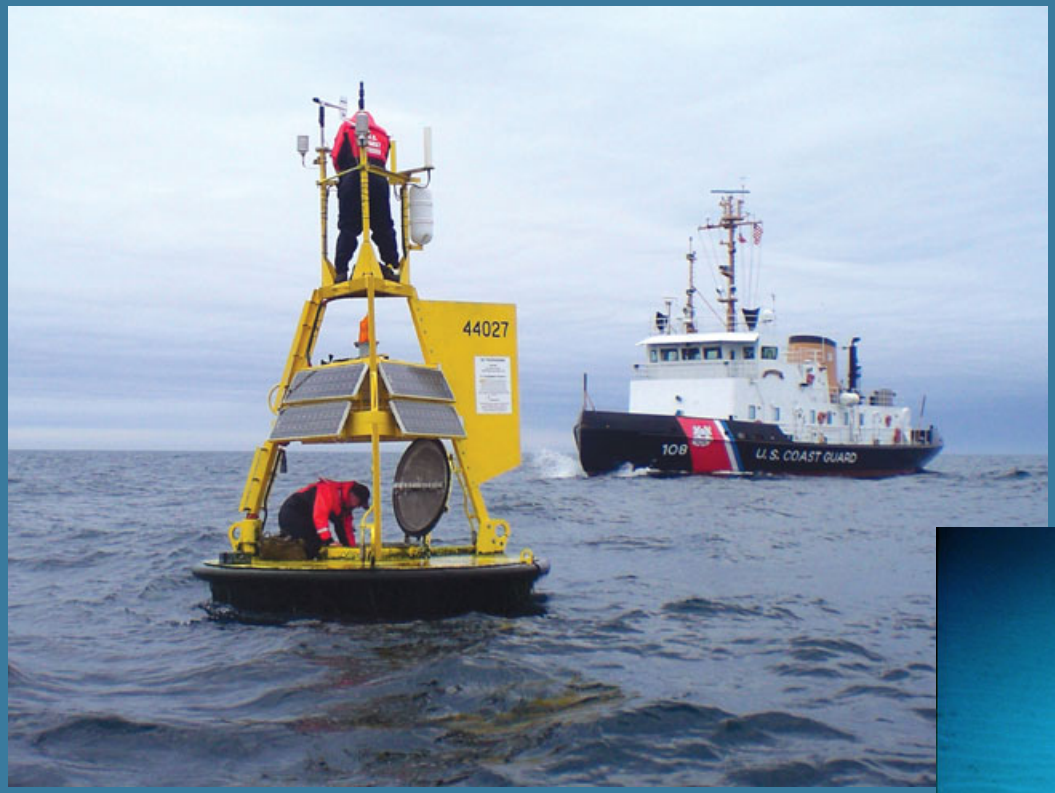
Issue: Ocean grids are not regularly spaced!



Unstructured (e.g. triangular) grid



Time Series, Trajectories



Meteorology and Wave Buoy in the Gulf of Maine. Image courtesy of NOAA.

Ocean Glider. Photo by Dave Fratantoni, Woods Hole Oceanographic Institution

NetCDF Climate and Forecast (CF) Conventions provide a solution

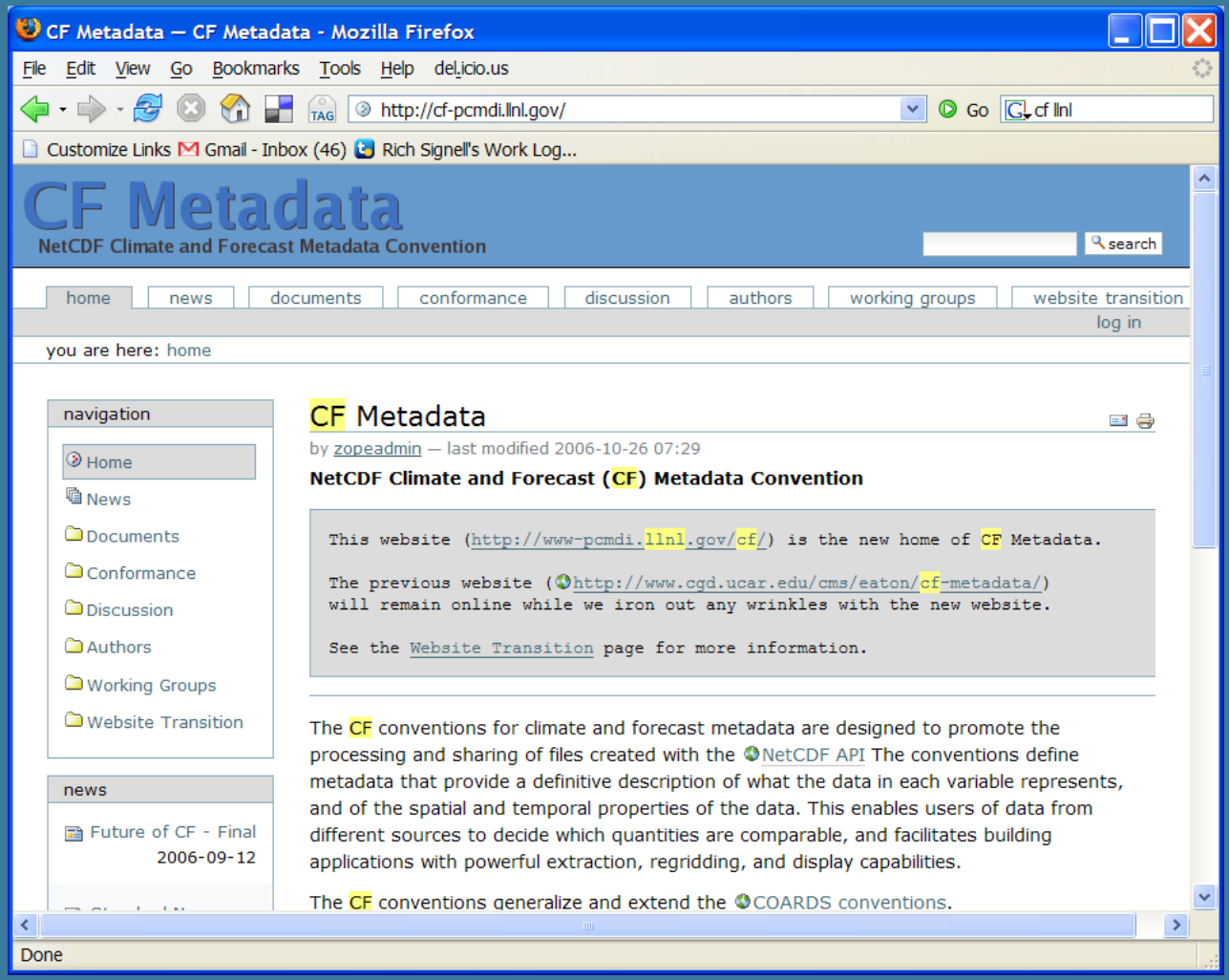
Groups using CF:

GO-ESSP: Global Organization for Earth System Science Portal

IOOS: Integrated Ocean Observing System

ESMF: Earth System Modeling Framework

OGC: Open Geospatial Consortium (GALEON: WCS profile)



UGRID Conventions on GitHub

GitHub, Inc. [US] https://github.com/ugrid-conventions

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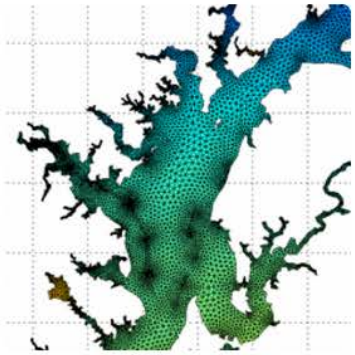

UGRID

ugrid-conventions

Joined on Sep 25, 2013

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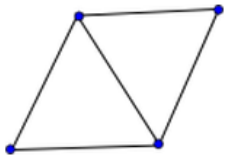
ugrid-conventions ★4 1

Unstructured Grid Metadata Conventions for Scientific Datasets

nFaces and nEdges respectively, and may have in turn a `bounds` attribute that specifies the bounding coordinates of the face or edge (thereby duplicating the data in the `node_coordinates` variables).



Example:

```
dimensions:
nMesh2_node = 4 ; // nNodes
nMesh2_edge = 5 ; // nEdges
nMesh2_face = 2 ; // nFaces

Two = 2 ;
Three = 3 ;

variables:
// Mesh topology
integer Mesh2 ;
Mesh2:cf_role = "mesh_topology" ;
Mesh2:long_name = "Topology data of 2D unstructured mesh" ;
Mesh2:topology_dimension = 2 ;
```

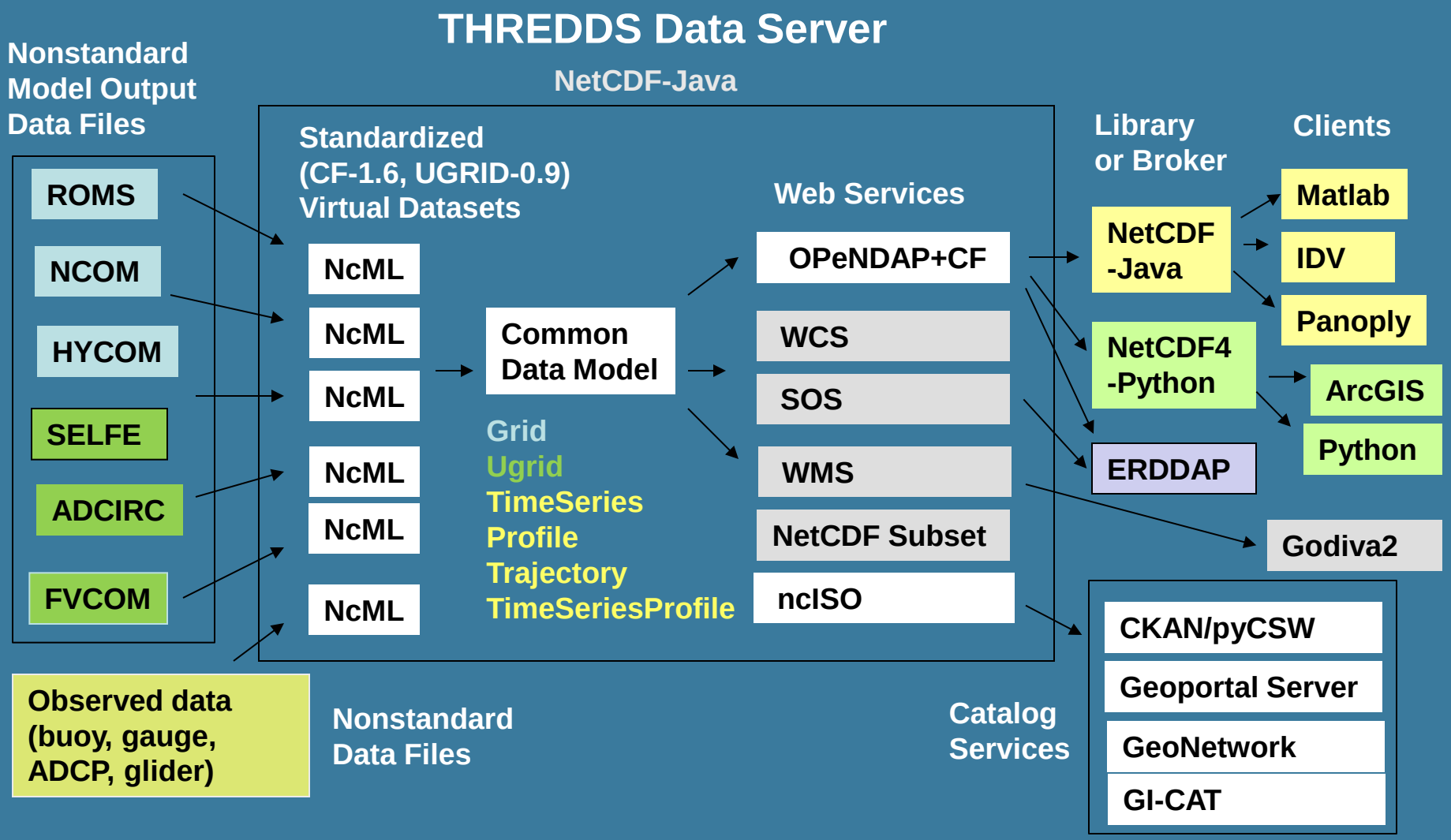
IOOS

Example NcML (on StackOverflow)

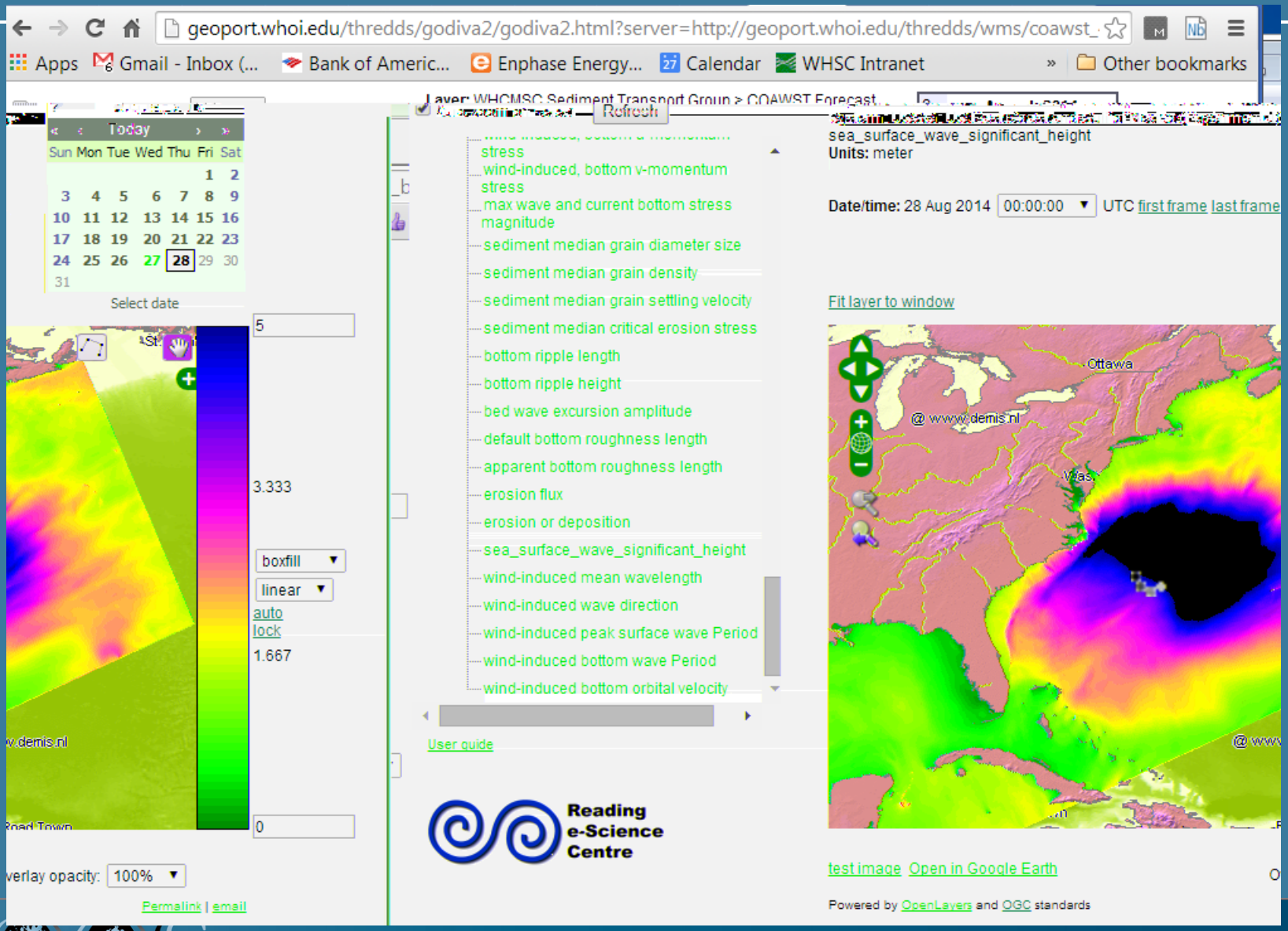
Here's an example:

```
<variable name="v" shape="time2 sigma node" type="float">
 <attribute name="standard_name" value="barotropic_northward_sea_water_velocity"/>
 <attribute name="mesh" value="selfe_mesh"/>
 <attribute name="location" value="node"/>
 <attribute name="coordinates" value="y x"/>
 <attribute name="units" value="m/s"/>
</variable>
<aggregation type="union">
 <netcdf xmlns="http://www.unidata.ucar.edu/namespaces/netcdf/ncml-2.2">
  <aggregation dimName="time" type="joinExisting">
   <scan
    location="/data/ftp/upload/Inundation/vims/selfe_tropical/runs/Rita/3D_varied_ro
    regExp=".*[0-9]{1}_WaterLevel\.nc$"/>
  </aggregation>
 </netcdf>
 <netcdf xmlns="http://www.unidata.ucar.edu/namespaces/netcdf/ncml-2.2">
  <aggregation dimName="time" type="joinExisting">
   <scan
    location="/data/ftp/upload/Inundation/vims/selfe_tropical/runs/Rita/3D_varied_ro
    regExp=".*[0-9]{1}_SigWaveHeight\.nc$"/>
  </aggregation>
 </netcdf>
```

IOOS Model Data Interoperability Design



WMS Browsing with THREDDS/ncWMS



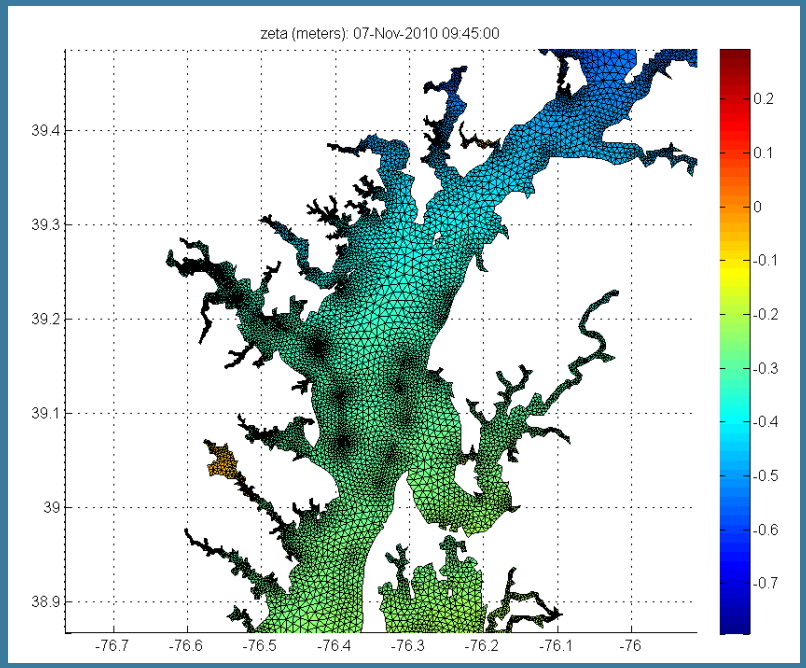
Matlab NCTOOLBOX
https://github.com/nctoolbox

- Objective: Make it simple to access CF data
- Example function:
- [t, geo]=nj_tslice(URL,'temp',1);
- t = 22x120x180 single
- geo =
  - lat: [120x180 single]
  - lon: [120x180 single]
  - z: [22x120x180 double]
  - time: 733582 (matlab datenum)
- nj_tslice works identically for ROMS, POM, ECOM, WRF, Wavewatch3
- URL can be: local NetCDF, remote NetCDF, NcML, OpenDAP Data URL

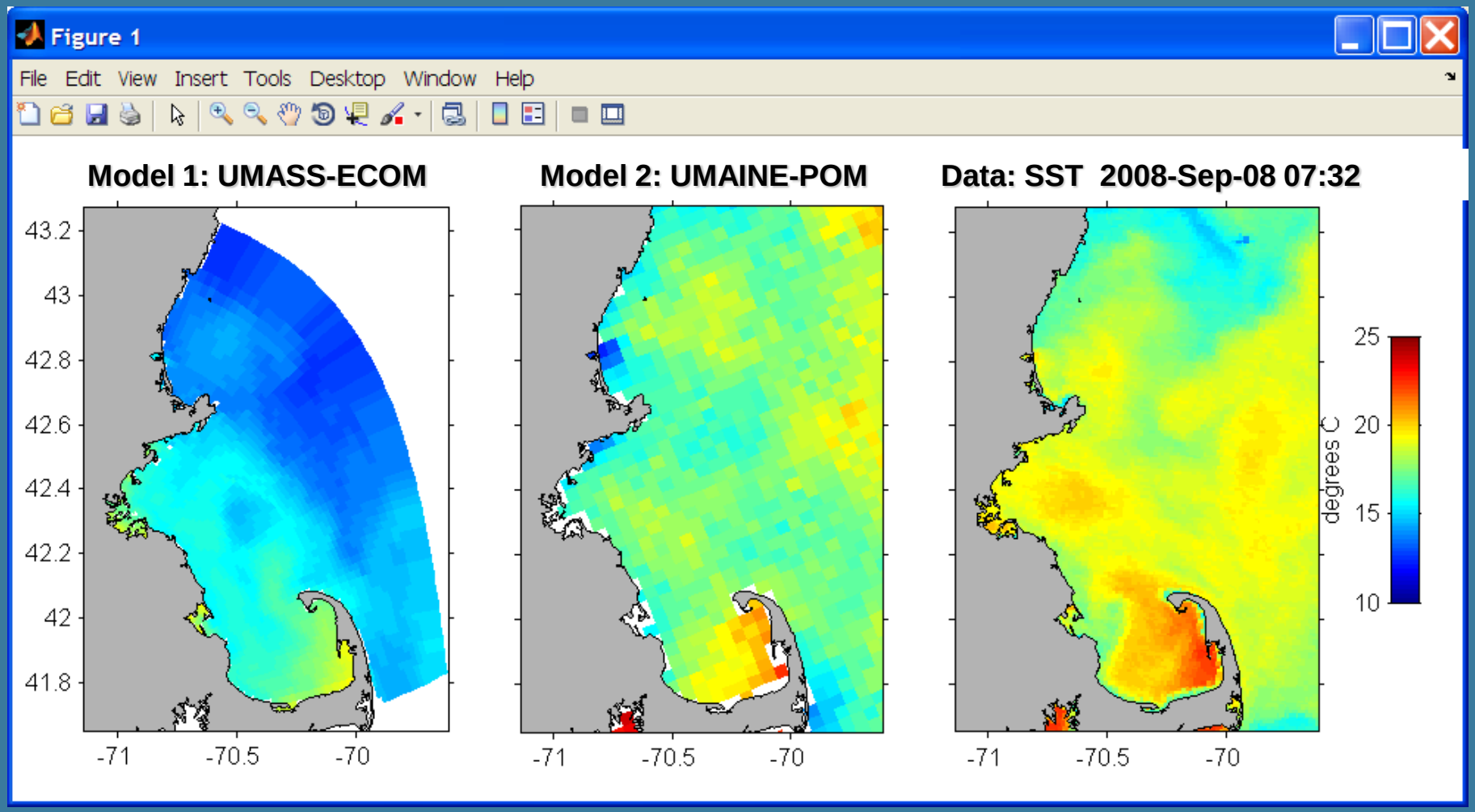
Matlab NCTOOLBOX
https://github.com/nctoolbox

```
nc = ncugrid(dap_url)
ncvar = nc.uvariable('zeta')
z  =  ncvar.data(itime,:)
grid = ncvar.grid(itime,:)
```

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

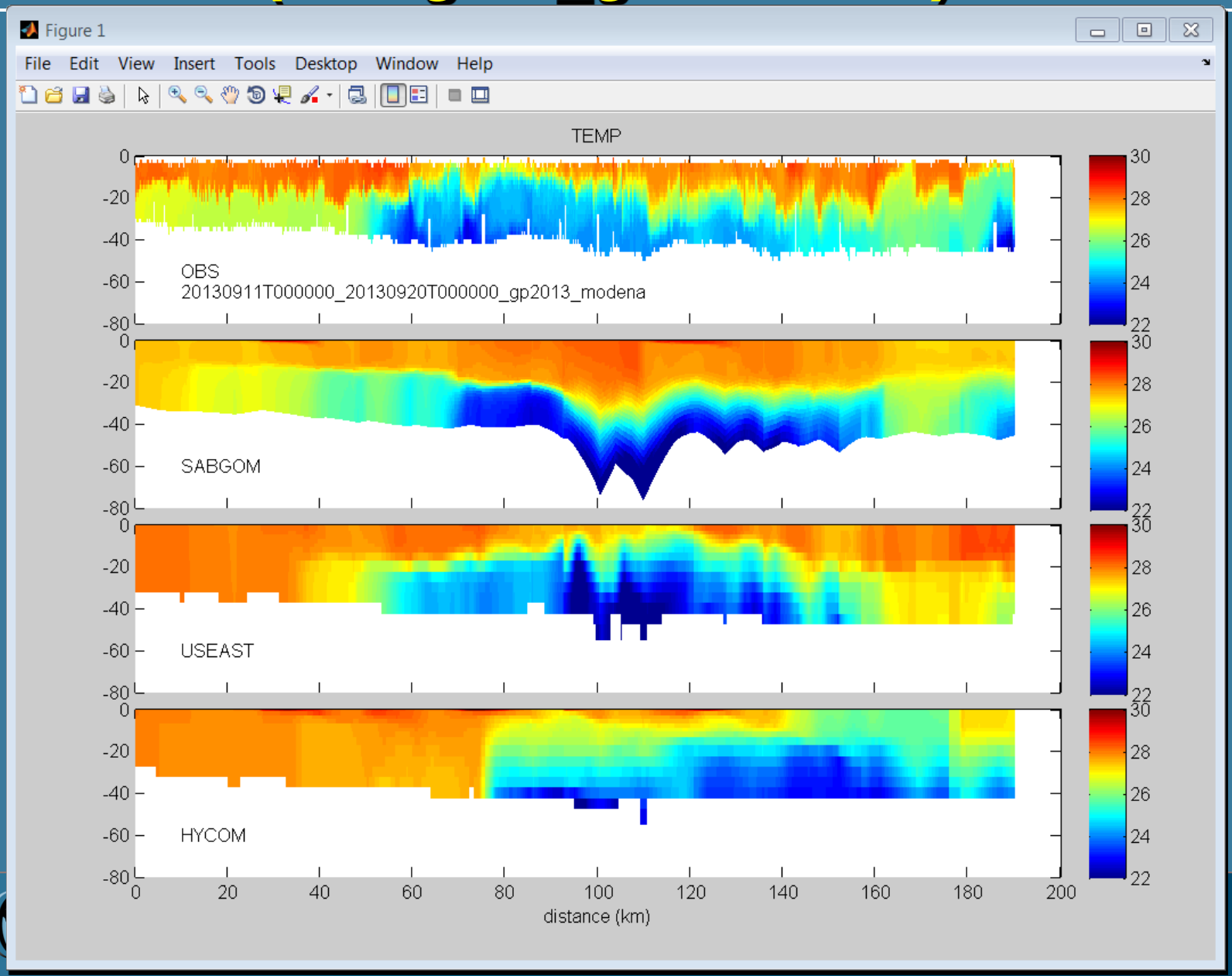


Comparing Models with Data in Matlab



Skidaway modena glider (Sep 11-23)

compare_secoora_model_sections.m (using nc_genslice.m)



test_cf_ugrid3.m

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

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```
% 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';
```

```
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(:);
```

Figure 1

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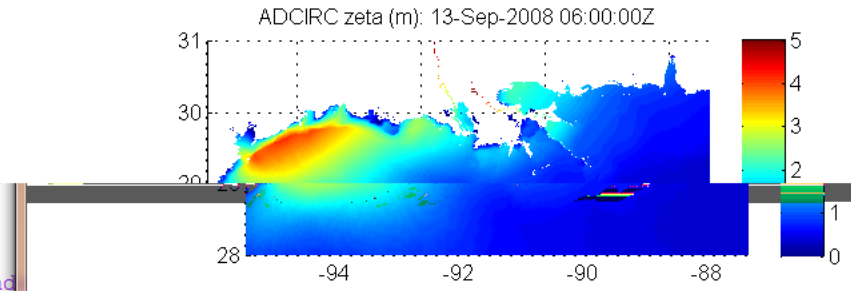
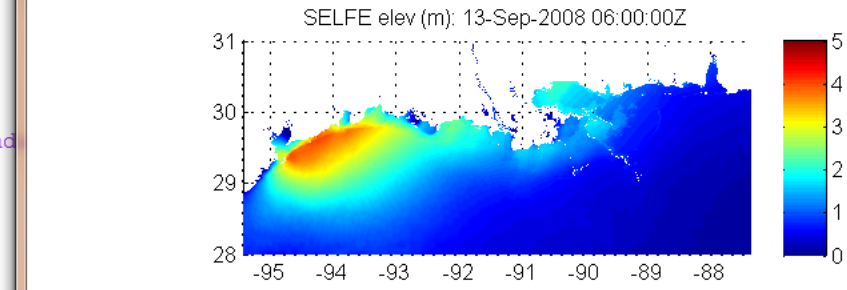
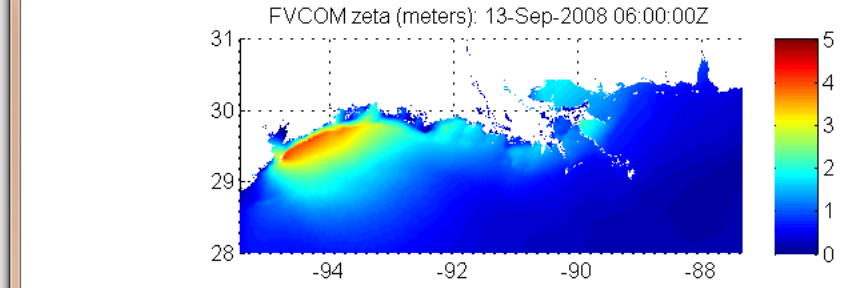
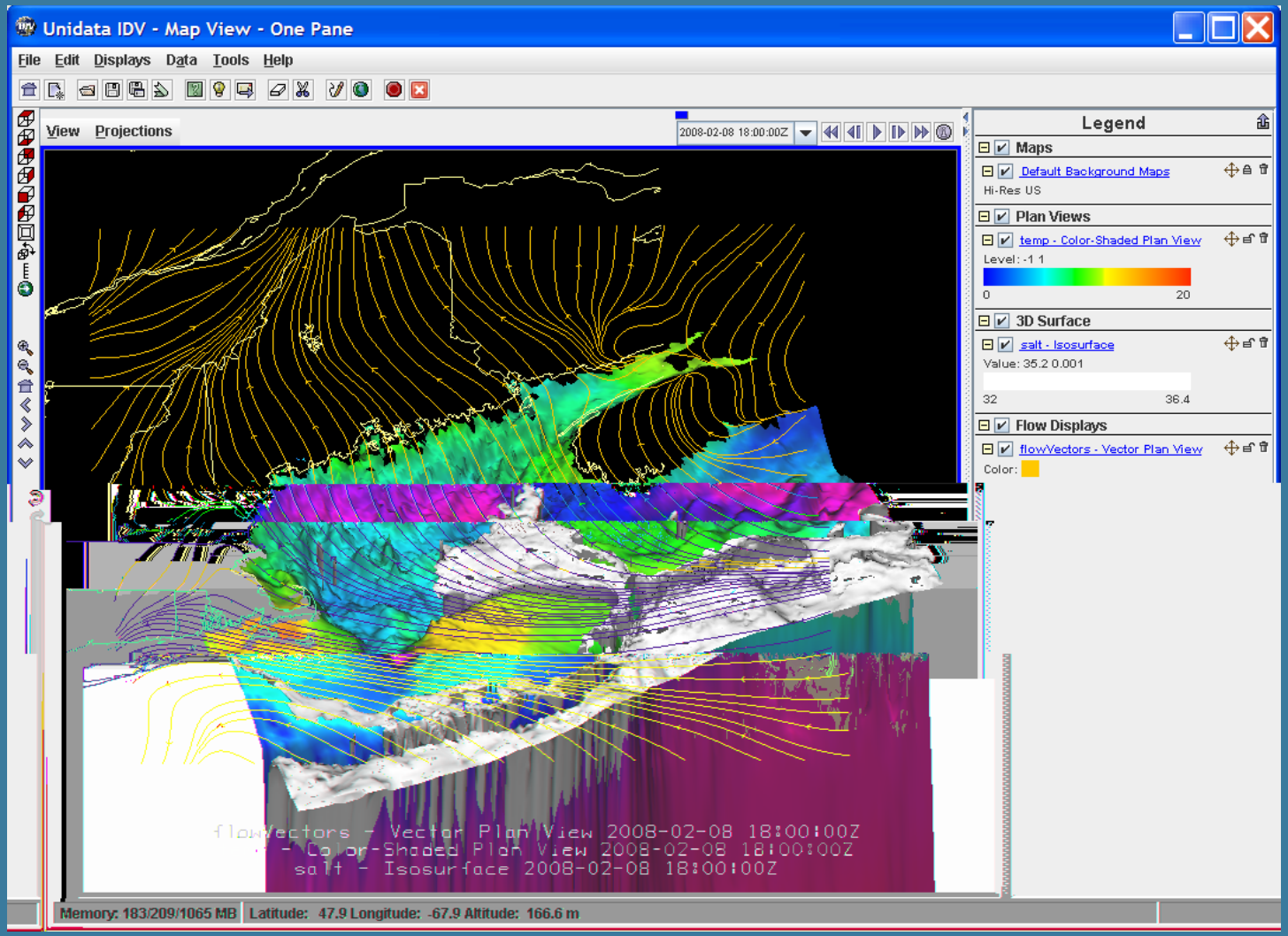






3D visualization of data with IDV



NetCDF Subset Service to CSV

WHCMSC Sediment Transport Group

THREDDS Data Server

Catalog http://geoport.whoi.edu/thredds/catalog/coawst_4/use/fmrc/catalog.html

Dataset: coawst_4_use/Best Time Series

- *Data format:* netCDF
- *Data type:* GRID
- *Naming Authority:* gov.usgs.er.whsc
- *ID:* coawst_4/use/fmrc/coawst_4_use_best.ncd

Documentation:

- **summary:** Best time series, taking the data from the most recent run available.
- **summary:** ROMS USE Output from COAWST
- Carolinas Coastal Change Program
- ReadMe.txt

Access:

1. **OPENDAP:** /thredds/dodsC/coawst_4/use/fmrc/coawst_4_use_best.ncd
2. **NetcdfSubset:** /thredds/ncss/grid/coawst_4/use/fmrc/coawst_4_use_best.ncd
3. **WMS:** /thredds/wms/coawst_4/use/fmrc/coawst_4_use_best.ncd
4. **ISO:** /thredds/iso/coawst_4/use/fmrc/coawst_4_use_best.ncd
5. **NCML:** /thredds/ncml/coawst_4/use/fmrc/coawst_4_use_best.ncd
6. **UDDC:** /thredds/uddc/coawst_4/use/fmrc/coawst_4_use_best.ncd

geoport.whoi.edu/thredds/ncss/grid/coawst_4/use/fmrc/coawst_4_use_best.ncd/pointDataset.html

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NCSS Grids As Point Data (Gridded Dataset)

unidata
THREDDS data server NetCDF Subset Service

Dataset: /thredds/ncss/grid/coawst_4/use/fmrc/coawst_4_use_best.ncd (Gridded Dataset Description)

Base Time: 2012-06-25T01:00:00Z

You must select at least one Variable and a Lat/Lon location.

Select Variable(s):

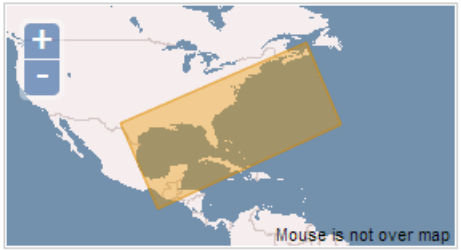
- [ ] angle = angle between XI-axis and EAST
- [ ] f = Coriolis parameter at RHO-points
- [ ] h = bathymetry at RHO-points
- [ ] mask_psi = mask on psi-points
- [ ] mask_rho = mask on RHO-points
- [ ] mask_u = mask on U-points
- [ ] mask_v = mask on V-points
- [ ] pm = curvilinear coordinate metric in XI
- [ ] pn = curvilinear coordinate metric in ETA

Variables with Time coordinate time

- [ ] Dwave = wind-induced wave direction
- [x] Hwave = wind-induced significant wave height
- [ ] Lwave = wind-induced mean wavelength
- [ ] Pwave_bot = wind-induced bottom wave Period
- [ ] Pwave_top = wind-induced peak surface wave Period
- [ ] Uwave_rms = wind-induced bottom orbital velocity
- [ ] Uwind = surface u-wind component
- [ ] Vwind = surface v-wind component
- [ ] Zo_app = apparent bottom roughness length
- [ ] Zo_def = default bottom roughness length
- [ ] bed_wave_amp = bed wave excursion amplitude
- [ ] bedload_Usand_01 = bed load flux of sand in U-direction, size class 01
- [ ] bedload_Usand_02 = bed load flux of sand in U-direction, size class 02
- [ ] bedload_Usand_03 = bed load flux of sand in U-direction, size class 03
- [ ] bedload_Usand_04 = bed load flux of sand in U-direction, size class 04
- [ ] bedload_Usand_05 = bed load flux of sand in U-direction, size class 05
- [ ] bedload_Usand_06 = bed load flux of sand in U-direction, size class 06

Format: csv

Choose Lat/Lon Location:



Latitude: 39.5
Longitude: -69.5

Within Bounding Box:

north: 48.4639
west: -101.7498
east: -53.2530
south: 11.8884

Choose Time Subset:

Time range | **Single time**

Starting: 2014-08-27T01:00:00Z
Ending: 2014-08-28T00:00:00Z
reset to full extension

Choose Vertical Level:

Level:

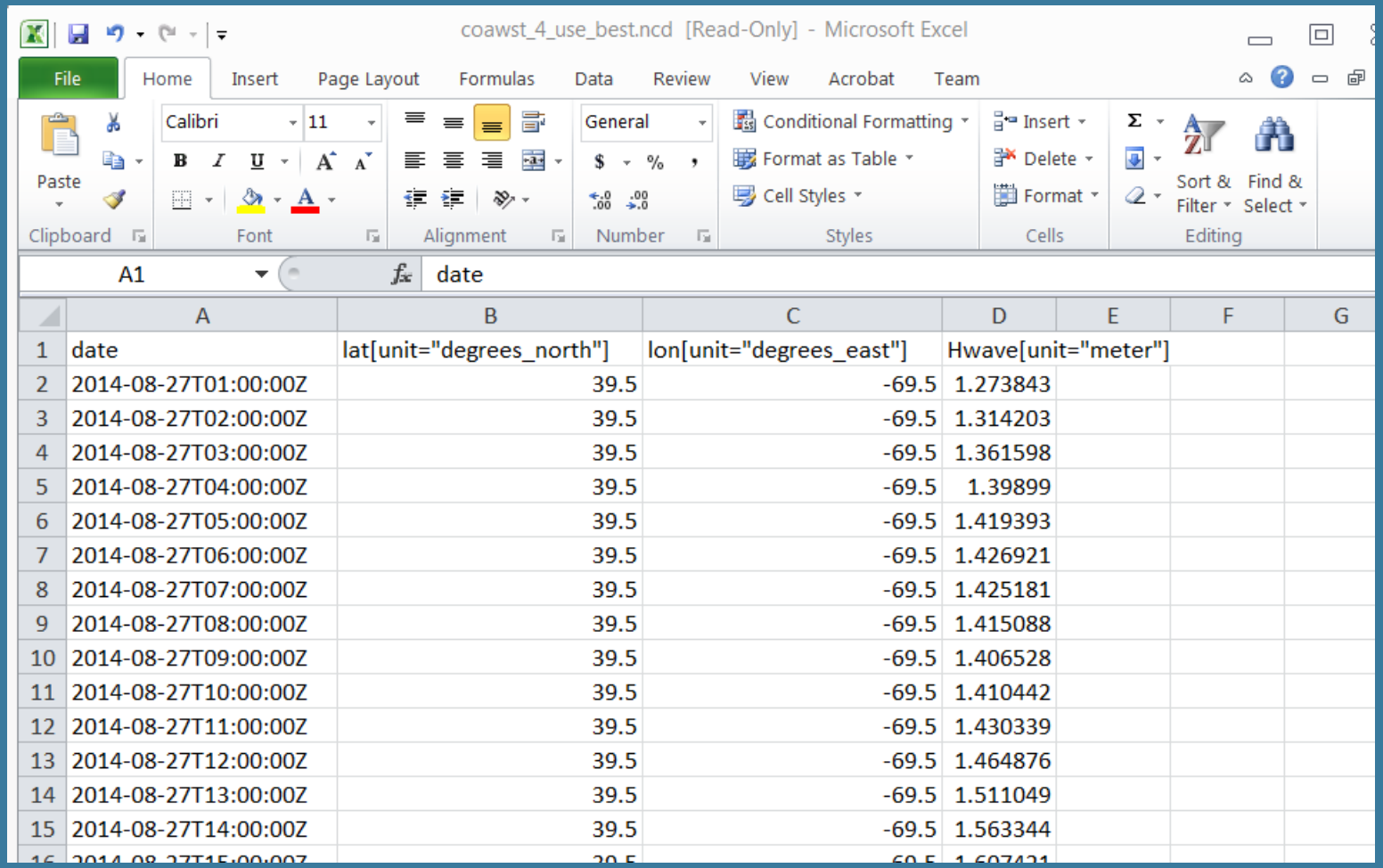
Choose Output Format:

CSV Time Series from Subset Service

```
date,lat[unit="degrees_north"],lon[unit="degrees_east"],Hwave[unit="meter"]
2014-08-27T01:00:00Z,39.5,-69.5,1.273842692375183
2014-08-27T02:00:00Z,39.5,-69.5,1.3142027854919434
2014-08-27T03:00:00Z,39.5,-69.5,1.3615976572036743
2014-08-27T04:00:00Z,39.5,-69.5,1.398990273475647
2014-08-27T05:00:00Z,39.5,-69.5,1.419392704963684
2014-08-27T06:00:00Z,39.5,-69.5,1.426921010017395
2014-08-27T07:00:00Z,39.5,-69.5,1.4251813888549805
2014-08-27T08:00:00Z,39.5,-69.5,1.4150882959365845
2014-08-27T09:00:00Z,39.5,-69.5,1.406528115272522
2014-08-27T10:00:00Z,39.5,-69.5,1.4104422330856323
2014-08-27T11:00:00Z,39.5,-69.5,1.4303393363952637
2014-08-27T12:00:00Z,39.5,-69.5,1.4648756980895996
2014-08-27T13:00:00Z,39.5,-69.5,1.5110485553741455
2014-08-27T14:00:00Z,39.5,-69.5,1.5633442401885986
2014-08-27T15:00:00Z,39.5,-69.5,1.6074210405349731
2014-08-27T16:00:00Z,39.5,-69.5,1.6265686750411987
2014-08-27T17:00:00Z,39.5,-69.5,1.6184144020080566
2014-08-27T18:00:00Z,39.5,-69.5,1.5933209657669067
2014-08-27T19:00:00Z,39.5,-69.5,1.5608850717544556
2014-08-27T20:00:00Z,39.5,-69.5,1.527510643005371
2014-08-27T21:00:00Z,39.5,-69.5,1.5050616264343262
2014-08-27T22:00:00Z,39.5,-69.5,1.5094025135040283
2014-08-27T23:00:00Z,39.5,-69.5,1.5698728561401367
2014-08-28T00:00:00Z,39.5,-69.5,1.7087903022766113
```

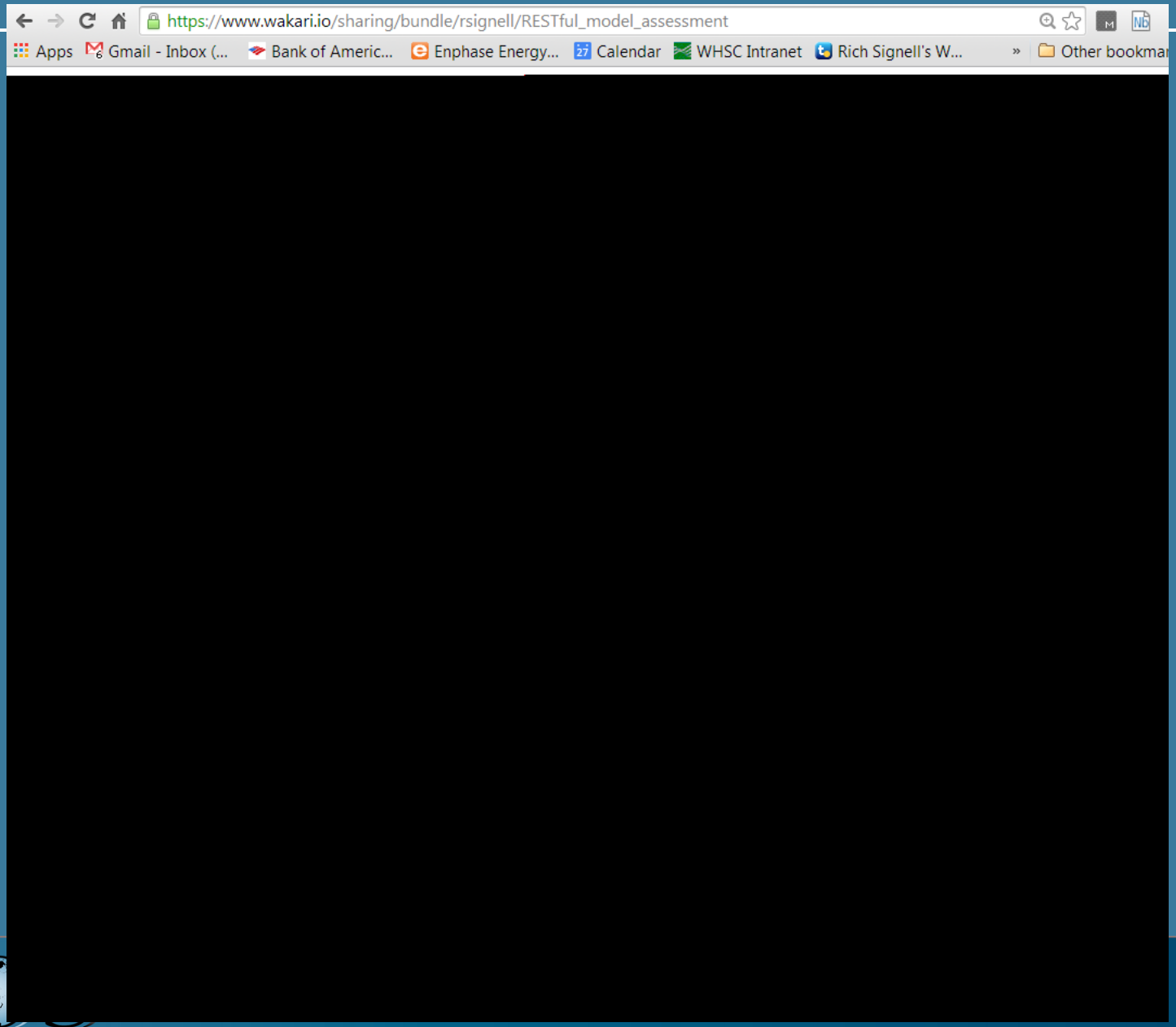
CSV request is a "RESTful" URL:
http://geoport.whoi.edu/thredds/ncss/grid/coawst_4/use/fmrc/coawst_4_use_best.ncd?var=Hwave&latitude=39.5&longitude=-69.5&time_start=2014-08-27T01:00:00Z&time_end=2014-08-28T00:00:00Z&vertCoord=&accept=csv

Accessing the CSV data in Excel



	A	B	C	D	E	F	G
1	date	lat[unit="degrees_north"]	lon[unit="degrees_east"]	Hwave[unit="meter"]			
2	2014-08-27T01:00:00Z	39.5	-69.5	1.273843			
3	2014-08-27T02:00:00Z	39.5	-69.5	1.314203			
4	2014-08-27T03:00:00Z	39.5	-69.5	1.361598			
5	2014-08-27T04:00:00Z	39.5	-69.5	1.39899			
6	2014-08-27T05:00:00Z	39.5	-69.5	1.419393			
7	2014-08-27T06:00:00Z	39.5	-69.5	1.426921			
8	2014-08-27T07:00:00Z	39.5	-69.5	1.425181			
9	2014-08-27T08:00:00Z	39.5	-69.5	1.415088			
10	2014-08-27T09:00:00Z	39.5	-69.5	1.406528			
11	2014-08-27T10:00:00Z	39.5	-69.5	1.410442			
12	2014-08-27T11:00:00Z	39.5	-69.5	1.430339			
13	2014-08-27T12:00:00Z	39.5	-69.5	1.464876			
14	2014-08-27T13:00:00Z	39.5	-69.5	1.511049			
15	2014-08-27T14:00:00Z	39.5	-69.5	1.563344			

Access the CSV data in Python, R, etc



IP[y]: Notebook Iris test 2 Last saved: Mar 28 10:17 AM

File Edit View Insert Cell Kernel Help

Code Cell Toolbar: None

In [12]:
```
# DAP URL: 30 year East Coast wave hindcast (Wave Watch 3 driven by CFSR Winds)
cubes = iris.load('http://geoport.whoi.edu/thredds/dodsC/fmrc/NCEP/ww3/cfsr/4m/best');
```

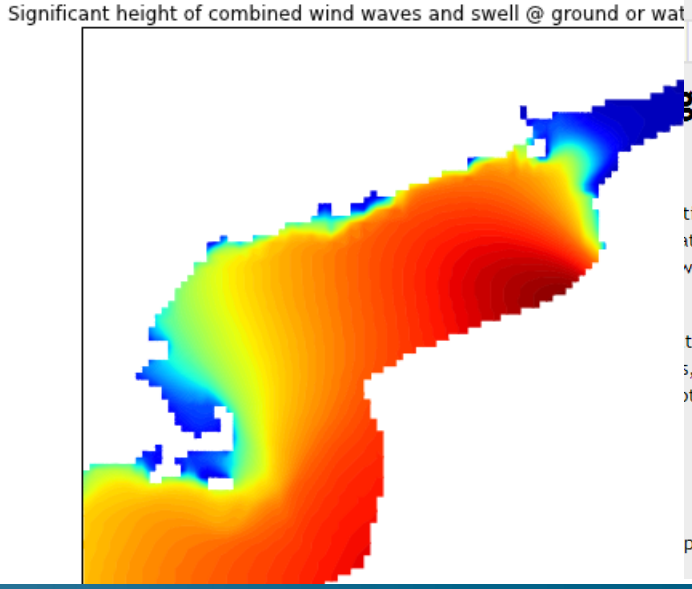
In [13]:
```
print cubes
```

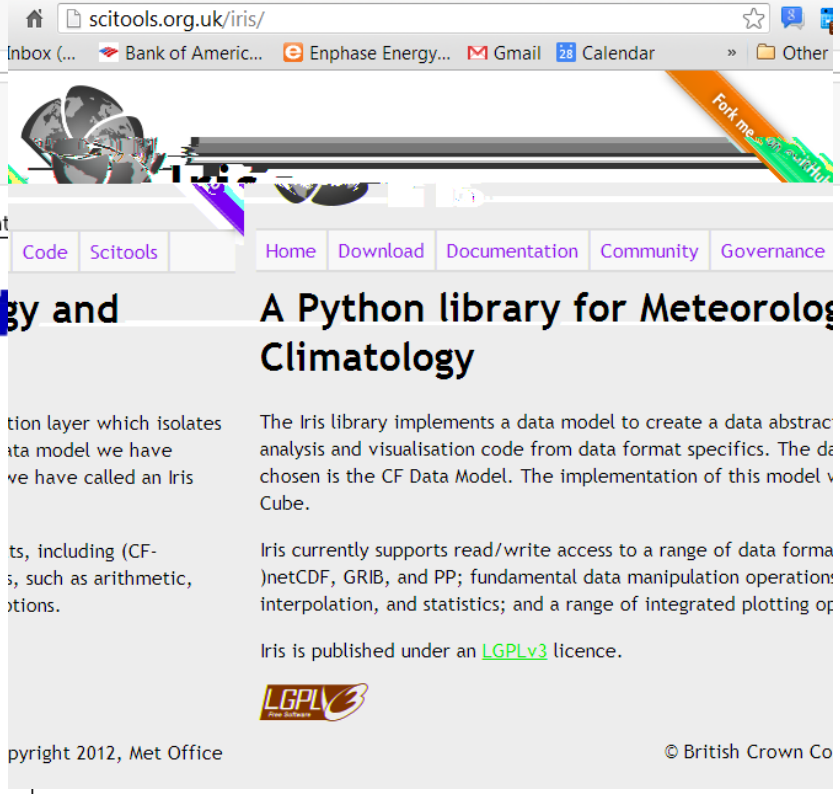
```
0: Significant height of combined wind waves and swell @ Ground or water surface / m (time: 90584; latitude: 481; longitude: 586)
1: u-component of wind @ Ground or water surface / m/s (time: 90096; latitude: 481; longitude: 586)
2: v-component of wind @ Ground or water surface / m/s (time: 90096; latitude: 481; longitude: 586)
3: Primary wave direction (degree true) @ Ground or water surface / unknown (time: 90584; latitude: 481; longitude: 586)
4: Primary wave mean period @ Ground or water surface / s (time: 90584; latitude: 481; longitude: 586)
```

In [14]:
```
hsig=cubes[0]
```

In [15]:
```
slice=hsig.extract(iris.Constraint(time=tval(hsig,'1989-05-07 21:00'),
    longitude=lambda cell: -71.5 < cell < -65.0,
    latitude=lambda cell: 39.5 < cell < 46.0))
```

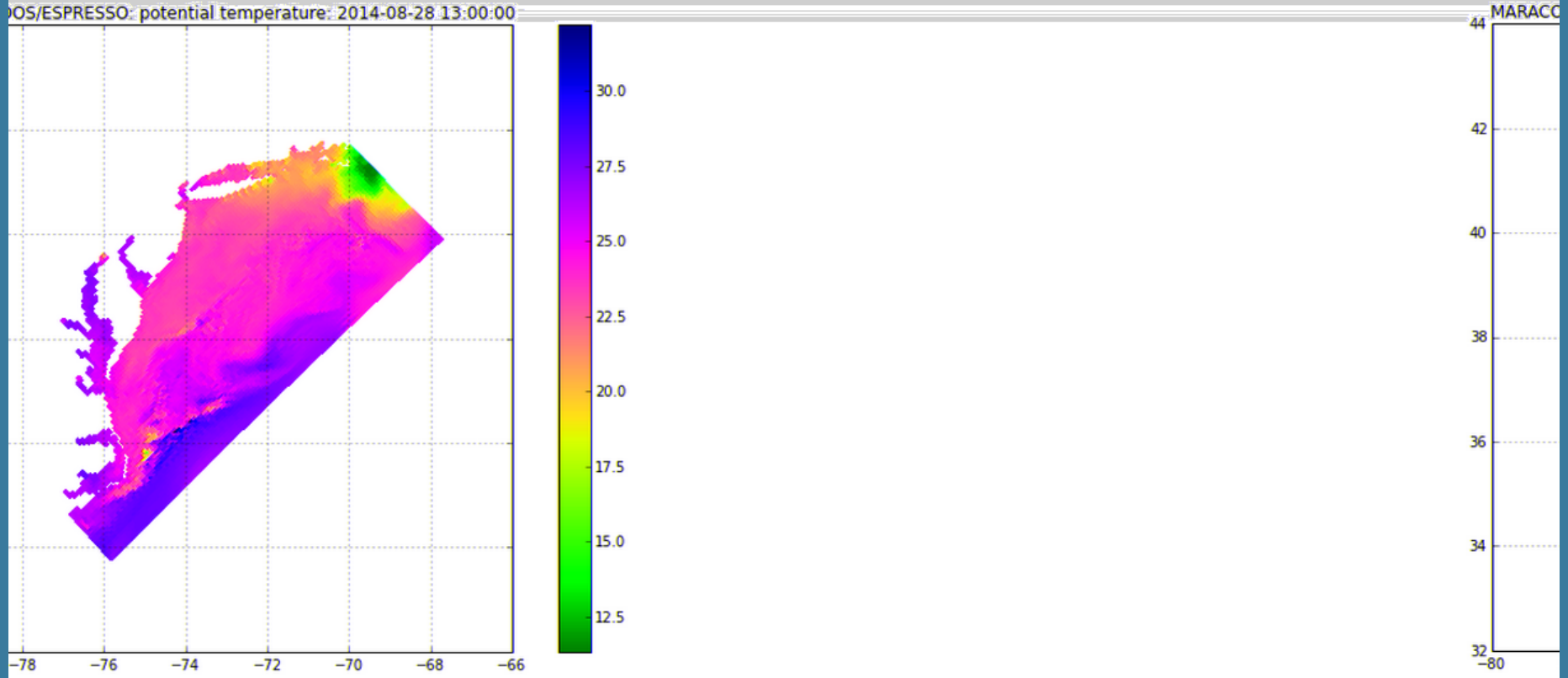
In [16]:
```
# make the plot
figure(figsize=(10,10))
qplt.contourf(slice,100);
```





ESPreSSO model (Rutgers)

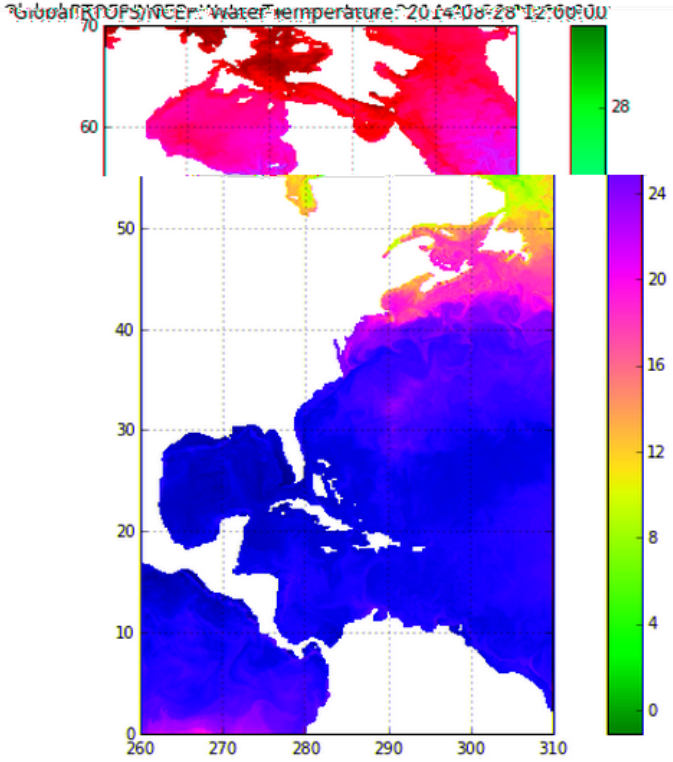
```
ACOOS/ESPRESSO'                                                                    In [9]: model='MARA
//tds.marine.rutgers.edu/thredds/dodsC/roms/espresso/2013_da/his_Best/ESPRESSO_Real-Time_v2_History_Best_Available_best.ncd'   url='http:/
ater_potential_temperature'                                                                var='sea_wa
                                                                                           lev=-1
lev_date(url=url,var=var, mytime=mytime, lev=lev)                                          slice=var_
ce,model=model)                                                                            myplot(slic
ieved in 1.875781 seconds                                                                  slice retr
```



Global RTOFS (NOAA)

In [13]:
```
model='Global RTOFS/NCEP'
url='http://ecowatch.ncddc.noaa.gov/thredds/dodsC/hycom/hycom_reg1_agg/HYCOM_Region_1_Aggregation_best.ncd'
var='sea_water_temperature'
lev=1
subsample=1
slice=var_lev_date(url=url,var=var, mytime=mytime, lev=lev, subsample=subsample)
myplot(slice,model=model)
```

```
slice retrieved in 1.225454 seconds
/opt/anaconda/envs/np18py27-1.9/lib/python2.7/site-packages/iris/fileformats/_pyke_rules/compiled_krb/fc_rules_cf_fc.py:1196: UserWarning: Ignoring netCDF variable 'salinity' invalid units 'psu'
  warnings.warn(msg.format(msg_name, msg_units))
```



IOOS Models Notebook on Wakari

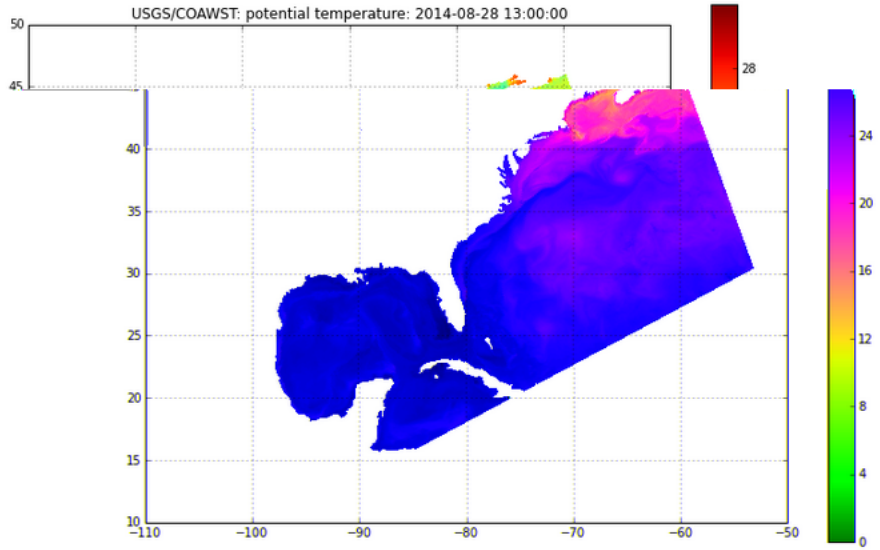
https://www.wakari.io/sharing/bundle/rsignell/IOOS_Models

Apps | Gmail - Inbox (... | Bank of Americ... | Enphase Energy... | Calendar | WHSC Intranet | Rich Signell's W... | Emoji cheat she... | Emoji ch

Wakari — IOOS_Models

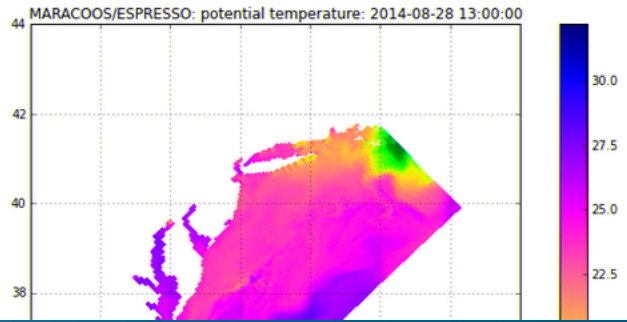
View Other Bundles by rsignell | Download Entire Bundle | Download This Notebook | Run/Edit this Notebook

```
slice retrieved in 4.816941 seconds
```



In [9]:
```
model='MARACOOS/ESPRESSO'
url='http://tds.marine.rutgers.edu/thredds/dodsC/roms/espresso/2013_da/his_Best/ESPRESSO_Real-Time_v2_History_Best_Available_best.nc
var='sea_water_potential_temperature'
lev=-1
slice=var_lev_date(url=url,var=var, mytime=mytime, lev=lev)
myplot(slice,model=model)
```

```
slice retrieved in 1.875781 seconds
```



60 minutes to serving your data

1. Install Sun/Oracle Java (10 min)
2. Install/configure Tomcat (15 min)
3. Install/configure the Thredds Data Server (15 min)
4. Put NetCDF (or HDF4, Grib1, Grib2, HDF5 files) in a directory (5 min)
5. Add NcML (XML) files for CF compliance and aggregation (15 min)

Adding data to THREDDS

```
rsignell@gam:/usgs/data0/bbleh/tidal$ ls *wide*
...
his_bbleh_wide_0048.nc  his_bbleh_wide_0100.nc  his_bbleh_wide_0152.nc
his_bbleh_wide_0049.nc  his_bbleh_wide_0101.nc  his_bbleh_wide_0153.nc
his_bbleh_wide_0050.nc  his_bbleh_wide_0102.nc  his_bbleh_wide_0154.nc
his_bbleh_wide_0051.nc  his_bbleh_wide_0103.nc  wide.ncml

$more wide.ncml

<netcdf xmlns="http://www.unidata.ucar.edu/namespaces/netcdf/ncml-2.2">
  <aggregation dimName="ocean_time" type="joinExisting">
        <scan location="." regExp=".*wide.*_[0-9]{4}\.nc$"/>
  </aggregation>
</netcdf>
```

WHCMSC Sediment Transport Group

THREDDS Data Server

alog.html Catalog http://geoport.whoi.edu/thredds/catalog/usgs/data0/bbleh/tidal/cat

Dataset: tidal/wide.ncml

- *Data size:* 218.0 bytes
- *ID:* usgs/data0/bbleh/tidal/wide.ncml

Access:

1. **OPENDAP:** /thredds/dodsC/usgs/data0/bbleh/tidal/wide.ncml
2. **HTTPServer:** /thredds/fileServer/usgs/data0/bbleh/tidal/wide.ncml
3. **NetcdfSubset:** /thredds/ncss/grid/usgs/data0/bbleh/tidal/wide.ncml
4. **ISO:** /thredds/iso/usgs/data0/bbleh/tidal/wide.ncml
5. **NCML:** /thredds/ncml/usgs/data0/bbleh/tidal/wide.ncml
6. **UDDC:** /thredds/uddc/usgs/data0/bbleh/tidal/wide.ncml
7. **WMS:** /thredds/wms/usgs/data0/bbleh/tidal/wide.ncml

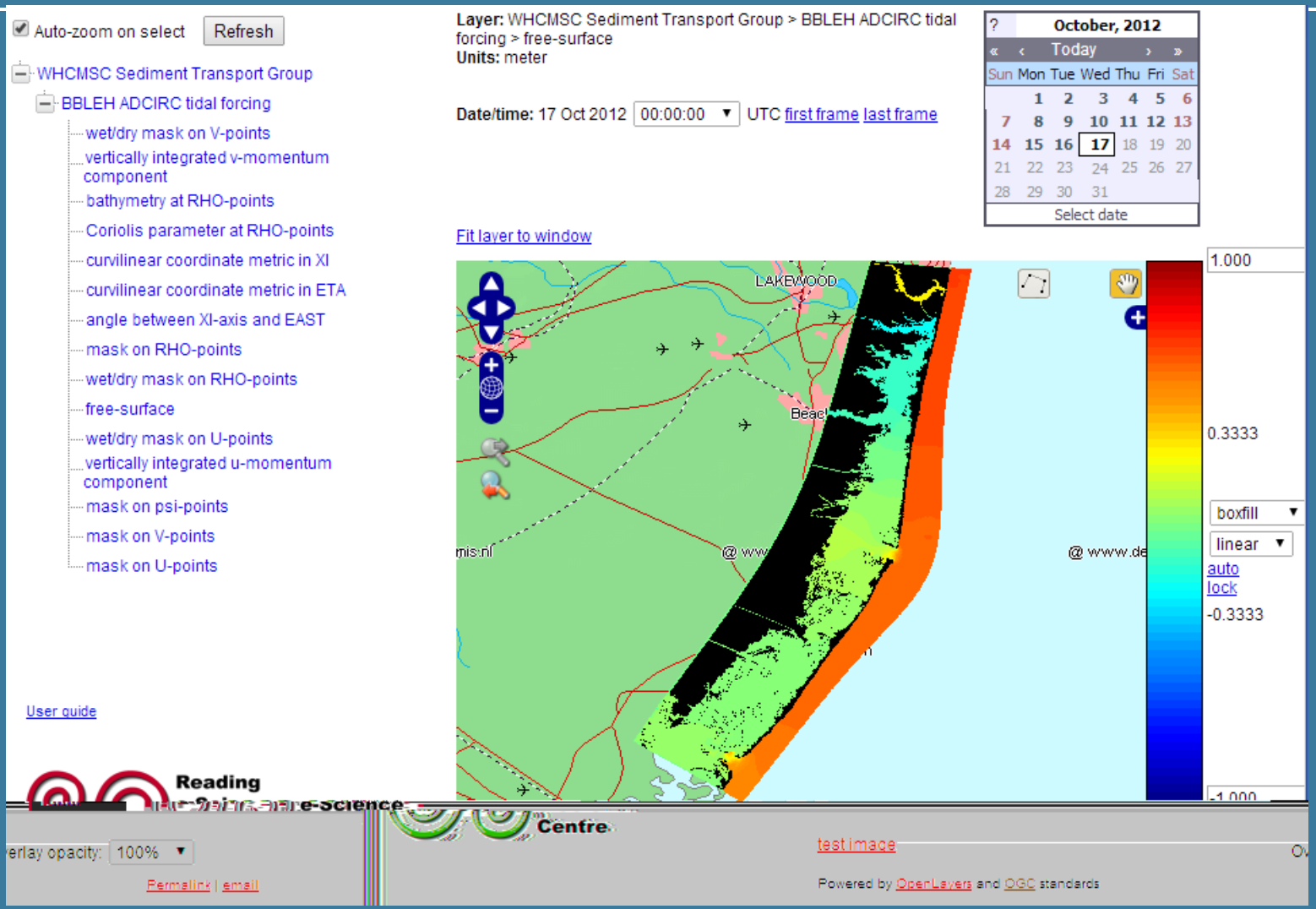
Dates:

- 2014-06-03T12:44:05Z **(modified)**

Viewers:

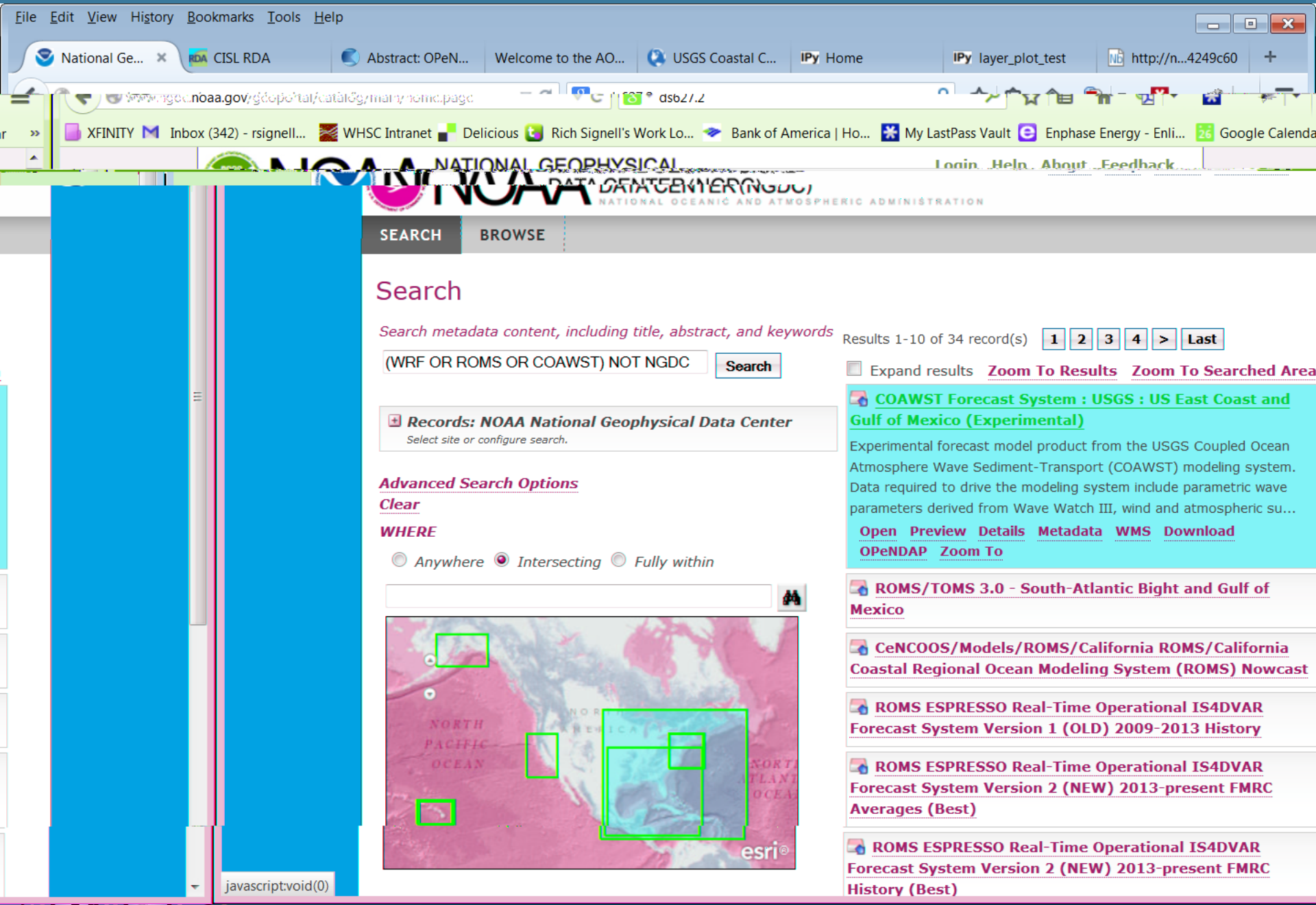
- Godiva2 (browser-based)
- NetCDF-Java ToolsUI (webstart)

Browsing WMS with Godiva2



Searching for Data

GI-CAT catalog broker service architecture


File Edit View History Bookmarks Tools Help
National Ge...
CISL RDA
Abstract: OPeN...
Welcome to the AO...
USGS Coastal C...
Home
layer_plot_test
XFINITY
Inbox (342) - rsignell...
WHSC Intranet
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Rich Signell's Work Lo...
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My LastPass Vault
Enphase Energy - Enli...
Google Calenda
NOAA NATIONAL GEOPHYSICAL DATA CENTER (NGDC)
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Login Help About Feedback
SEARCH
BROWSE
Search
Search metadata content, including title, abstract, and keywords
(WRF OR ROMS OR COAWST) NOT NGDC
Search
Results 1-10 of 34 record(s)
1 2 3 4 > Last
Expand results
Zoom To Results
Zoom To Searched Area
Records: NOAA National Geophysical Data Center
Select site or configure search.
Advanced Search Options
Clear
WHERE
Anywhere
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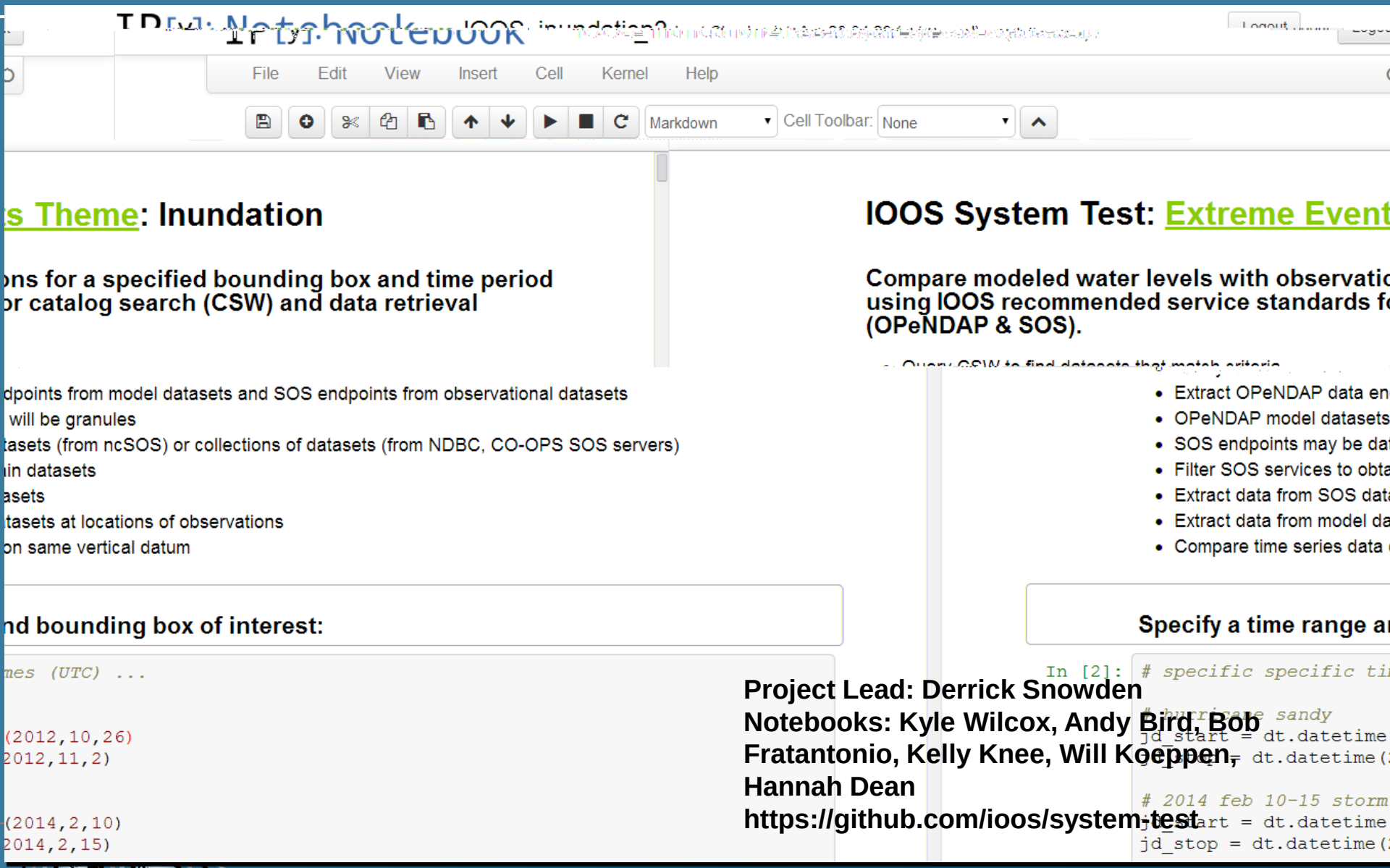
Fully within
NORTH PACIFIC OCEAN
esri
COAWST Forecast System : USGS : US East Coast and Gulf of Mexico (Experimental)
Experimental forecast model product from the USGS Coupled Ocean Atmosphere Wave Sediment-Transport (COAWST) modeling system. Data required to drive the modeling system include parametric wave parameters derived from Wave Watch III, wind and atmospheric su...
Open Preview Details Metadata WMS Download
OPeNDAP Zoom To
ROMS/TOMS 3.0 - South-Atlantic Bight and Gulf of Mexico
CeNCOOS/Models/ROMS/California ROMS/California Coastal Regional Ocean Modeling System (ROMS) Nowcast
ROMS ESPRESSO Real-Time Operational IS4DVAR Forecast System Version 1 (OLD) 2009-2013 History
ROMS ESPRESSO Real-Time Operational IS4DVAR Forecast System Version 2 (NEW) 2013-present FMRC Averages (Best)
ROMS ESPRESSO Real-Time Operational IS4DVAR Forecast System Version 2 (NEW) 2013-present FMRC History (Best)
javascript:void(0)

IOOS System Test



Project Lead: Derrick Snowden
Notebooks: Kyle Wilcox, Andy Bird, Bob Fratantonio, Kelly Knee, Will Koeppen, Hannah Dean
https://github.com/ioos/system-test

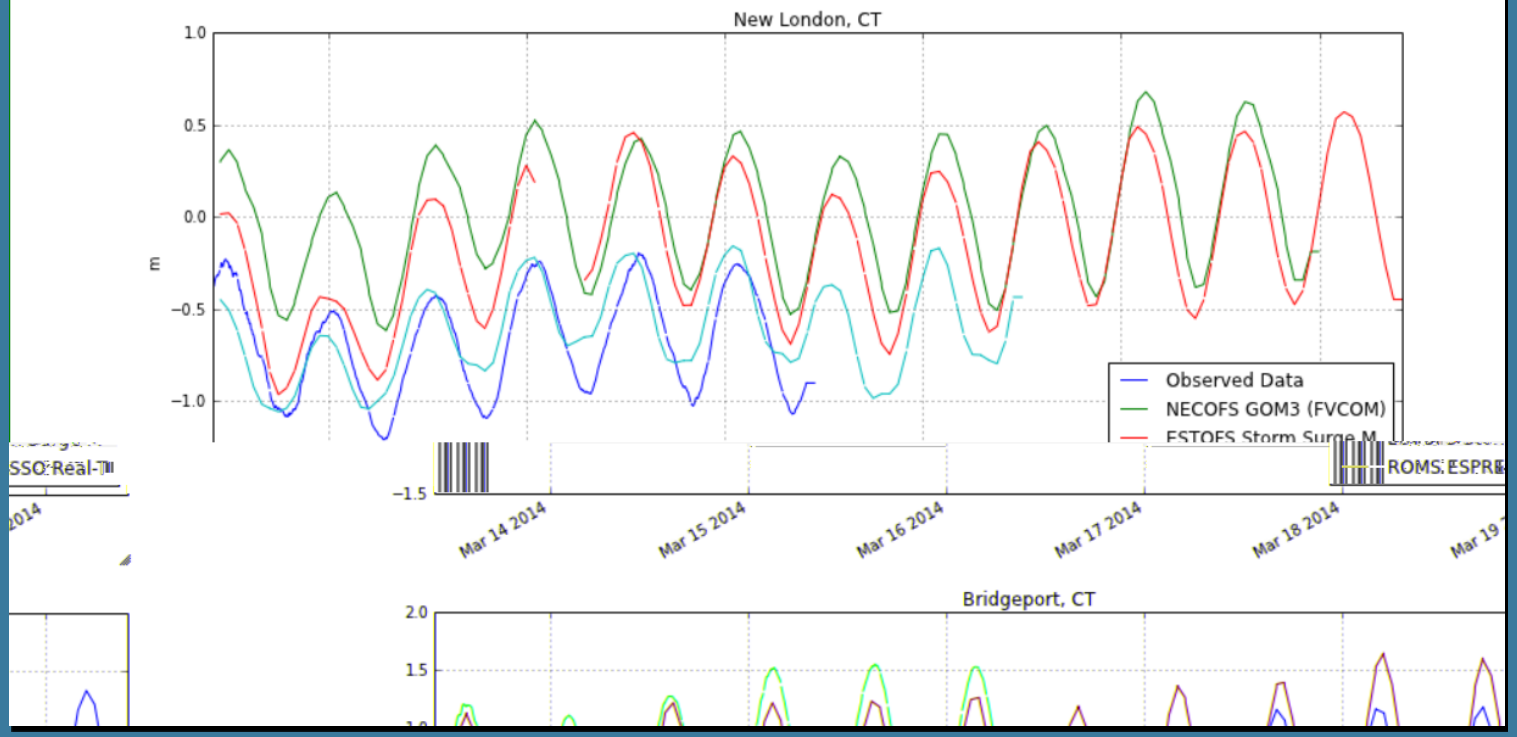
Automated model comparison

IP[y]: Notebook IOOS_inundation Last Checkpoint: Mar 15 16:08 (autosaved)

File Edit View Insert Cell Kernel Help

Code Cell Toolbar: None

```
In [45]: for df in obs_df:
             df.plot(figsize=(14,6),title=df.name)
             ylabel('m')
```



SECOORA Model Assessment

Nbviewer link

nbviewer.ipython.org/github/ioos/secoora/blob/master/notebooks/inundation/00-generate_page_html.ipynb

Apps | Gmail - Inbox (... | Bank of Americ... | Enphase Energy... | Calendar | WHSC Intranet | Rich Signell's W... | Emoji cheat she... | Em

```
with open(fname, 'w') as f:
    f.writelines(table)

to_html(bias.T)
```

Project Lead: Vembu Subramanian
Notebook: Filipe Fernandes
URL: https://github.com/ioos/secoora

Out[21]:

	COAWST_4	ESPRESSO	ESTOFS	HYCOM	SABGOM
Duck, NC	--	--	0.05	--	0.43
Oregon Inlet Marina, NC	-0.07	0.21	0.00	0.45	--
Wrightsville Beach, NC	-0.03	--	0.07	0.32	0.45
Springmaid Pier, SC	-0.04	--	0.08	--	0.45
Oyster Landing (N Inlet Estuary), SC	--	--	0.18	--	--
Fort Pulaski, GA	--	--	0.13	--	--
Fernandina Beach, FL	--	--	0.04	--	--
Mayport (Bar Pilots Dock), FL	--	--	0.01	--	--
Trident Pier, FL	--	--	-0.13	--	--
Lake Worth Pier, FL	-0.30	--	-0.11	0.07	--
Virginia Key, FL	--	--	-0.06	--	0.25
Vaca Key, FL	--	--	-0.06	--	--
Key West, FL	-0.28	--	-0.08	--	0.14
Naples, FL	--	--	-0.03	--	--
Port Manatee, FL	--	--	0.02	--	--
Clearwater Beach, FL	--	--	0.07	--	--
Cedar Key, FL	-0.10	--	0.09	--	0.18
Apalachicola, FL	-0.04	--	0.15	--	--
Panama City, FL	-0.02	--	--	--	--
Pensacola, FL	0.04	--	--	--	--

Back to top

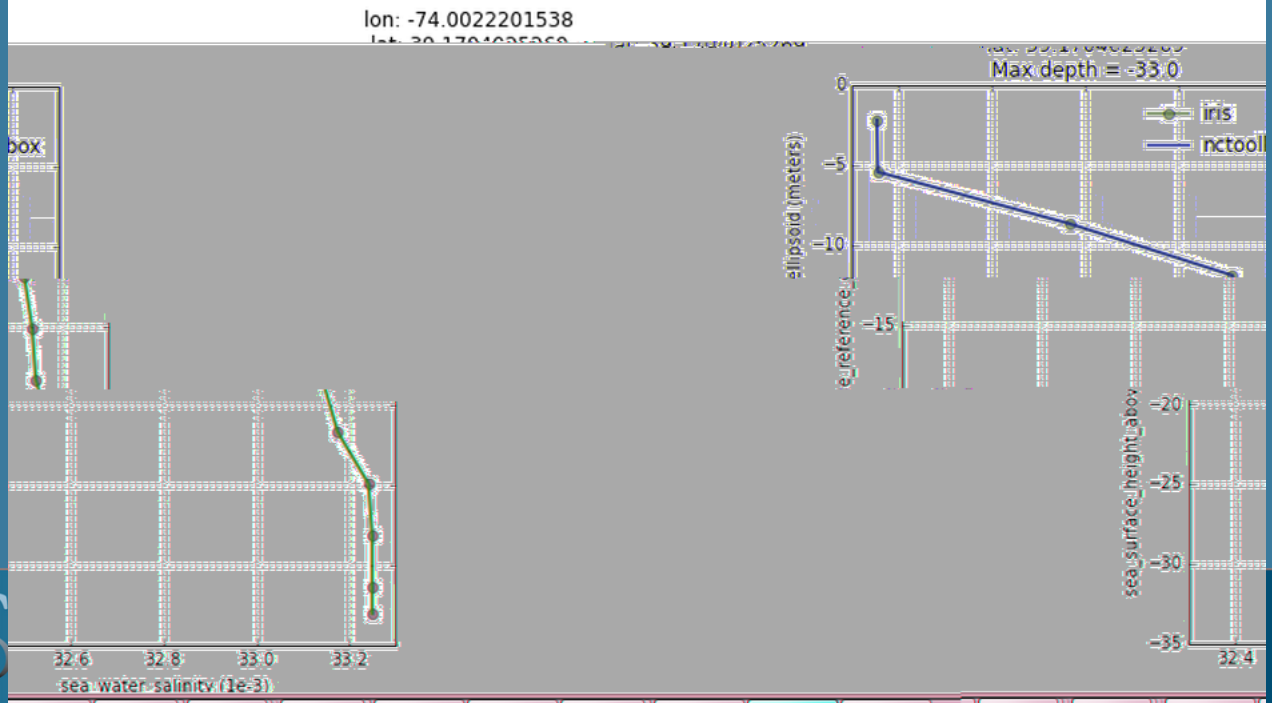
IOOS

Python & Matlab notebook

In [5]:
```
%%matlab -i url -o s -o g
addpath(genpath('/home/filipe/IOOS/nctoolbox'));
nc = ncgeodataset(url);

s = nc{'salt'}(1, :, 11, 21);
g = nc{'salt'}(1, :, 11, 21).grid;
```

```
log4j:WARN No appenders could be found for logger (ucar.nc2.NetcdfFile).
log4j:WARN Please initialize the log4j system properly.
```

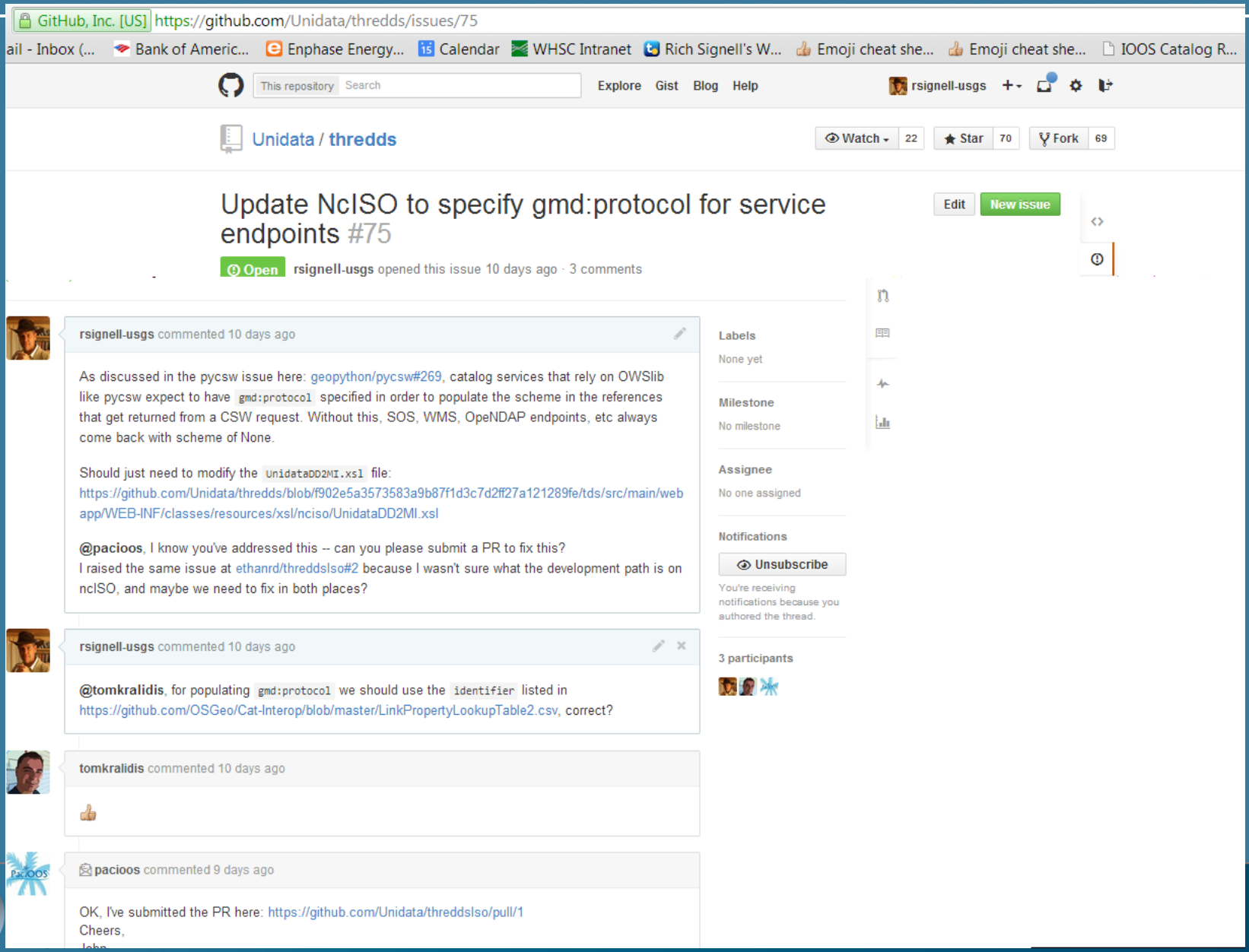
In [6]:
```
kw = dict(linewidth=2,  color=(0.6, 0.1, 0.15),
          alpha=0.75, label='nctoolbox')
leg = dict(numpoints=1, loc='best', framealpha=0)

c = cube[0, :, 10, 20]
fig, ax = plot_profile(c)

ax.plot(s, g['z'], **kw)
l = ax.legend(**leg)
```



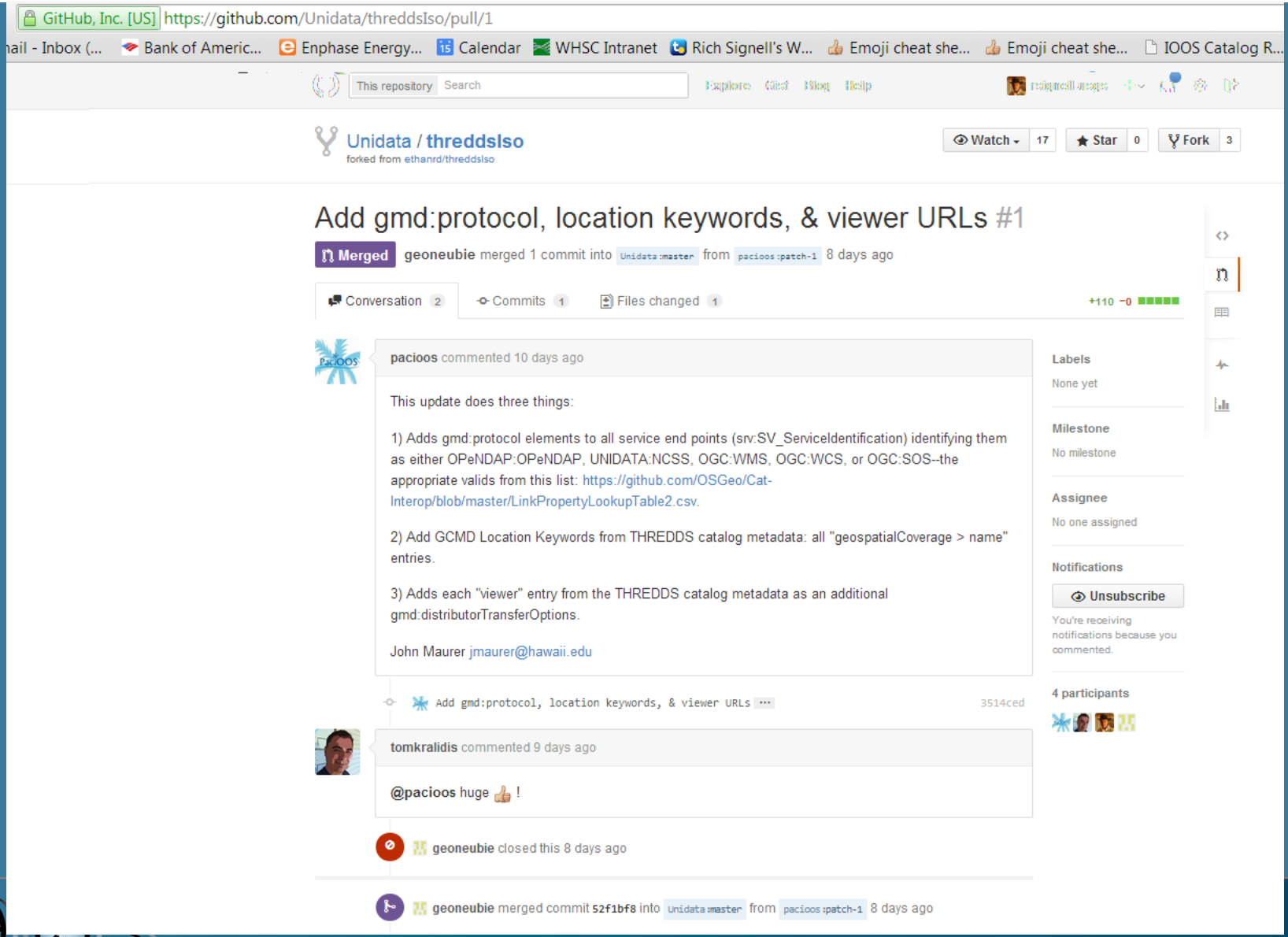
Unidata Challenges

- Community THREDDS Data Servers robustness
- Support as popularity increases
- UGRID incorporated into Unidata NetCDF-Java
- Aggregation of large collections of NetCDF files
- Met/Ocean tools developed for Python on top of CF/Ugrid conventions (Iris, libCF)
- IDV-like client built on top of Python tools
- Participation in standards (e.g. OGC)
- Managing community development

Community Development



Community Development



Why do I promote Unidata technologies?

- Powerful
- Flexible
- Easy to install
- Free
- Supported
- Driven by community of users


NPS160 12
NPS160 13


ALTAVISION
MITSUBISHI
PICJOKE.COM
MIZUHO
MIZUHO
NOVA


angel
baby
PHOTOFUNIA
SHINE ON!

Summary (1 of 2)

- Common data models for “feature types” (structured and unstructured grids, time series, profiles, swaths) (Unidata CDM)
- Standard web services for delivering these data and metadata (OGC, Unidata)
- Tools to access and process these services in common analysis environments: R, Matlab, Python, ArcGIS, JavaScript

Summary (2 of 2)

- It's easy (1 hour) to deploy free, supported systems that allow for standards-based delivery of aggregated data from native model grids that put little effort on the data provider
- What do you get?
  - Lots of choices for data access (Browser, Matlab, Python, Excel, IDV, R, IDL)
  - More usage of model results by more people
  - Faster feedback to modelers, leading to improved models
  - Shared code base in the community
  - Increased community support for standards-based access
  - Less time wasted messing with data, more time spent on ecosystem based management
- What should you do? Encourage providers to use these standards, and develop tools that use standardized access

More at: Github.com/rsignell-usgs