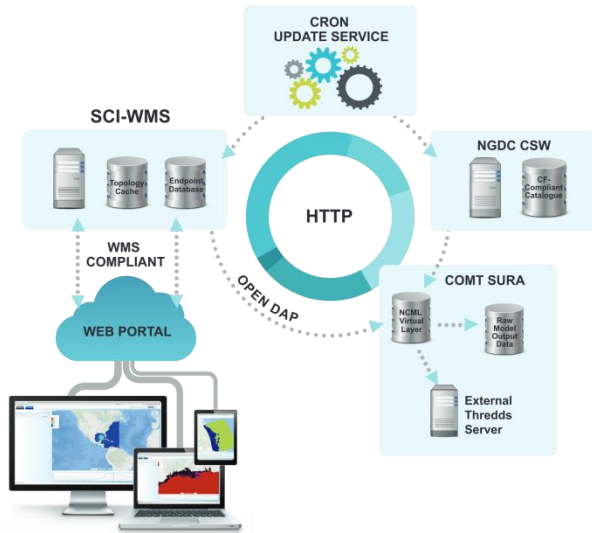


COMT CI: Y3 in Review & Goals for Y4  
Kelly Knee & Brian McKenna  
RPS ASA



# COMT Cyber-Infrastructure



## Motivation

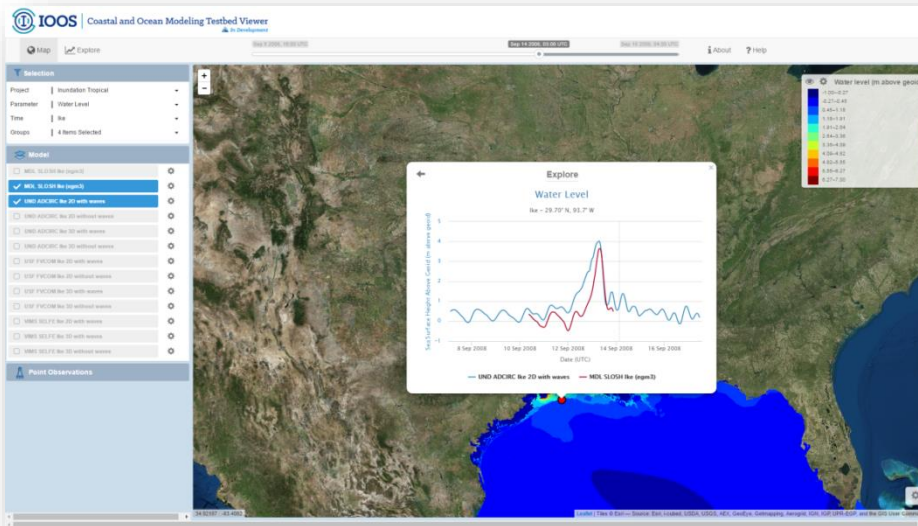
- facilitate **collaboration** across various institutions and models
- enable **exploration**, presentation and archive of research results
- provide **community** access and tools to the COMT research

## Implementation/Tools

- modelers upload data via FTP to central server
- CI works with modelers to make all data CF-compliant
- direct data access available via TDS (OPeNDAP and HTTP)
- visualization via Python based SCI-WMS for graphic display of data
  - handles structured, staggered and unstructured GRIDS
- user interface enables exploration of catalog and graphics for all projects

|        | TOPOLOGY | OPEN DAP ENDPOINT |
|--------|----------|-------------------|
| C-GRID |          | HTTP://...        |
|        |          | HTTP://...        |
|        | ⋮        | ⋮                 |
| U-GRID |          | HTTP://...        |
|        |          | HTTP://...        |

## Presentation/User Interface



## Services

sci-wms (1.6.0-dev) @ Python WMS service for geospatial gridded data

[datasets](#) [defaults](#) [documentation](#) [demo \(Leaflet WMS client\)](#) [login](#)

| Description                                 | Preview | Info  | Actions                |
|---|---------|---|------------------------|
| <a href="#">cb_hypoxia.CHEROMS_1term...</a> | n/a     | <a href="#">GetCaps</a><br><a href="#">Data (DAP)</a><br>Updated: 1 week, 1 day ago<br>Keep up to date: <input checked="" type="checkbox"/> | <a href="#">Update</a> |
| <a href="#">cb_hypoxia.CHEROMS_1termDO</a>  | n/a     | <a href="#">GetCaps</a><br><a href="#">Data (DAP)</a><br>Updated: 1 week, 1 day ago<br>Keep up to date: <input checked="" type="checkbox"/> | <a href="#">Update</a> |
| <a href="#">usw_integration.exp16</a>       | n/a     | <a href="#">GetCaps</a><br><a href="#">Data (DAP)</a><br>Updated: 1 week, 1 day ago   | <a href="#">Update</a> |

## Data Access (eg. OPeNDAP)

```

OPeNDAP
-----
Tested on Netscape 4.01 and Internet Explorer 5.00.

ASRON: GetASCII | GetBinary | ShowHelp
Data URL: http://comt.sura.org/thredds/dodsC/iod2/pr_
Global Attributes: _FillValue: -99999.0
                  model: ADCIRC
                  version: 51.28
                  grid_type: Triangular
                  description: PRU1 TIDAL
Variables:
  @ time: Array of 64 bit Reals [time = 0.47][node = 0.2733257]
  @ zeta: Array of 64 bit Reals [time = 0.47][node = 0.2733257]
  @ u-vel: Array of 64 bit Reals [time = 0.47][node = 0.2733257]
  @ v-vel: Array of 64 bit Reals [time = 0.47][node = 0.2733257]
  @ X: Array of 64 bit Reals [node = 0.2733257]
  @ Y: Array of 64 bit Reals [node = 0.2733257]
  @ element: Array of 32 bit Integers [node = 0.2733257]
  @ adcirc_mesh: Array of 32 bit Integers [node = 0.2733257]
  @ neta: 32 bit Integer [node = 0.2733257]
  @ windx: Array of 64 bit Reals [time = 0.47][node = 0.2733257]
  @ windy: Array of 64 bit Reals [time = 0.47][node = 0.2733257]
  @ swan_HS: Array of 64 bit Reals [time = 0.47][node = 0.2733257]
    
```

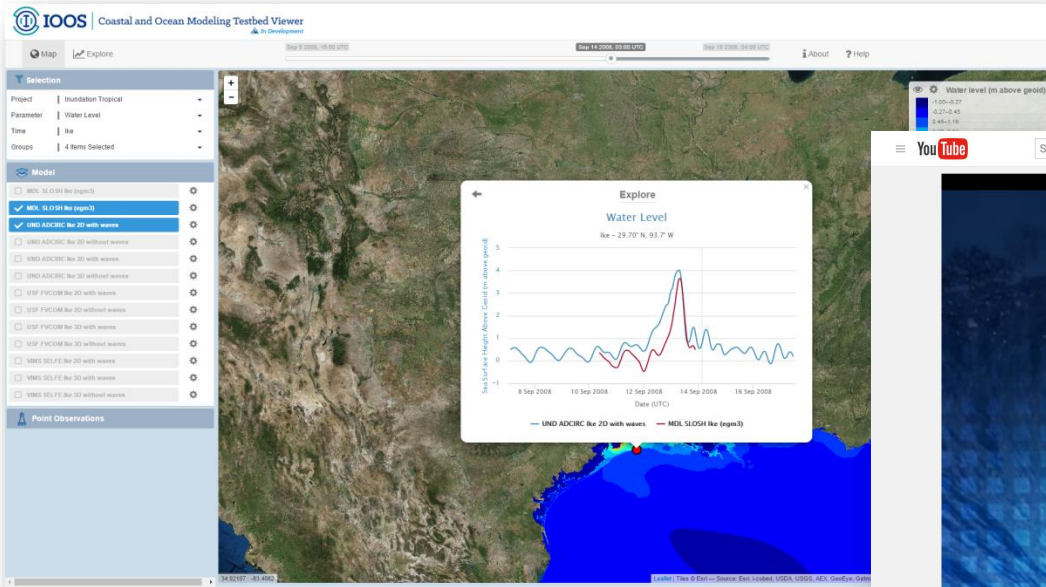
# Year 3 In Review

- Deployment of comt.ioos.us
- Addition of <http://comt.sura.org/thredds> to RPA ASA's operational service monitoring system
- Model Viewer Improvements

The image displays two overlapping screenshots from the IOOS website. The top screenshot shows the main IOOS homepage with a navigation bar and several content tiles: 'EDS Model Viewer', 'IOOS By The Numbers', 'Profiling Gliders', 'Data Discovery', 'Coastal and Ocean Modeling Testbed', 'Marine Biodiversity (MBON) Data', and 'Regional Associations'. The bottom screenshot shows the 'Coastal and Ocean Modeling Testbed Viewer' interface, which includes a map of the United States with a highlighted area in the Gulf of Mexico, a legend for 'Water level (m above geoid)', and a sidebar with selection options for Project, Parameter, Time, Groups, and Model.

# Year 3 In Review

- Coordination with modeling teams & participation on team calls
- Demos and [tutorials](#)
- **Development of Data Upload Tool**
- Review of draft Data Management Plan



# Year 3 In Review: CB Hypoxia

## Challenge: Downloadable Publication Archives

- Create unique and stable (and now branded!) TDS catalog location for archiving publication model runs & related observations
  - [http://comt.sura.org/thredds/catalog/comt\\_2\\_full/cb\\_hypoxia/2004-2005/catalog.html](http://comt.sura.org/thredds/catalog/comt_2_full/cb_hypoxia/2004-2005/catalog.html)
  - [http://thredds.comt.ioos.us/thredds/projects/cb\\_hypoxia/papers/irbyetal2016.html](http://thredds.comt.ioos.us/thredds/projects/cb_hypoxia/papers/irbyetal2016.html)



Catalog [http://thredds.comt.ioos.us/thredds/projects/cb\\_hypoxia/papers/irbyetal2016.html](http://thredds.comt.ioos.us/thredds/projects/cb_hypoxia/papers/irbyetal2016.html)

| Dataset  | Size | Last Modified |
|--|------|---------------|
| Irby et al. 2016                                       |      | --            |
| VIMS ChesROMS 1-term DO surfsat/                       |      | --            |
| NOAA CSDL CROFS2 (ROMS) development Synoptic Hindcast/ |      | --            |
| UMCES ROMS RCA/  |      | --            |

COMT TDS at RPS ASA see [Info](#)  
THREDDS Data Server [Version 4.6.6 - 2016-06-13T15:13:41-0600] [Documentation](#)

# Year 3 In Review: CB Hypoxia

- Added new model runs
  - ChesROMS
  - CBOFS
  - ROMS\_RCA
- Organized model runs by project period
  - 2004-2005
  - 1984-2013
  - 2014-2015
- Re-organization of Model Viewer filters to allow multiple time periods per project
- Enabled water temperature variable in the model viewer
- Integrated the Chesapeake Bay Program observation data with the TDS catalog and Model Viewer
- Added CBIBS buoy data to the Model Viewer

# Year 3 In Review: CB Hypoxia

## Outstanding Requests:

- Process observation data
- Enable model-observation comparisons
- Enable inter-comparison of models with sigma coordinates at various depths
- Add additional biogeochemical variables (chlorophyll and nitrate)
- Integration of 'Station' data from simulations
- Allow Model Viewer to generate longer (2-yr) time-series
- Calculation of hypoxic volume



# Year 3 In Review: GoM Hypoxia

## Challenge: Calculation of bottom boundary layer

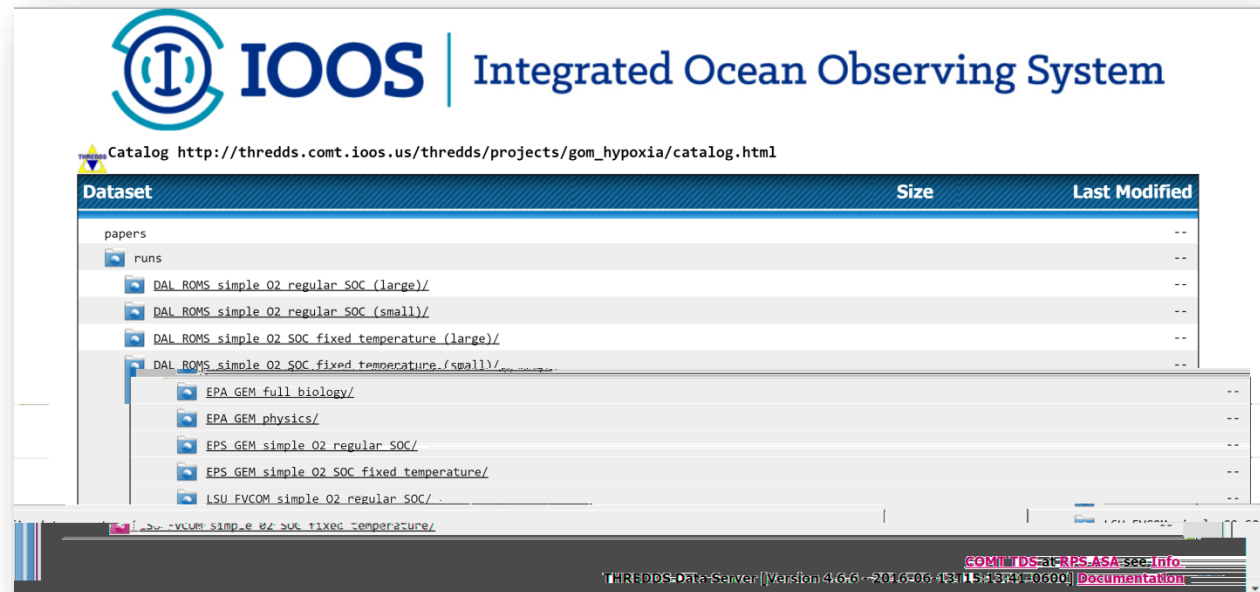
- Boundary layer thickness, as compared to NGOFS, is a key diagnostic for inclusion of new models.
- Review existing Matlab code for boundary layer calculation provided by modeling team
- Convert to Python and performed test integration with data ingest process as a post-processing step

## Potential Next Steps

- Testing!
- Add boundary layer thickness as 2D variable to model output files;
  - Requires discussion of CF convention for new variable
- Determine best practices for visualization, color scheme, etc
- Comparison with NGOFS

# Year 3 In Review: GoM Hypoxia

- Defined the model data expectations for Y3 and Y4 for all three models (ROMS, GEM, FVCOM)
  - Y3: (1) simple oxygen model and (2) the diagnostic run
  - Y4: full biogeochemical model results
- Created a [stable TDS catalog link](#) for use in publications
- Continued coordination with FVCOM group to work through topology and time variable issues
- Added first round of simple O2 models to the TDS catalog



The screenshot displays the IOOS Integrated Ocean Observing System interface. At the top, the IOOS logo and name are visible, along with the text "Integrated Ocean Observing System". Below this, the URL "Catalog http://thredds.comt.ioos.us/thredds/projects/gom\_hypoxia/catalog.html" is shown. The main content is a table with three columns: "Dataset", "Size", and "Last Modified". The table lists several datasets, including "papers", "runs", and various model runs for ROMS, GEM, and FVCOM. The "Dataset" column contains folder names, and the "Size" and "Last Modified" columns show "--".

| Dataset   | Size | Last Modified |
|---|------|---------------|
| papers  | --   | --            |
| runs  | --   | --            |
| DAL_ROMS_simple_O2_regular_SOC_(large)/           | --   | --            |
| DAL_ROMS_simple_O2_regular_SOC_(small)/           | --   | --            |
| DAL_ROMS_simple_O2_SOC_fixed_temperature_(large)/ | --   | --            |
| DAL_ROMS_simple_O2_SOC_fixed_temperature_(small)/ | --   | --            |
| EPA_GEM_full_biology/                             | --   | --            |
| EPA_GEM_physics/                                  | --   | --            |
| EPS_GEM_simple_O2_regular_SOC/                    | --   | --            |
| EPS_GEM_simple_O2_SOC_fixed_temperature/          | --   | --            |
| LSU_FVCOM_simple_O2_regular_SOC/                  | --   | --            |

At the bottom of the screenshot, there is a footer with the text "THREDDS Data Server [Version 4.6.6 - 2016-06-13 11:58:47 -0600]". To the right of the footer, there are links for "COMMIT DS at RPS-ASA see info" and "documentation".

# Year 3 In Review: GoM Hypoxia

## Outstanding Requests:

- Process observation data
- Enable model-observation comparisons
- Add full biogeochemical model output
- Add bottom boundary layer thickness to UI
  - Perform a simple difference calculation between NGOFS and the testbed runs

# Year 3 In Review: USWC Integration

## Challenge: Integration of real-time simulations

- Primarily leveraging remotely served ongoing forecast products
- A single case study dataset has been added to the COMT TDS catalog: full aggregation available at [http://comt.sura.org/thredds/dodsC/comt2/usw\\_integration/Exp16/roms.xml.html](http://comt.sura.org/thredds/dodsC/comt2/usw_integration/Exp16/roms.xml.html)

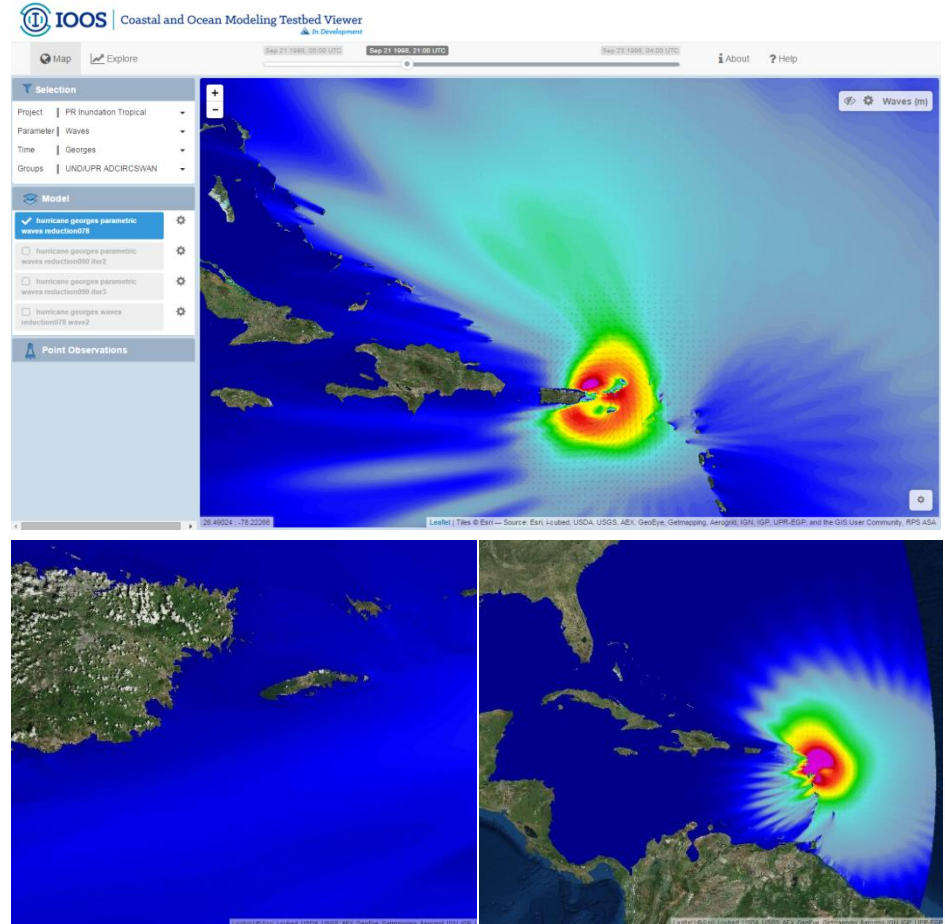
## Outstanding Requests:

- Add time-series of public buoys to compare with model
- Mechanism for analyzing past month of model performance

# Year 3 In Review: PR Inundation

## Challenge: Many, massive, model runs

- Pushing boundaries of fast & efficient integration of new model runs
- Datasets with millions of nodes too slow to draw in Model Viewer
- Leveraged a python-based tile cache for key model results



# Year 3 In Review: PR Inundation

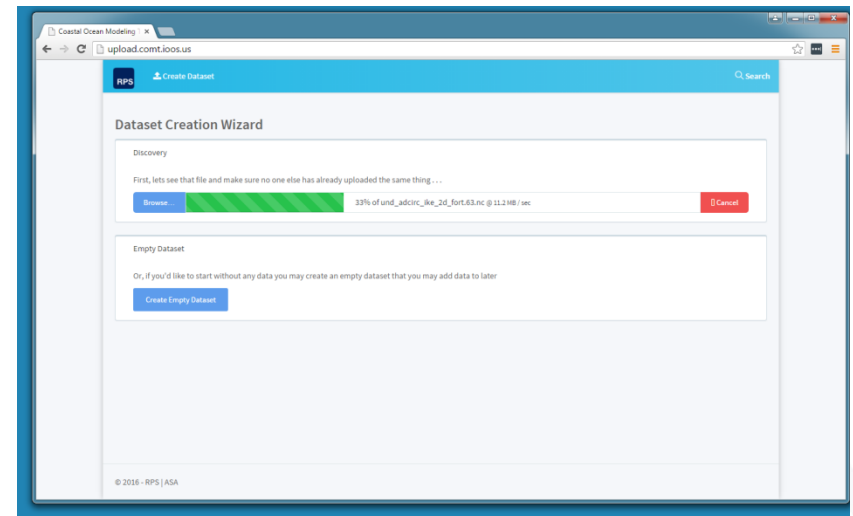
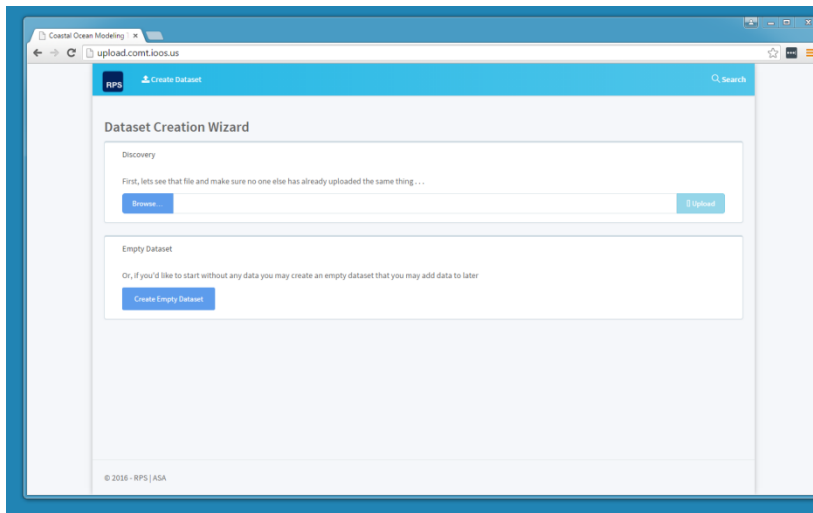
- Addition of Georges, Irene, and Sandy ADCIRC runs to the TDS Catalog
- Addition of Georges observation data to the TDS catalog
- Support of NOAA Testbed Conference abstract and presentation
- Continued coordination with PR team to work through SLOSH basin issues

## **Outstanding Requests:**

- Integration of observation data
- Enable model-observation comparisons
- Continued coordination with NHC on SLOSH integration
- Difference calculation

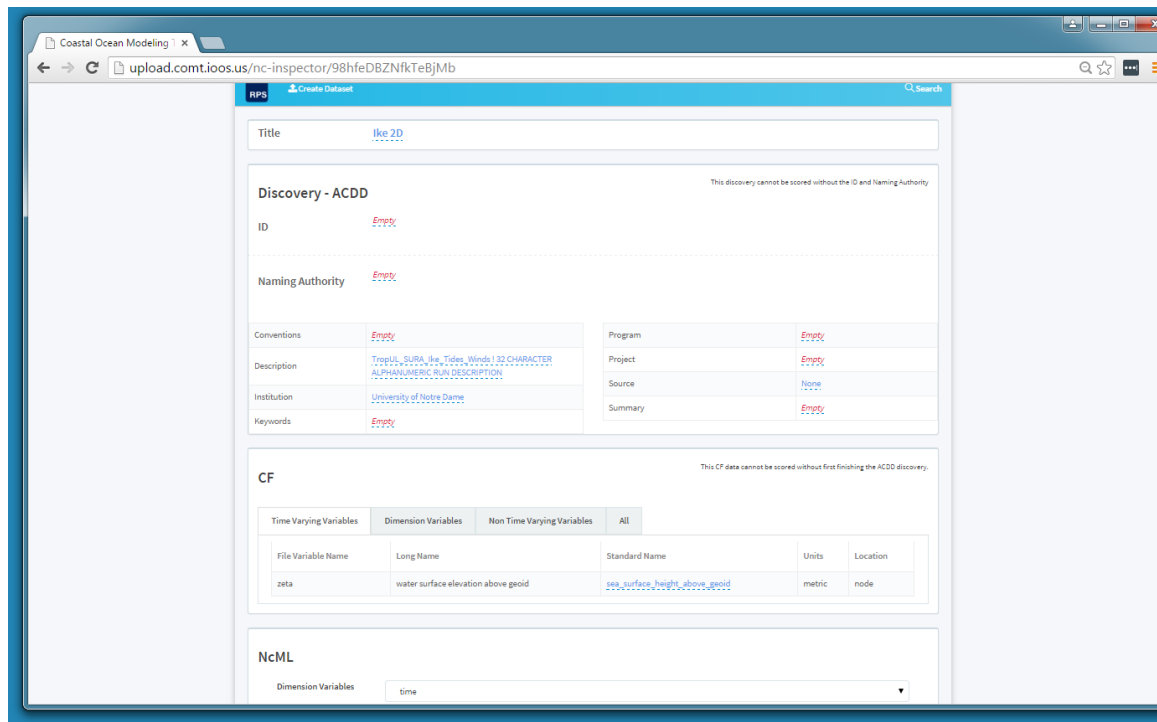
# Data Upload Tool

Upload View/Creation Wizard allows local files to be uploaded  
*(checks file hash before upload to see if this file has been processed)*



# Data Upload Tool

Once uploaded, metadata is used to fill in initial dataset profile  
(standards such as ACDD and CF are initial targets)



The screenshot shows a web browser window with the URL `upload.comt.ioos.us/nc-inspector/98hfeDBZNfkTeBjMb`. The page title is "RPS Create Dataset". The main content area displays a dataset profile for "Ike 2D".

**Discovery - ACDD**  
This discovery cannot be scored without the ID and Naming Authority.

**ID** Empty

**Naming Authority** Empty

**Conventions** Empty

**Description** [TropM\\_SURA\\_Ike\\_Tides\\_Winds132 CHARACTER ALPHANUMERIC\\_RUN DESCRIPTION](#)

**Institution** [University of Notre Dame](#)

**Keywords** Empty

**Program** Empty

**Project** Empty

**Source** None

**Summary** Empty

**CF**  
This CF data cannot be scored without first finishing the ACDD discovery.

Time Varying Variables | Dimension Variables | Non Time Varying Variables | All

| File Variable Name | Long Name                           | Standard Name                                  | Units  | Location |
|--------------------|-------------------------------------|--|--------|----------|
| zeta               | water surface elevation above geoid | <a href="#">sea_surface_height_above_geoid</a> | metric | node     |

**NcML**

Dimension Variables: [time](#)



# Data Upload Tool

Additional conventions/standards such as UGRID are presented

The screenshot shows a web browser window titled "Coastal Ocean Modeling" with the URL "upload.comt.ioos.us/nc-inspector/98hfeDBZNfkTeBjMb". The main content is a table of variables with the following data:

|         |   |                                |                |
|---------|---|--------------------------------|----------------|
| ibtype  | type of normal flow (discharge) boundary  | Empty                          | nondimensional |
| ibtypee | elevation boundary type   | Empty                          | nondimensional |
| nbdv    | node numbers on each elevation specified boundary segment   | Empty                          | nondimensional |
| nbvv    | node numbers on normal flow boundary segment  | Empty                          | nondimensional |
| neta    | total number of elevation specified boundary nodes  | Empty                          | nondimensional |
| mdli    | number of nodes in each elevation specified boundary segment  | Empty                          | nondimensional |
| mvcl    | total number of normal flow specified boundary nodes including both the front and back nodes on internal barrier boundaries | Empty                          | nondimensional |
| mvll    | number of nodes in each normal flow specified boundary segment  | Empty                          | nondimensional |
| x       | longitude   | longitude                      | degrees_east   |
| y       | latitude  | latitude                       | degrees_north  |
| zeta    | water surface elevation above geoid   | sea surface height above geoid | metric node    |

Below the table, there are two configuration sections:

- NcML**: Dimension Variables dropdown menu set to "time".
- UGRID**: Node Coordinates dropdown menu set to "x" and "y"; Face Node Connectivity dropdown menu set to "element".

# Data Upload Tool

When required metadata is provided (e.g., *id* and *naming\_authority*) OPeNDAP endpoint is dynamically created using provided metadata and IOOS compliance checker is run using DAP

**IOOS | Integrated Ocean Observing System**

**OPeNDAP Dataset Access Form**

Action: [Get ASCII](#) | [Get Binary](#) | [Show Help](#)

Data URL:

**Global Attributes:**

```
nbcr: 8
NCID: 4.4.0
id: example_ike2d
naming_authority: noaa.ioos.comt
Conventions: OPeNDAP
summary: Name
keywords: GOCIC
group: tropical_inundation
```

**Variables:**

- depth:** Array of 64 bit Reals [node = 0.417641]  
node:  
long\_name: distance below geoid  
standard\_name: depth below geoid  
coordinates: time, x  
location: node  
mesh: mesh\_topology
- element:** Array of 32 bit Integers [nele = 0.826865][nvertex = 0.2]  
nele: 1  
long\_name: element  
standard\_name: face\_node\_connectivity  
start\_index: 1  
units: nondimensional

**Coastal Ocean Modeling**

**upload.comt.ioos.us/nc-inspector/98hfeDBZNR1e8jMb**

**Create Dataset**

Title:

Discovery - ACDD:  (This discovery scored 45 out of 100 points for completeness)

ID:

Naming Authority:

Comments:  Program:  Project:  Source:  Summary:

Description:  Institution:  Keywords:

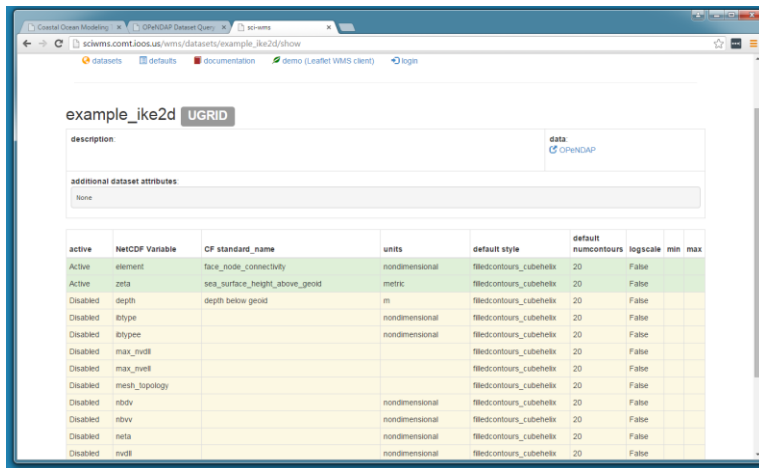
CF:  (This CF score set covered 100 out of 100 points for completeness)

| Time Varying Variables | Dimension Variables                 | Non Time Varying Variables     | All    |          |
|------------------------|-------------------------------------|--------------------------------|--------|----------|
| File/Variable Name     | Long Name                           | Standard Name                  | Units  | Location |
| data                   | water surface elevation above geoid | sea_surface_height_above_geoid | metric | node     |

compliance checker scores

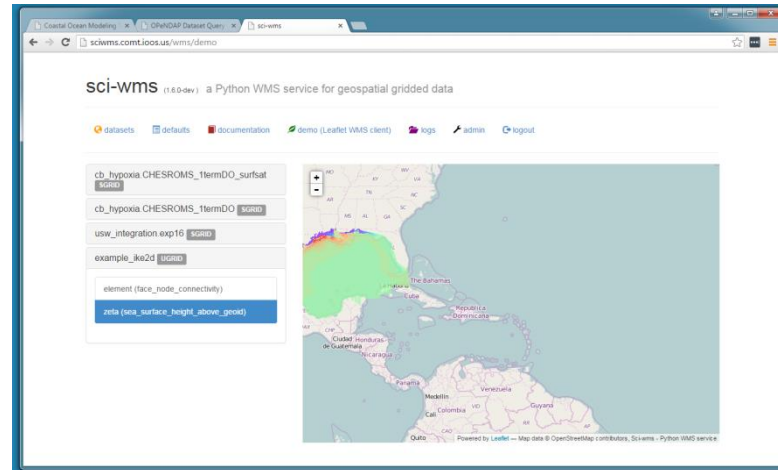
# Data Upload Tool

If sufficient metadata is provided (eg. CF + UGRID) a **sci-wms** dataset is created automatically allowing visual access to the data via WMS



The screenshot shows the 'example\_ike2d' dataset configuration page in the sci-wms interface. The page includes a description field, a 'data' dropdown set to 'CF UGRID', and a table of dataset attributes.

| active   | NetCDF Variable | CF standard_name               | units          | default style             | default numcontours | logscale | min | max |
|----------|-----------------|--------------------------------|----------------|---------------------------|---------------------|----------|-----|-----|
| Active   | element         | face_node_connectivity         | nondimensional | filled:contours_cubehelix | 20                  | False    |     |     |
| Active   | zeta            | sea_surface_height_above_geoid | metric         | filled:contours_cubehelix | 20                  | False    |     |     |
| Disabled | depth           | depth below geoid              | m              | filled:contours_cubehelix | 20                  | False    |     |     |
| Disabled | btype           |                                | nondimensional | filled:contours_cubehelix | 20                  | False    |     |     |
| Disabled | btypee          |                                | nondimensional | filled:contours_cubehelix | 20                  | False    |     |     |
| Disabled | max_rvdl        |                                |                | filled:contours_cubehelix | 20                  | False    |     |     |
| Disabled | max_rvdl        |                                |                | filled:contours_cubehelix | 20                  | False    |     |     |
| Disabled | mesh_topology   |                                |                | filled:contours_cubehelix | 20                  | False    |     |     |
| Disabled | rbdv            |                                | nondimensional | filled:contours_cubehelix | 20                  | False    |     |     |
| Disabled | rbdv            |                                | nondimensional | filled:contours_cubehelix | 20                  | False    |     |     |
| Disabled | net             |                                | nondimensional | filled:contours_cubehelix | 20                  | False    |     |     |
| Disabled | rvdl            |                                | nondimensional | filled:contours_cubehelix | 20                  | False    |     |     |



The screenshot shows the 'sci-wms' demo page, which is a Python WMS service for geospatial gridded data. The page includes a list of datasets and a map of the Caribbean region. The 'example\_ike2d' dataset is selected, and the 'zeta (sea\_surface\_height\_above\_geoid)' variable is highlighted in the legend.

sci-wms (1.6.0-dev) a Python WMS service for geospatial gridded data

- datasets
- defaults
- documentation
- demo (Leaflet WMS client)
- logs
- admin
- logout

cb\_hypoxia CHESROMS\_1termDO\_surfbat [toggle]

cb\_hypoxia CHESROMS\_1termDO [toggle]

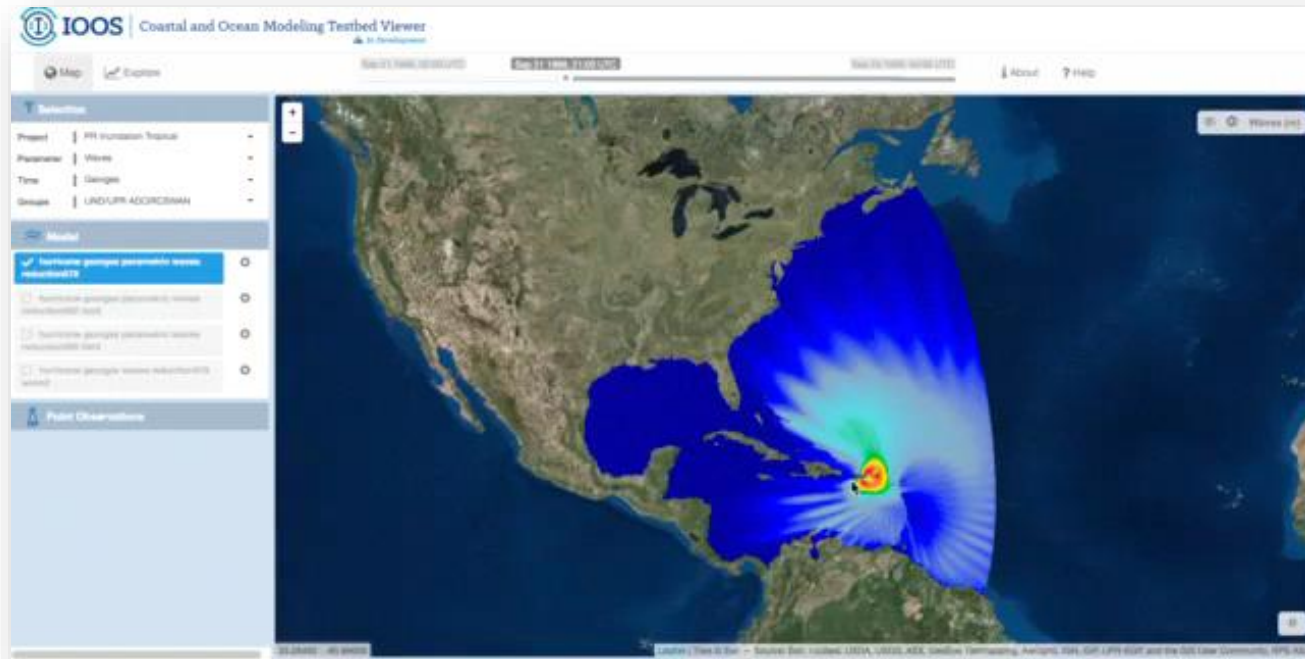
usw\_integration.exp16 [toggle]

example\_ike2d [toggle]

element (face\_node\_connectivity)

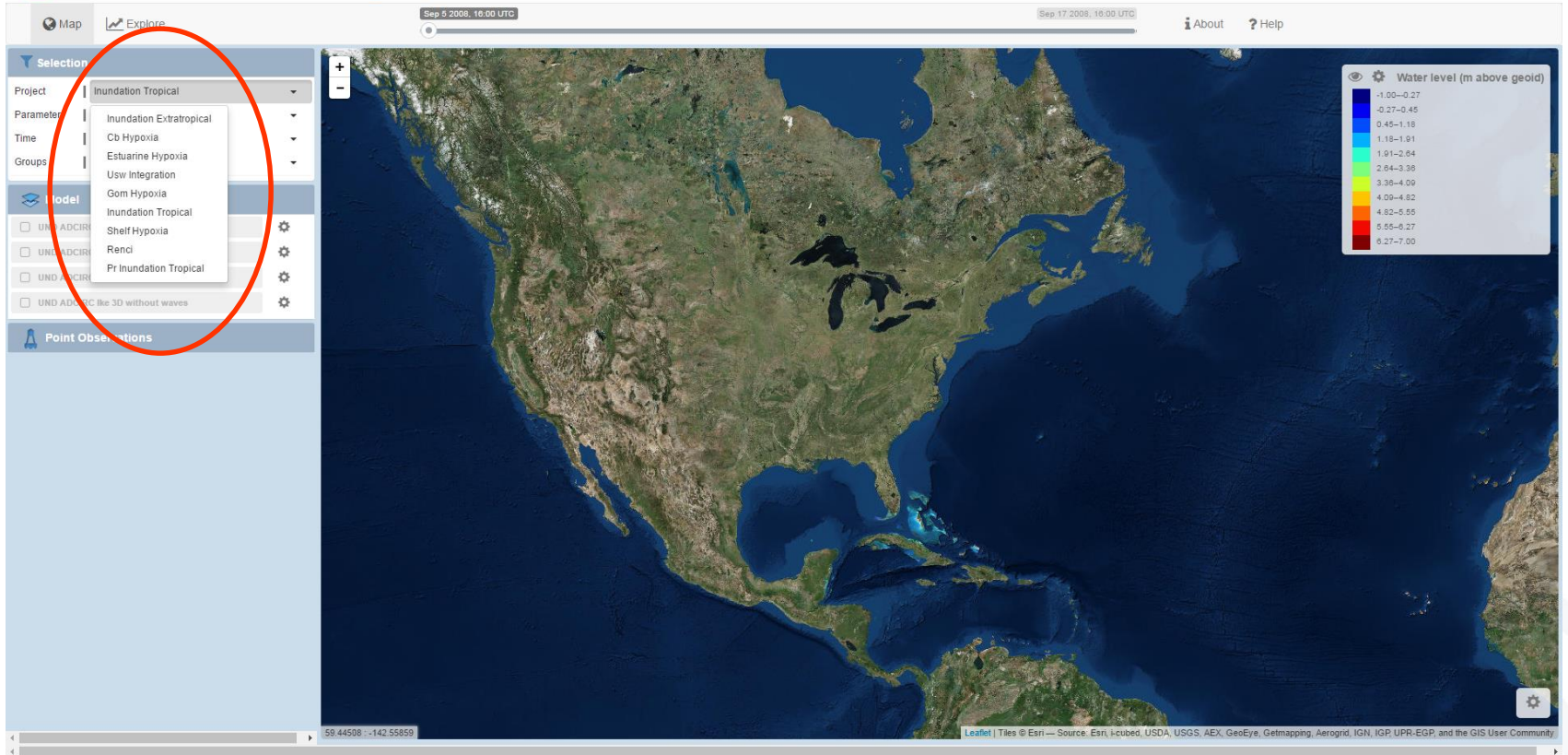
zeta (sea\_surface\_height\_above\_geoid)

# Model Viewer

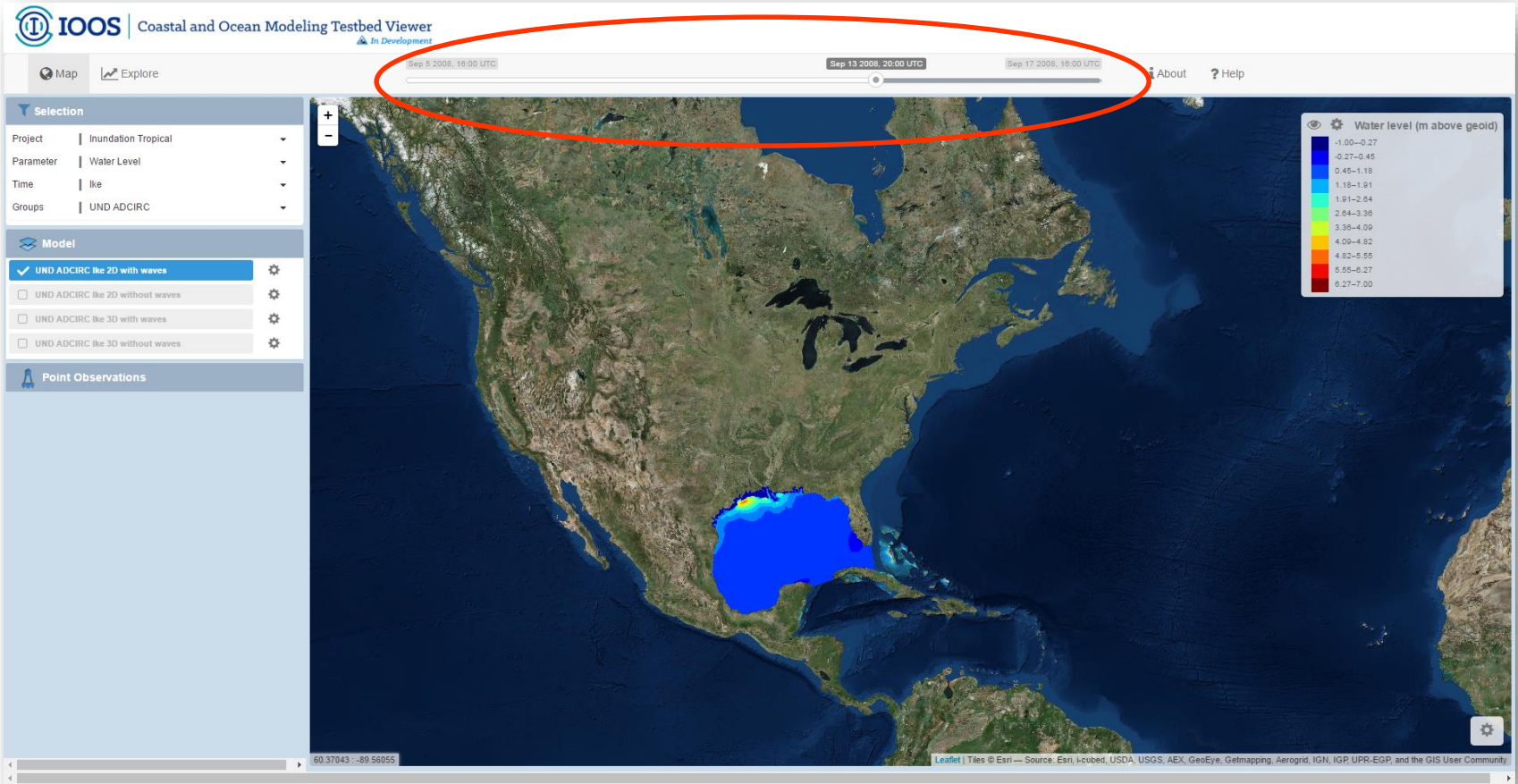


- Web-based map view enabled rapid exploration of model output from large scale to local
- Inter-comparison of models regardless of grid or domain
- Time-series comparison across models available for any point within domain via OGC WMS GetFeatureInfo requests

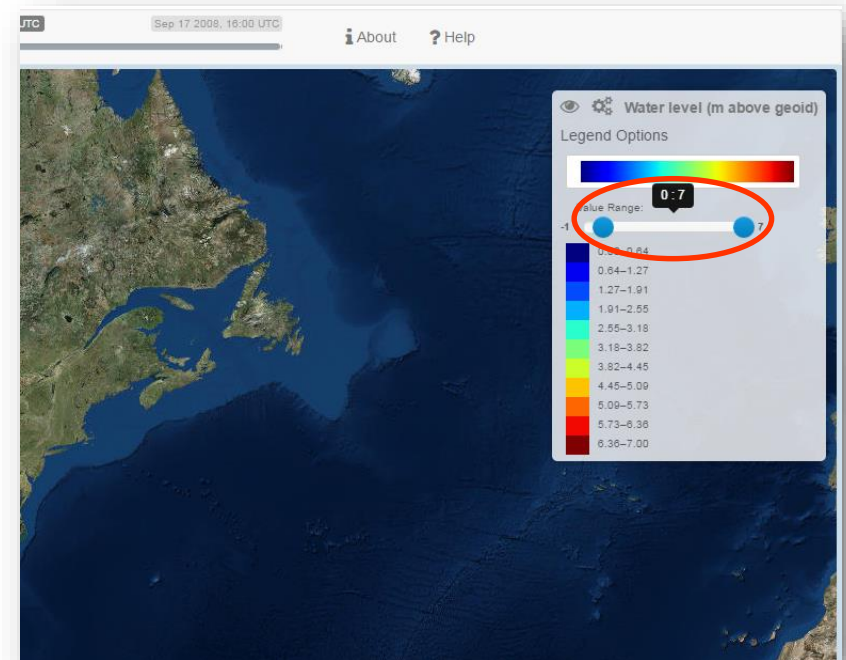
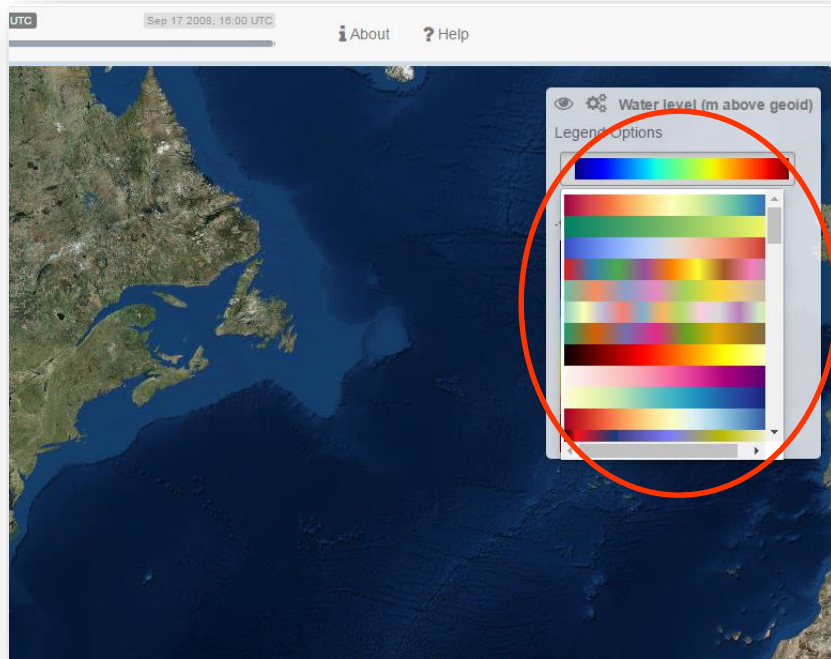
# Model Viewer



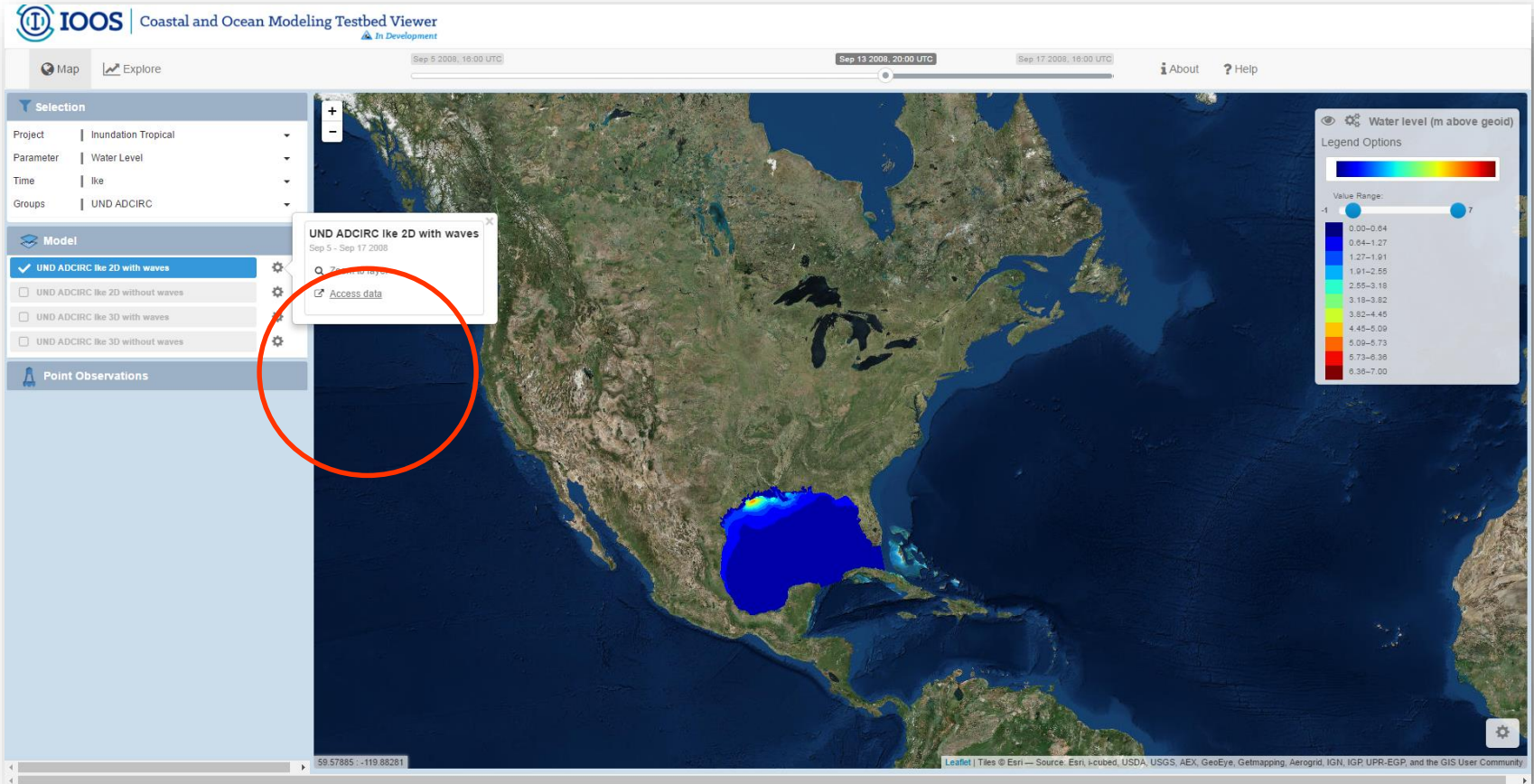
# Model Viewer



# Model Viewer

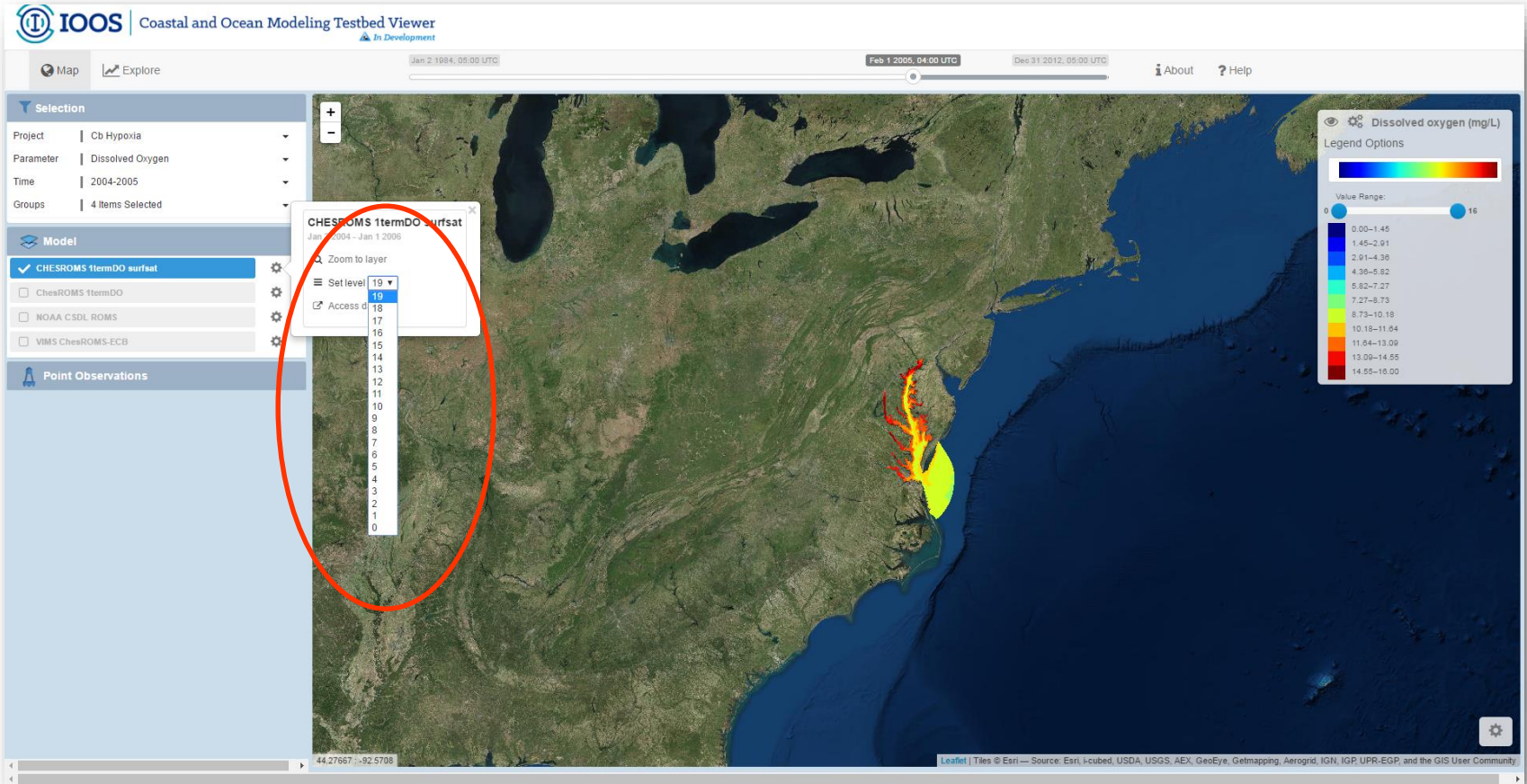


# Model Viewer

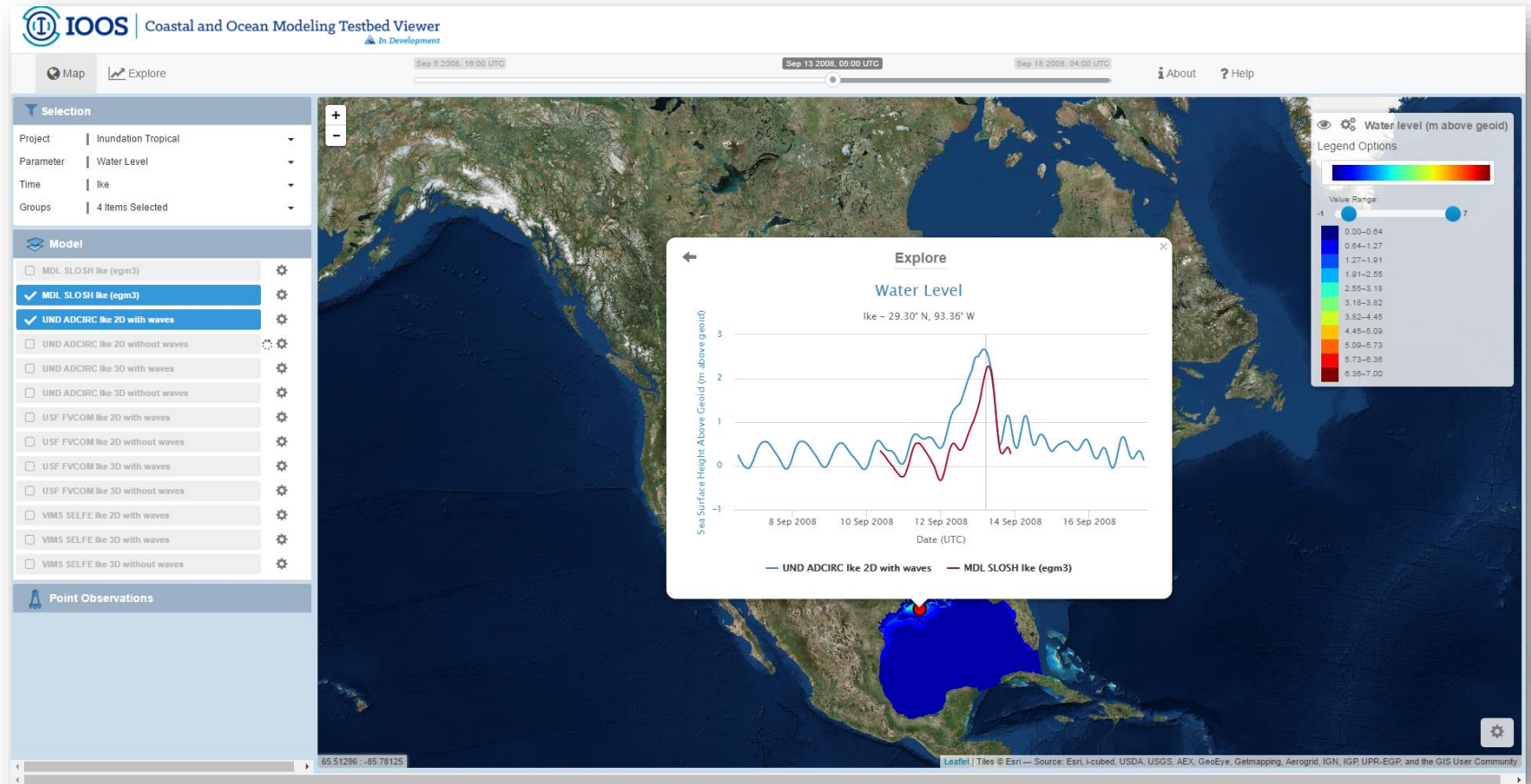




# Model Viewer



# Model Viewer



# Model Viewer Updates

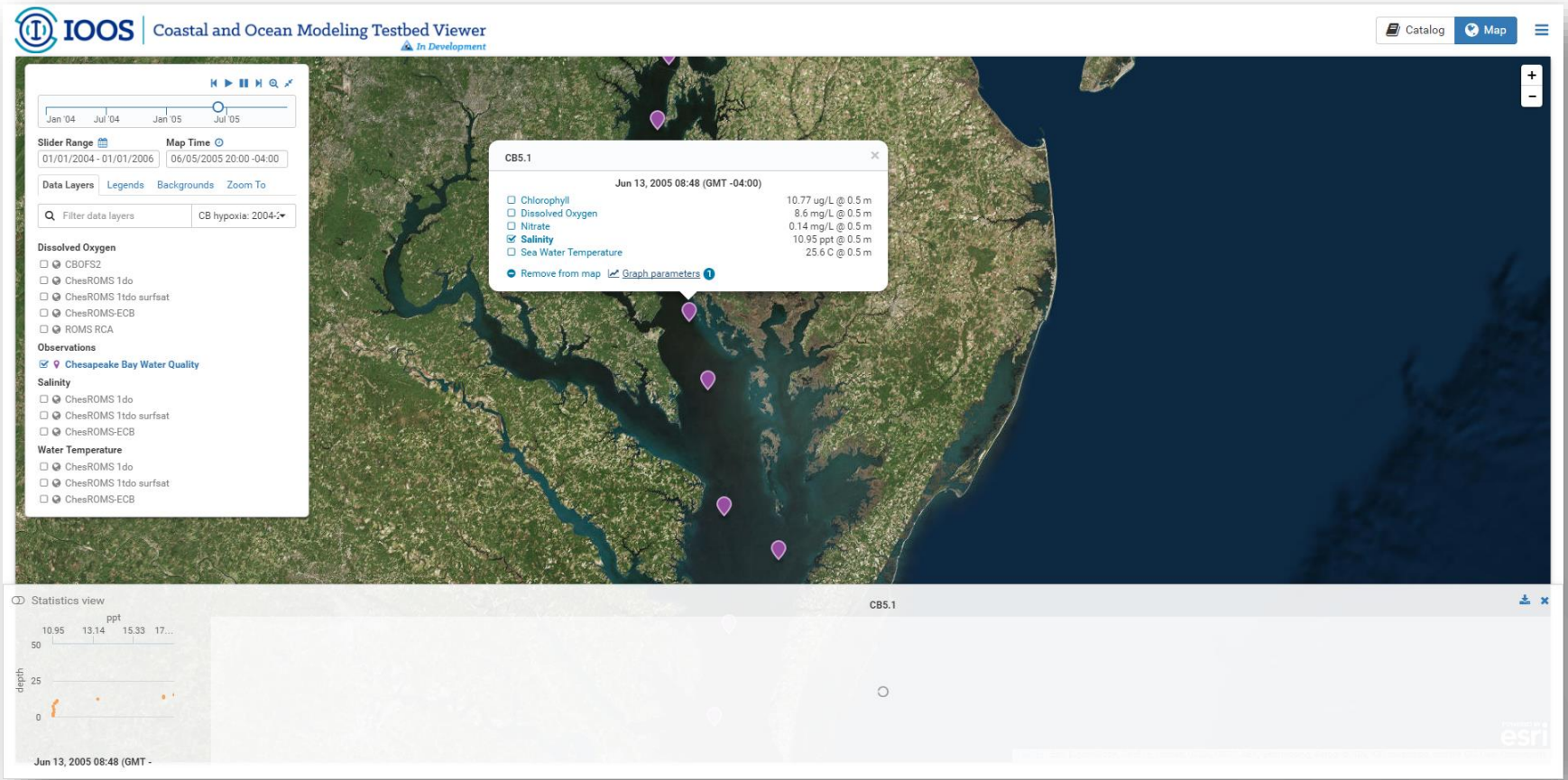
## Simplified Project Filters & Addition of Search

The screenshot shows the Model Viewer interface with a search filter set to "Inundation Tropical". The interface includes a timeline slider for the period 09/01 to 09/29, a "Slider Range" of 09/01/2008 - 10/01/2008, and a "Map Time" of 09/12/2008 20:00 -04:00. The "Data Layers" menu is open, showing a search bar with "Filter data layers" and a dropdown menu with "Inundation Tropical". The "Observations" section is checked for "CO-OPS Stations". The "Water Level" section is expanded, showing a list of data layers including ADIRC 2D/3D, FVCOM 2D/3D, and SLOSH (UND) egl3/egl8. The "Wave Height" section is also expanded, showing a list of data layers.

The screenshot shows the Model Viewer interface with a search filter set to "CB hypoxia: 2004-2005". The interface includes a timeline slider for the period Jan '04 to Jul '05, a "Slider Range" of 01/01/2004 - 01/01/2006, and a "Map Time" of 06/05/2005 20:00 -04:00. The "Data Layers" menu is open, showing a search bar with "Filter data layers" and a dropdown menu with "CB hypoxia: 2004-2005". The "Dissolved Oxygen" section is expanded, showing a list of data layers including CBOFS2, ChesROMS 1do, ChesROMS 1tdo surfsat, ChesROMS-ECB, and ROMS RCA. The "Observations" section is checked for "Chesapeake Bay Water Quality". The "Salinity" section is expanded, showing a list of data layers including ChesROMS 1do, ChesROMS 1tdo surfsat, and ChesROMS-ECB. The "Water Temperature" section is also expanded, showing a list of data layers including ChesROMS 1do, ChesROMS 1tdo surfsat, and ChesROMS-ECB.

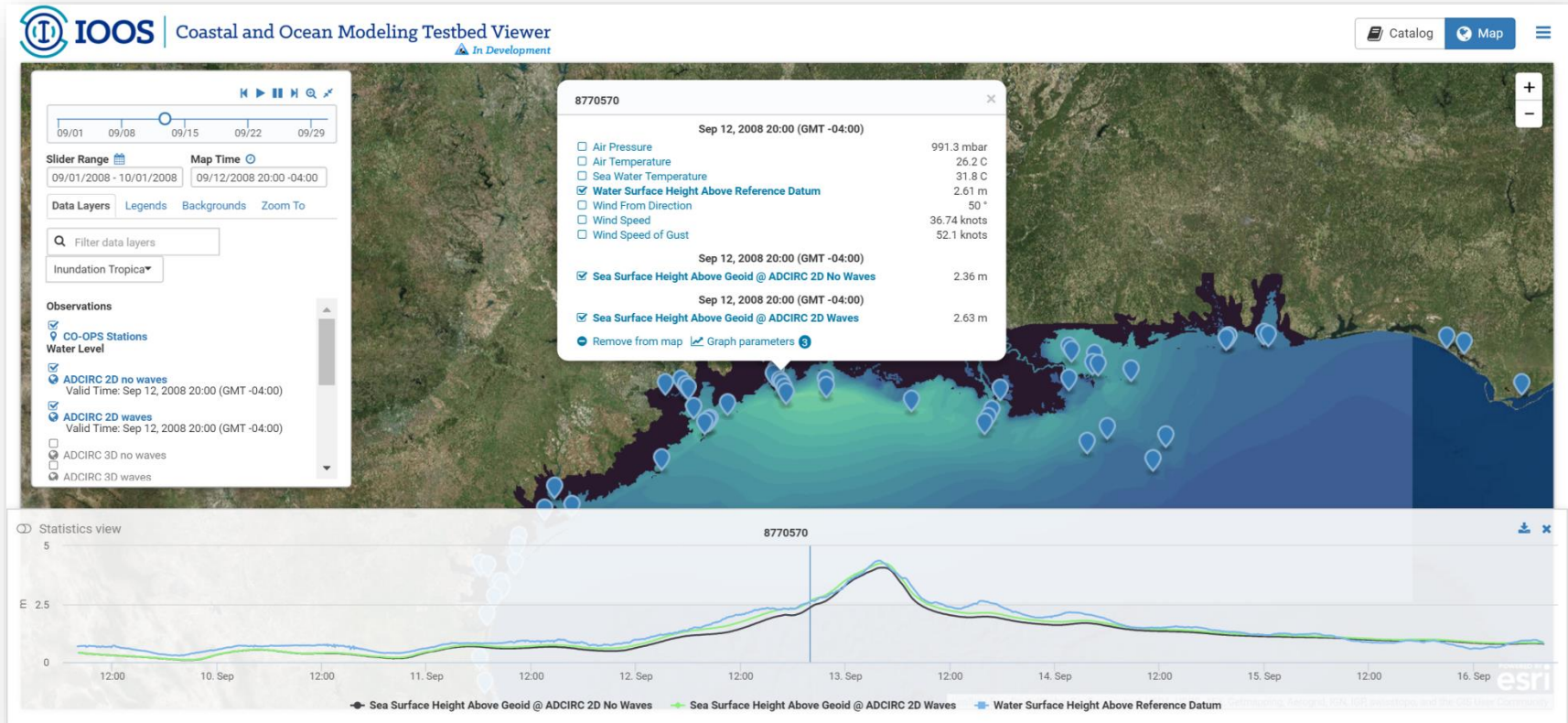
# Model Viewer Updates

## Addition of Observations



# Model Viewer Updates

## Addition of Observations



# Model Viewer Updates

## Web-based Catalog

The screenshot displays the IOOS Coastal and Ocean Modeling Testbed Viewer interface. At the top left is the IOOS logo and the text "Coastal and Ocean Modeling Testbed Viewer" with a sub-label "In Development". On the top right, there are buttons for "Catalog" and "Map", and a hamburger menu icon. A search bar labeled "Search catalog" is positioned below the header. On the left side, a "Category" dropdown menu is open, showing options: "All", "Observations", "Dissolved Oxygen", and "Salinity". The main content area shows a list of model entries. The first entry is "ADCIRC 2D no waves" with a map thumbnail, and its details are: title: ADCIRC 2D no waves, institution: UND, Conventions: UGRID, group: pr\_inundation, model: ADCIRC. A "Find on map" link is next to it. The second entry is "ADCIRC parametric wave reduction 078 wave2" with a map thumbnail, and its details are: title: ADCIRC parametric wave reduction 078 wave2, institution: UND, Conventions: UGRID, group: pr\_inundation, model: ADCIRC, and uuid: 7712b49a-f48d-41e3-aba3-15b5213144c8. A third entry is partially visible at the bottom, titled "ADCIRC parametric wave reduction 078 wave2". On the right side of the catalog, it says "Showing 1 to 10 of 25 entries".

**IOOS** | Coastal and Ocean Modeling Testbed Viewer Catalog Map

*In Development*

Search catalog

Showing 1 to 10 of 25 entries

**Category**

- All
- Observations
- Dissolved Oxygen
- Salinity

**ADCIRC 2D no waves** [Find on map](#)

**title:**ADCIRC 2D no waves  
**institution:**UND  
**Conventions:**UGRID  
**group:**pr\_inundation  
**model:**ADCIRC

**ADCIRC parametric wave reduction 078 wave2**

**title:**ADCIRC parametric wave reduction 078 wave2  
**institution:**UND  
**Conventions:**UGRID  
**group:**pr\_inundation  
**model:**ADCIRC  
**uuid:**7712b49a-f48d-41e3-aba3-15b5213144c8

**ADCIRC parametric wave reduction 078 wave2**

# Y4 Draft Workplan

## Landing Page/Catalog

- Intuitive & self-explanatory
- Discoverability & accessibility

The image displays a collage of screenshots from the IOOS (Integrated Ocean Observing System) website and its various data viewers. At the top, the main landing page is shown, featuring a navigation bar with 'IOOS', 'DATA', 'VIEWERS', 'DACS', 'REGIONAL ASSOCIATIONS', and 'ABOUT'. Below the navigation bar, there are several interactive tiles: 'EDS Model Viewer', 'IOOS by the Numbers', 'Floating Gliders', 'Data Discovery', 'Coastal and Ocean Modeling Testbed Viewer', 'Environmental Sensor Map', 'Marine Biotechnology (MBO)', and 'Regional Associations'. Below the landing page, there are three main viewer screenshots. The first is the 'IOOS Glider DAC' page, which includes a description of the Glider Data Acquisition Center and a map of the 'Underwater Glider Network Map'. The second is the 'Coastal and Ocean Modeling Testbed Viewer', which shows a search catalog with a search bar and a list of data entries, including 'ADCIRC 2D no waves', 'ADCIRC parametric wave reduction 078 wave2', and 'ADCIRC parametric waves full tide oarrest'. The third is a map viewer showing a satellite-style map of the United States and surrounding oceans, with a blue area indicating a specific region of interest. The IOOS logo and tagline 'EYES ON THE OCEAN' are visible in the bottom right corner of the collage.

# Y4 Draft Workplan

## sciWMS Enhancements

- Improved color schemes/scales

## Modeling Team Support

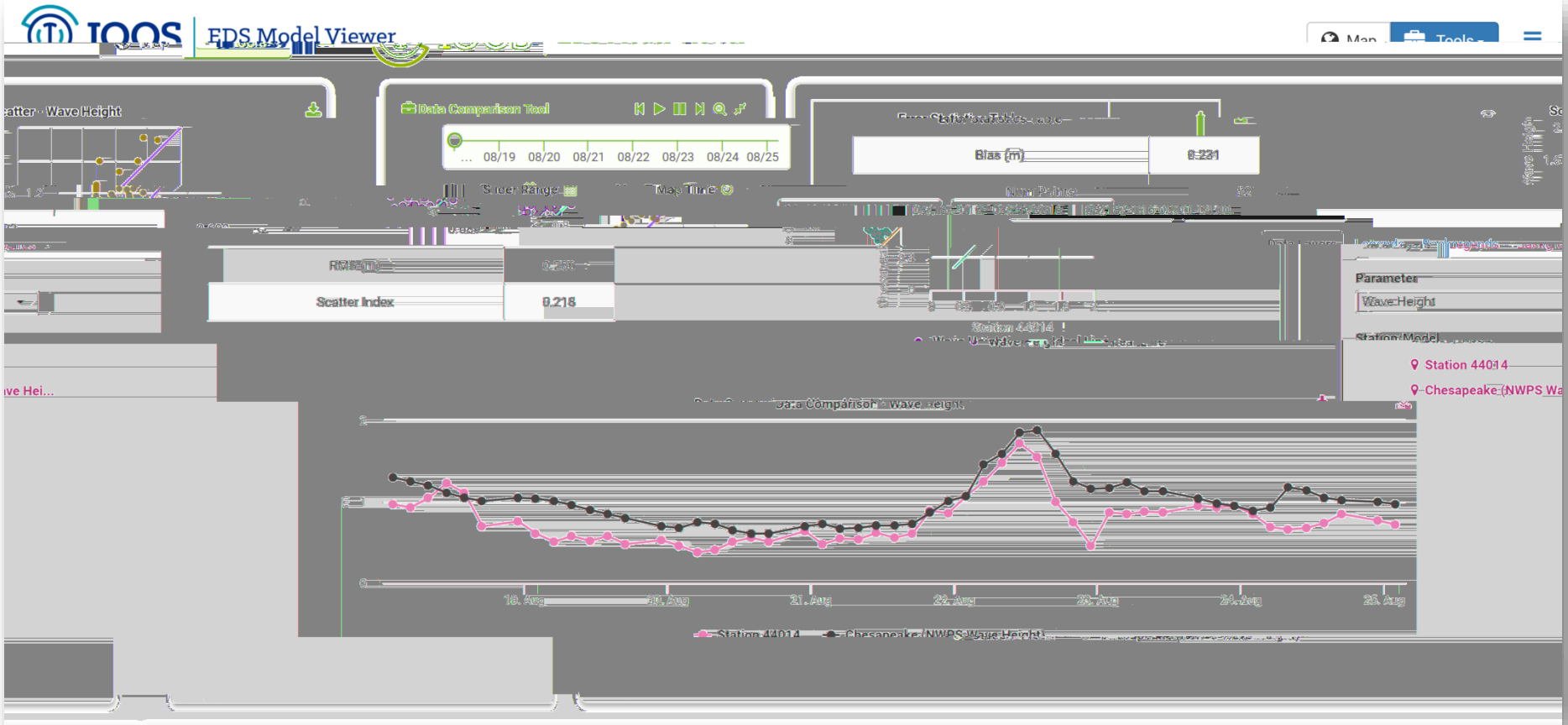
- Identify key datasets for Y4
- Launch data upload tool and provide training
- Hands on facilitation of data ingest
- Maintenance and oversight of TDS catalog
- Finalize data management plan
- Approach/Tools for deriving new parameters (e.g. BBL, Hypoxic Volume, Difference)

## Model Viewer

- Continued integration of observation data
- Enhanced data comparison tools
- Animations
- Landing page/catalog view
- Balance between sciWMS & tile services
- Additional 3D visualization tools



# Y4 Draft Workplan



# Questions

***Enables decision making  
Fosters Advances in Science and Technology***

<https://ioos.noaa.gov>

 <https://www.facebook.com/usioosgov>

 @usioosgov

