IOOS IOOC

The Health of the US Coastal Observing System

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ESA coastal altimetry (2017) workshop participants

Assigned Questions

WHAT

- What is the status of the current system?
- What elements are there?

HOW

- How robust is in terms of funding and technology?
- Where might it be expanded and what might be gained?

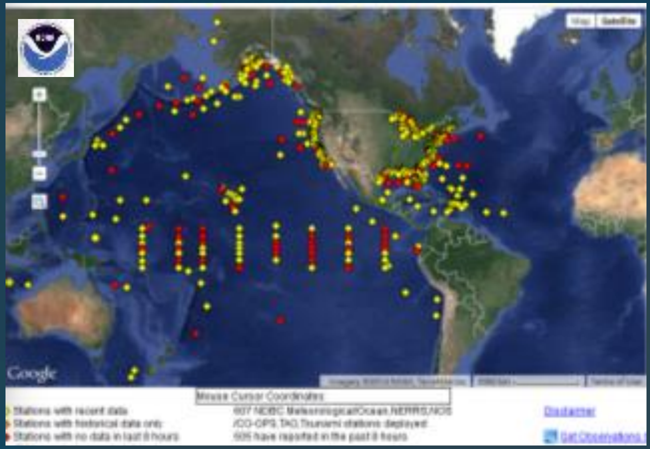
WHY

- What are the gaps?
- What are some unobserved key weather/climate processes that could be addressed with an expanded observing system, and what would we need for this?

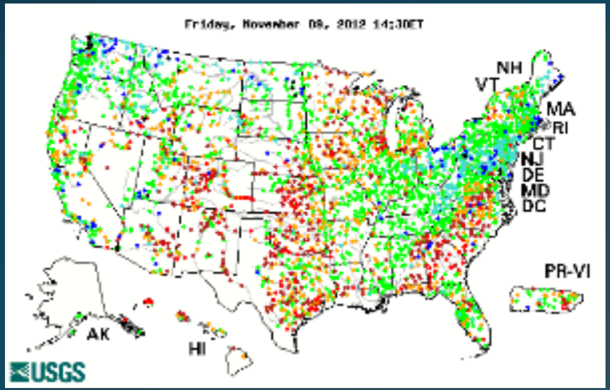
IOOS - National Backbone has consistency in coverage/data/access

Satellites

Buoys, Water Level Gauges, Coastal and Estuary stations



PORTS®



Stream Gauges

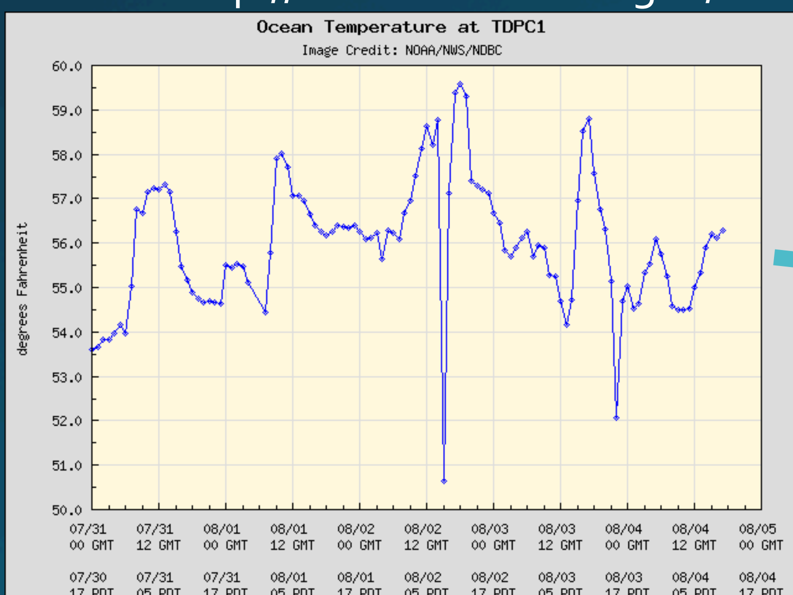
Water Quality e.g. EPA Beaches

OOI Research Infrastructure

E.g. NOAA NDBC buoys and stations

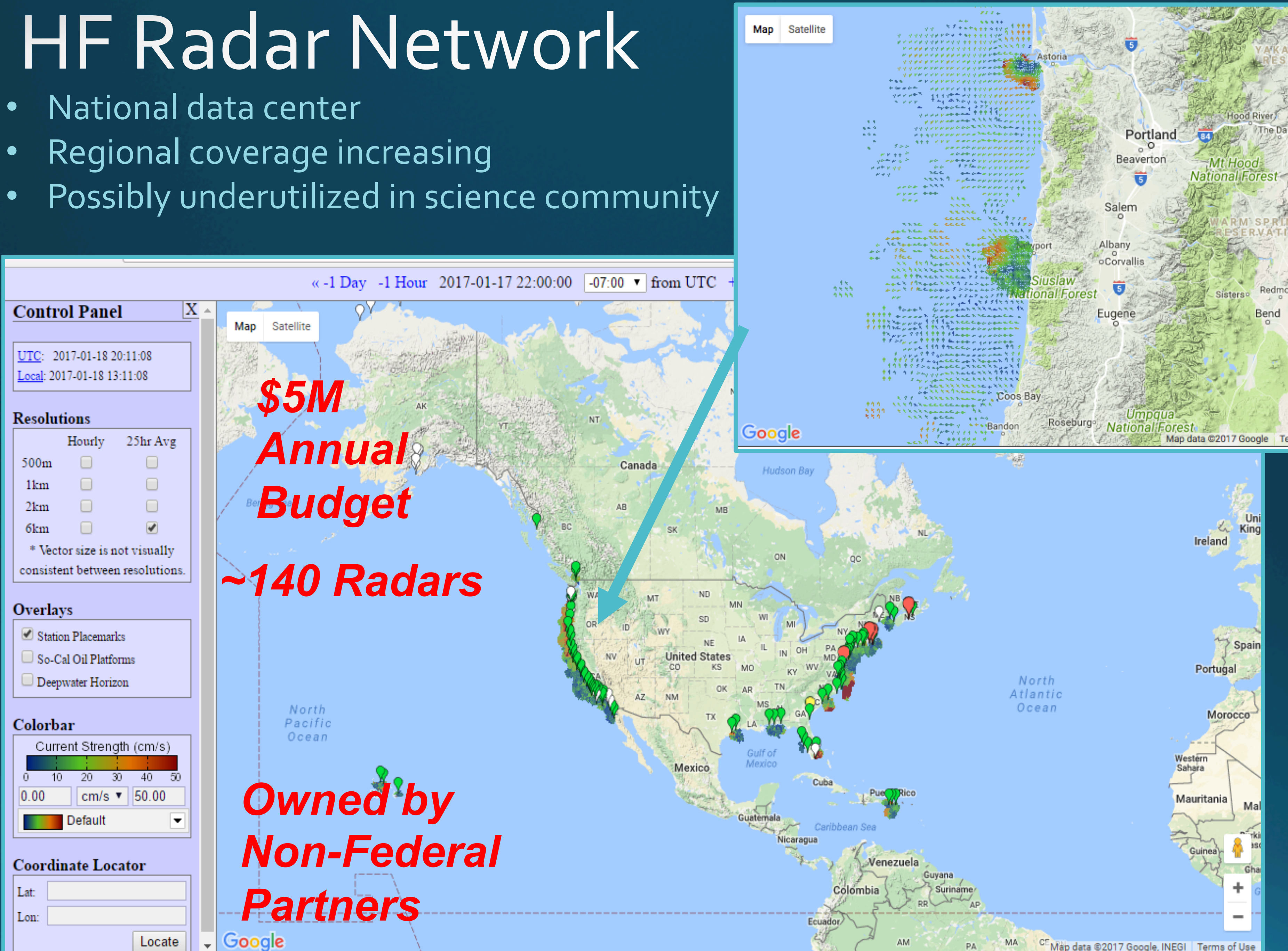
- Coastal weather buoys (106) [SST, wave height & period] + [wind speed, direction, pressure, airT]
- Land-based C-Man (46) [wind speed, direction, pressure, airT]
- Possibly underfunded – concerns about data gaps – rely on coastguard activities for maintenance and rescue

http://www.ndbc.noaa.gov/



HF Radar Network

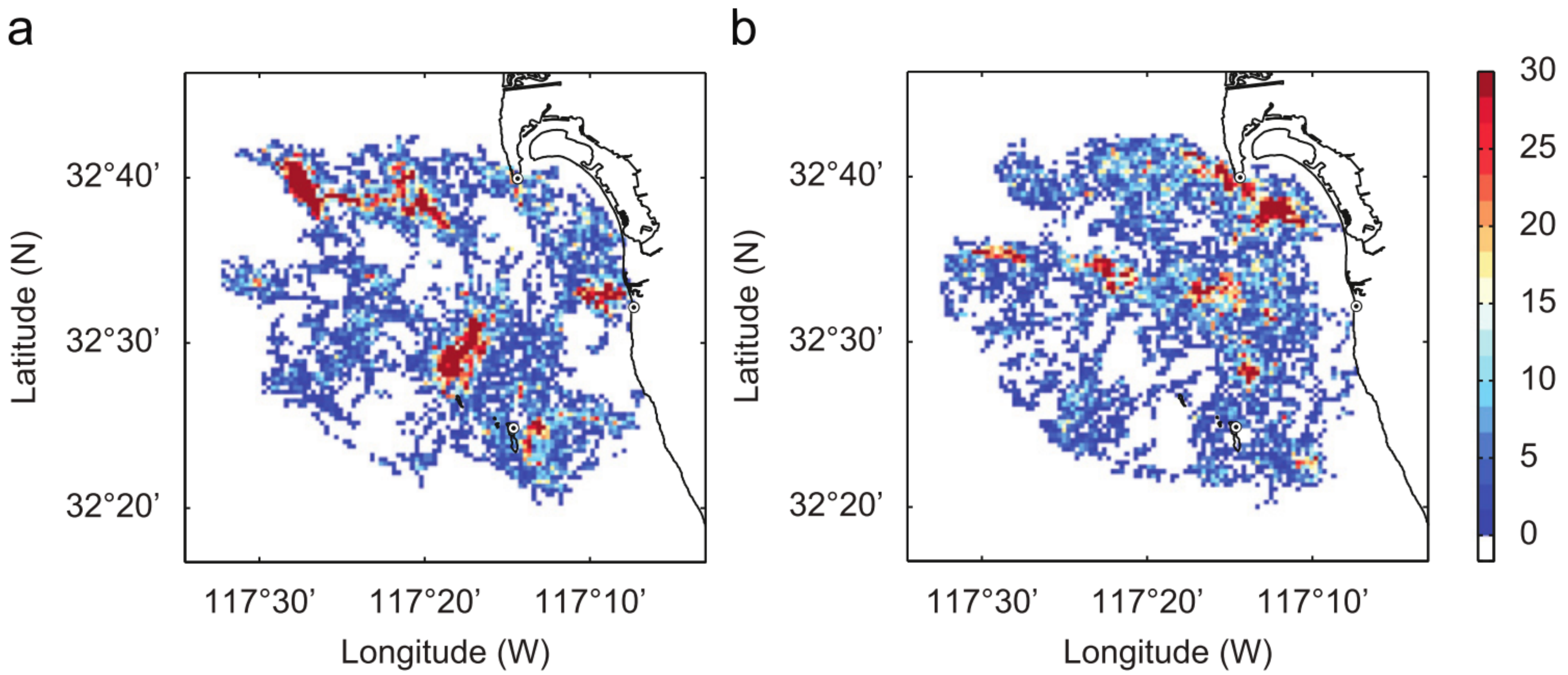
- National data center
- Regional coverage increasing
- Possibly underutilized in science community



HF Radar used to detect submesoscale eddies that can be linked to flow and topography

Anti-cyclonic eddy count

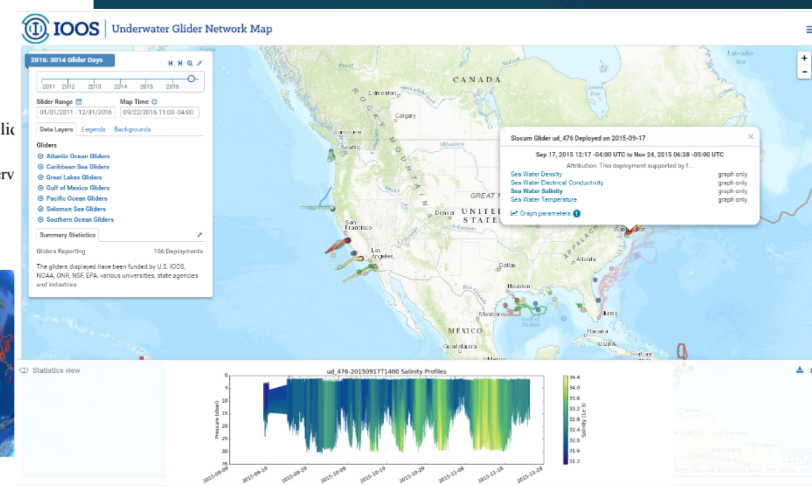
Cyclonic eddy count



Submesoscale eddies persisting 1-7 days, and translating at 4-15 cm/sec. Spatial heterogeneity as a function of vorticity.
S-Y Kim 2011 Continental Shelf Res.

IOOS: Glider Program

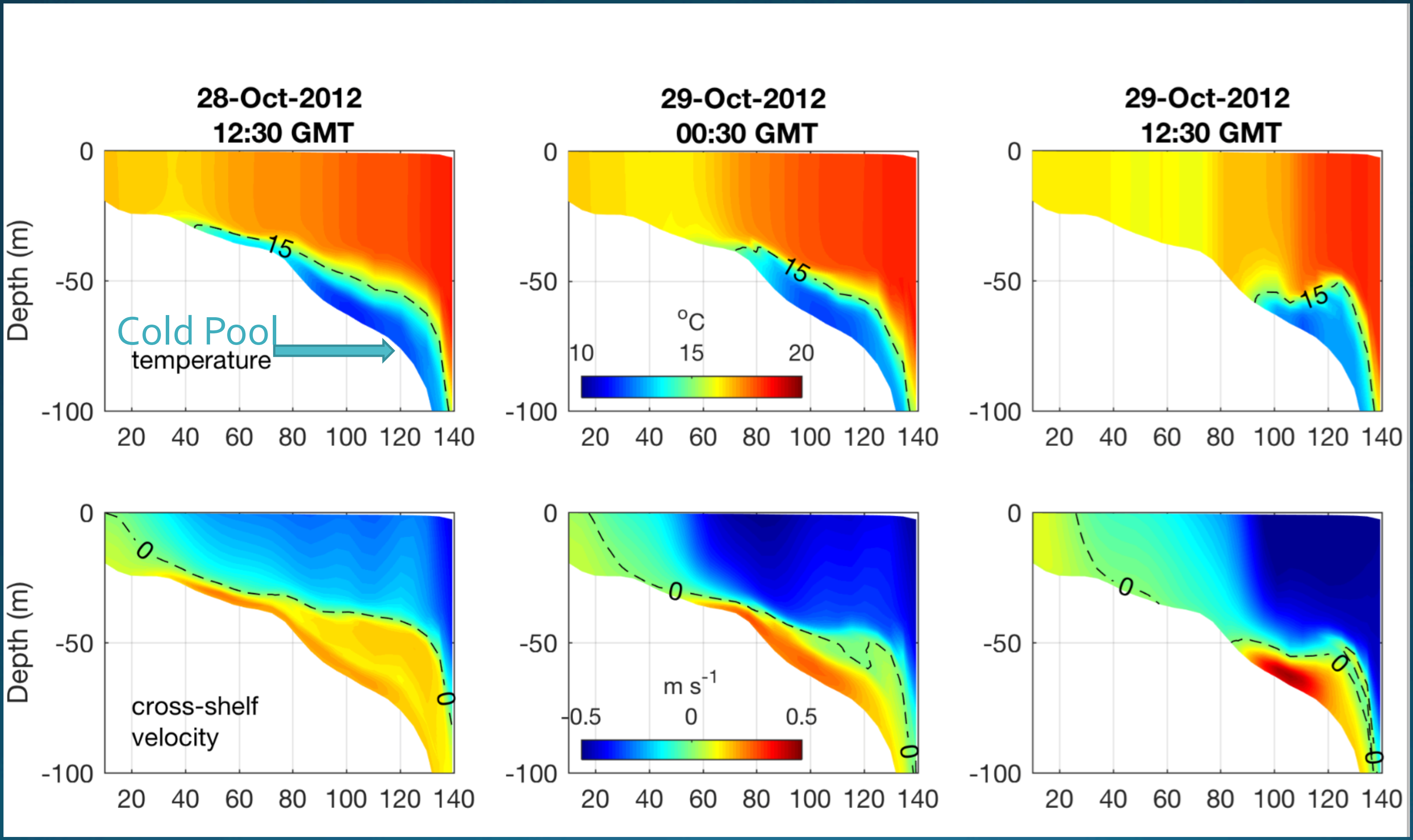
- Regional Associations provide glider observations and presence
- Certification program – standardizing best practices
- Gliders run very differently regionally –routinely, sustained, event driven



Glider DAC

- National standards to ease data exchange from regional operators
- Real-time distribution to partners (GTS)
- Archiving (NCEI)
- QC processing

Mid Atlantic Bight Gliders used to determine how subsurface stratification, missing in models, reduce hurricane intensity (Irene) or … not (Sandy).



Miles et al, JGR Oceans 2017

Remote Sensing is evolving to better represent coastal regions – Ocean Color

- Geostationary platforms - resolve coastal variability
- Increased spectral resolution -functional groups, remove bottom contamination, total suspended matter
- Atmospheric corrections continue to be a challenge
- Gaps in number of in-water measurements needed to validate and refine algorithms?

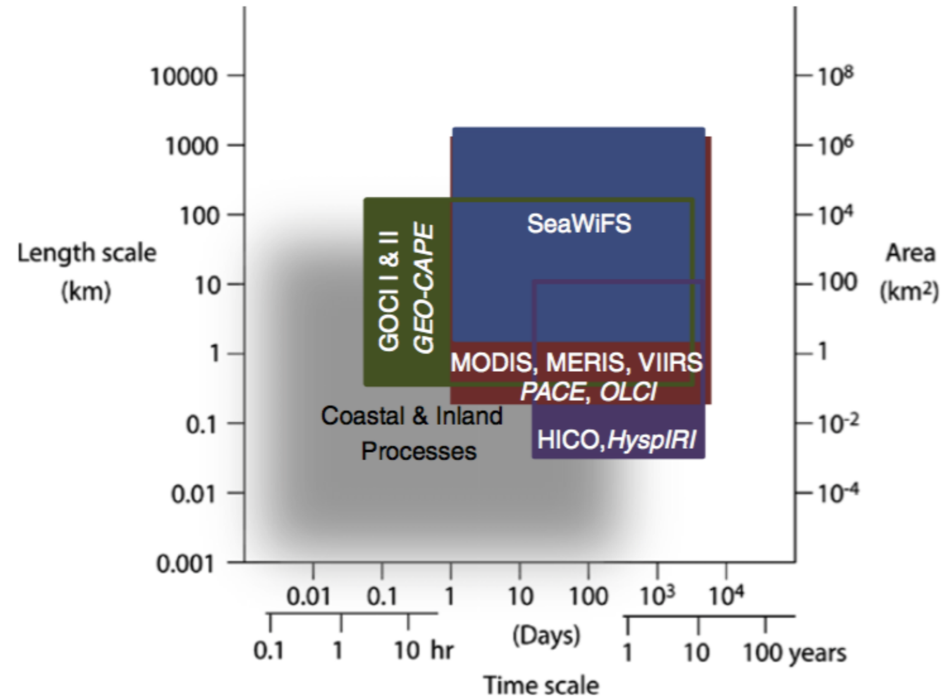


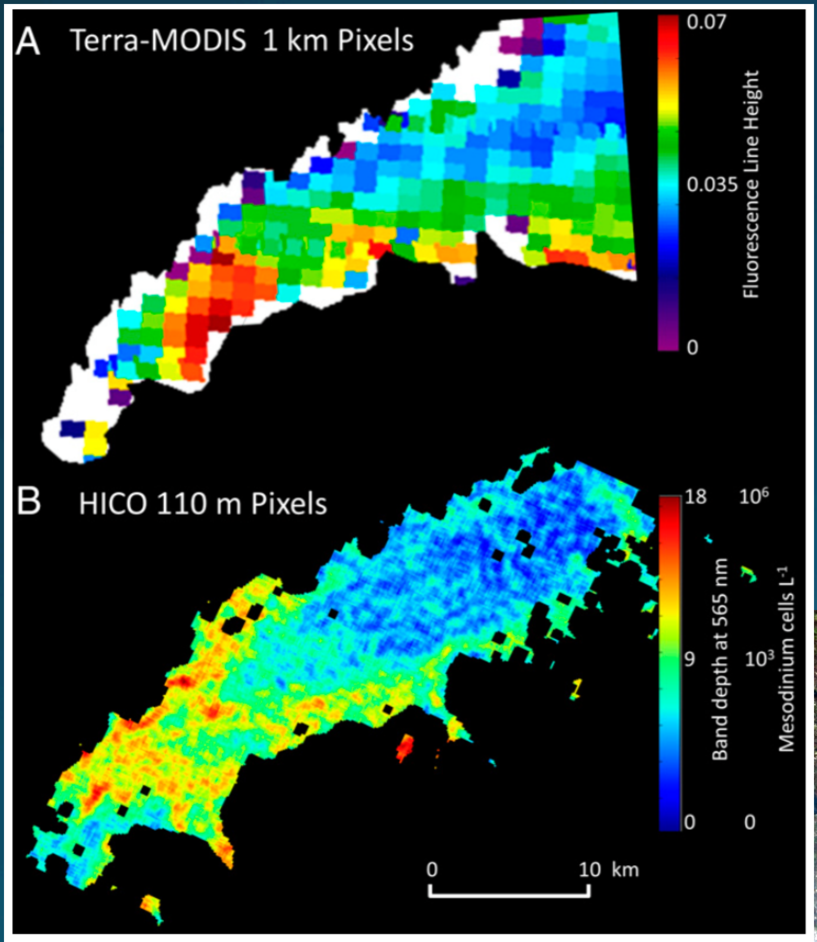
Fig. 2. Length- and timescales of coastal and inland processes in relation to heritage, current and planned aquatic color sensors (SeaWiFS, MODIS, MERIS, VIIRS, HICO, GOCI, OLCI) and missions (PACE/ACE, GEO-CAPE, HyspIRI). Planned sensors and missions are italicized.
Adapted from Robinson (2010).

Mouw et al, 2015

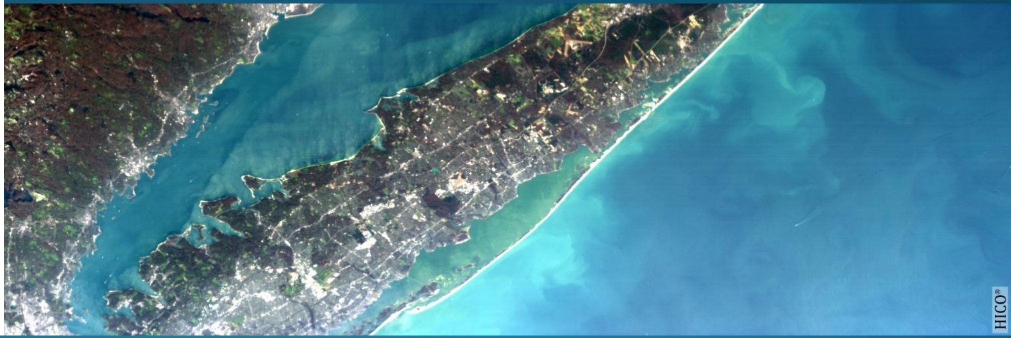
HICO instrument detects HAB: Western Long Island Sound

Dierssen et al, 2015 PNAS

(A) elevated Chl a fluorescence from MODIS Terra sensor (B) HICO yellow fluorescence of the ciliate M. rubrum.



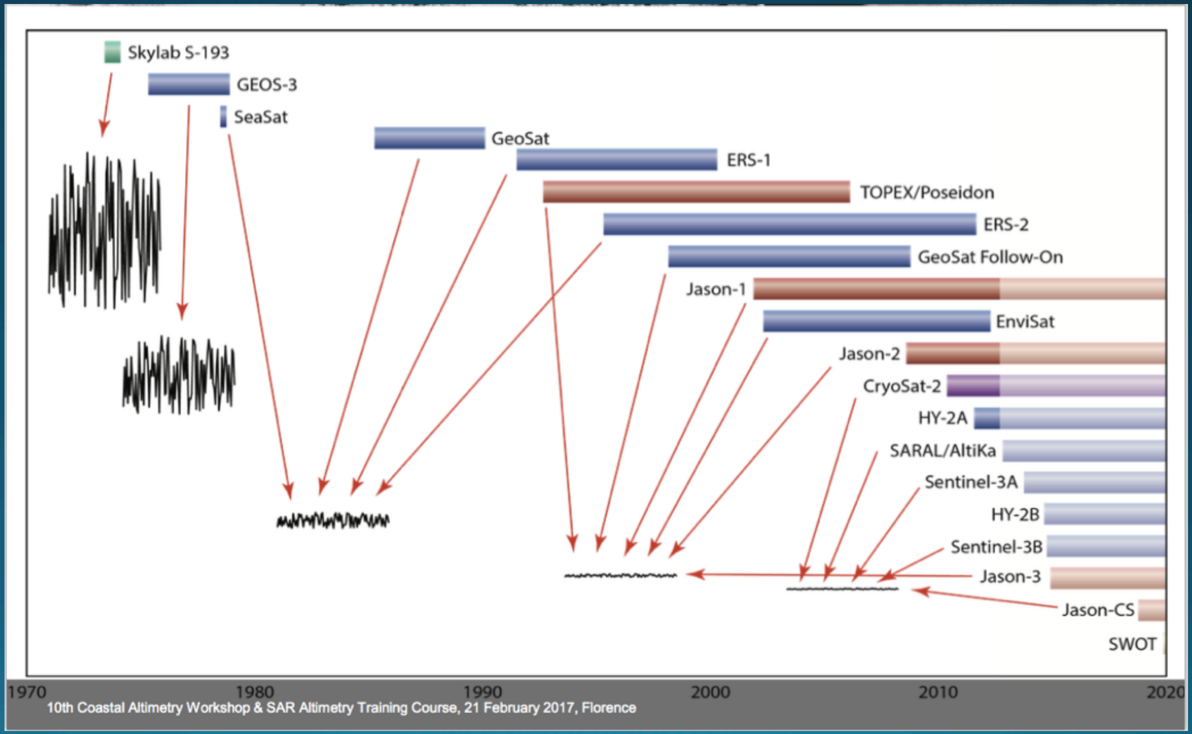
A topological approach for quantitative comparisons of ocean model fields to satellite ocean color data, R. Heister et al, 2015 Methods in Oceanography.



New technologies enabling better coastal applications using altimetry

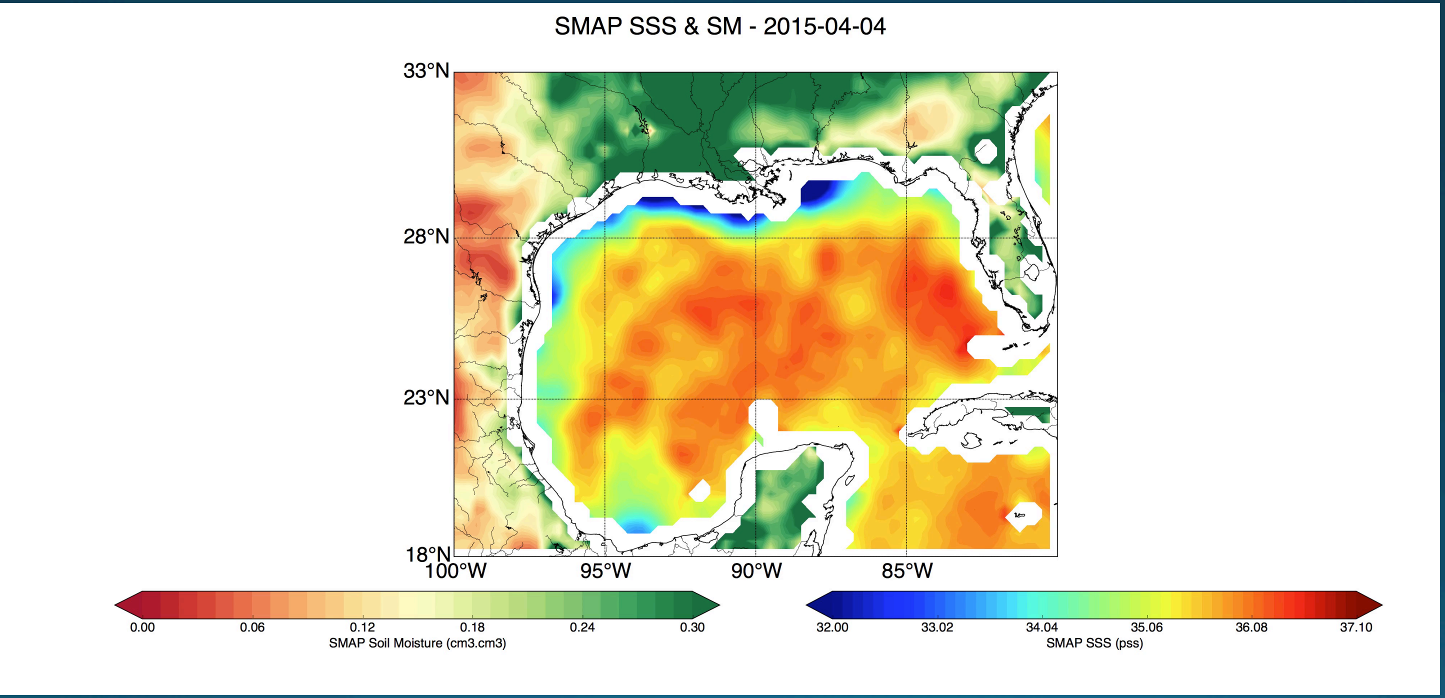
- CryoSat-2, HY-2, AltiKa, Jason-3 and Sentinel-3A,B Improvements in resolution!
- Atmospheric corrections and tides (resolution plus bathymetry) remain challenging, and it will take time to survey mean sea surface over new track areas.
- Data retrievals 0-4km offshore remain challenging
- Gaps in communication between model and satellite topography communities could be facilitated by providing various level 2 and 3 products for survey vs in depth analysis

ESA coastal altimetry (2017) workshop participants



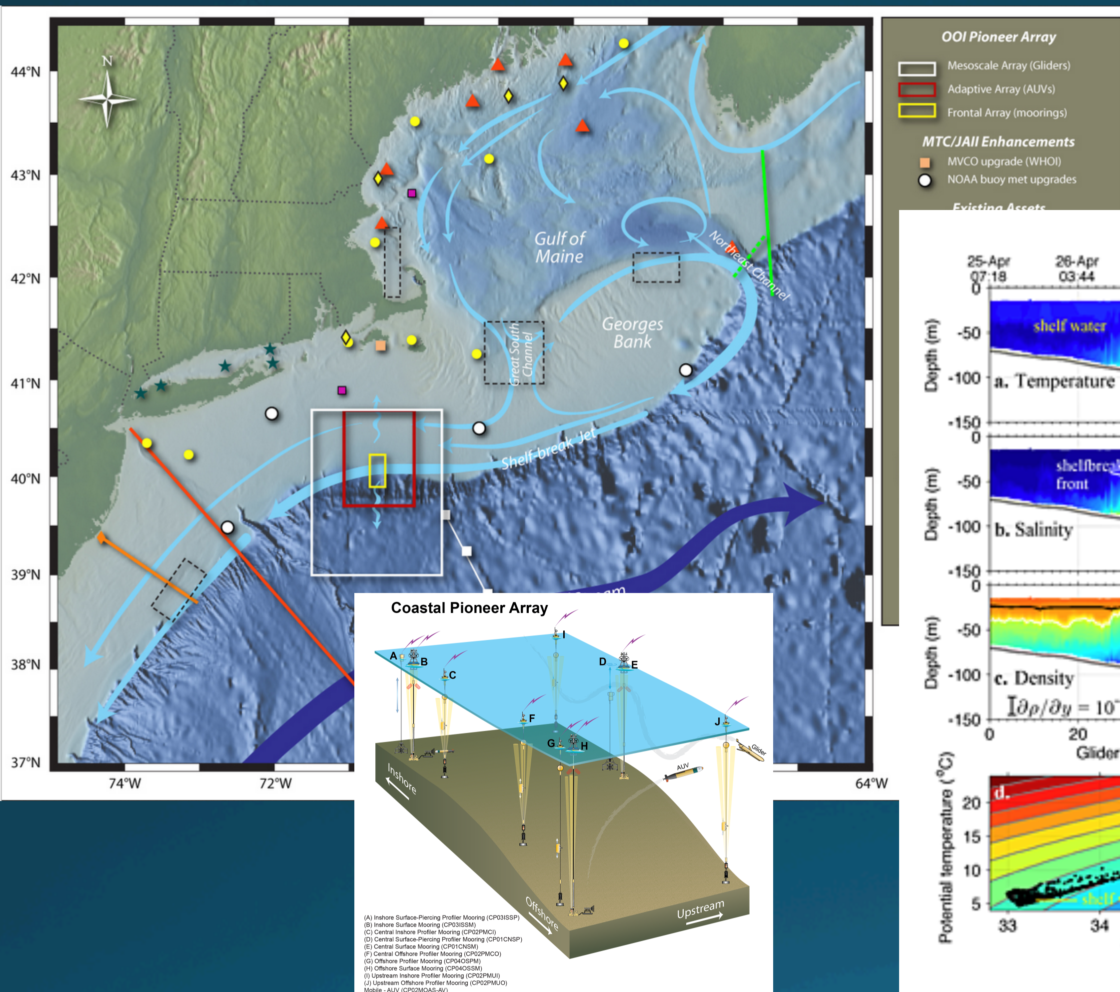
SMAP surface salinity & soil moisture: May-2015 extreme flooding event in Texas

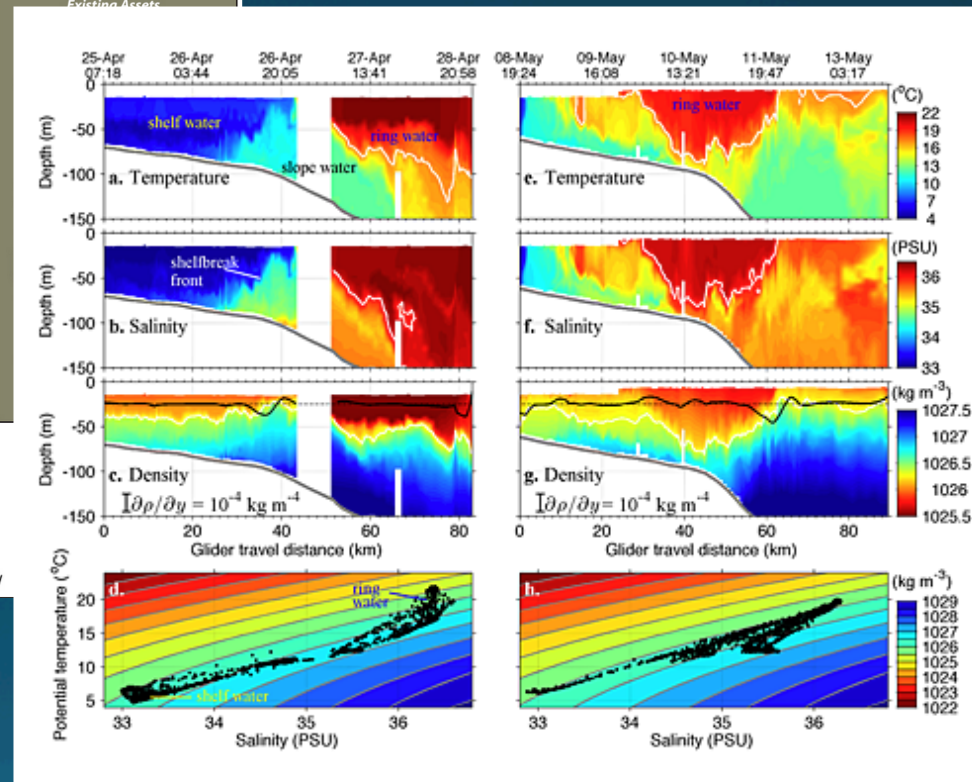
Multi-variate satellite observations (e.g., SMAP, GPM/TRMM, MODIS, JASON-2, GRACE, and SMOS) provide integrated assessment of land/sea impacts associated with flooding.



Unusually large freshwater plume in the central Gulf of Mexico was caused by runoff to Texas shelf (*Fournier, Reager, Lee, et al. 2016)*

OOI – Pioneer Array





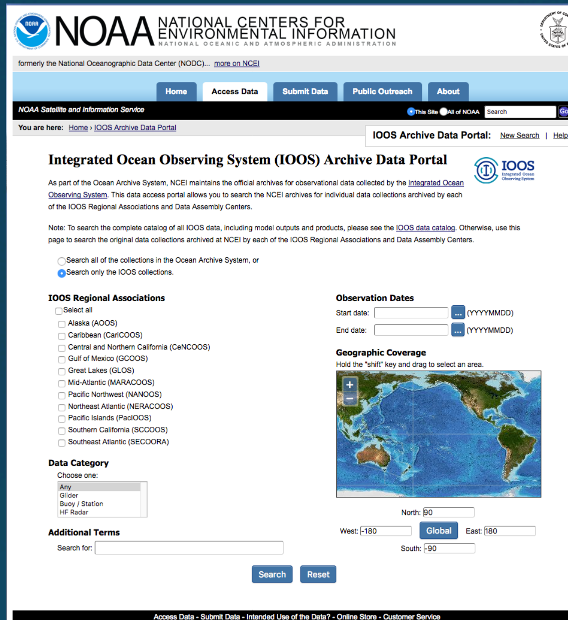
Zhang, W.G. and G.G. Gawarkiewicz, 2015. Dynamics of the direct intrusion of Gulf Stream ring water onto the Mid-Atlantic Bight shelf, Geophysical Research Letters, 42: 7687–7695. doi:10.1002/2015GL065530.

Accessing regional ioos datasets

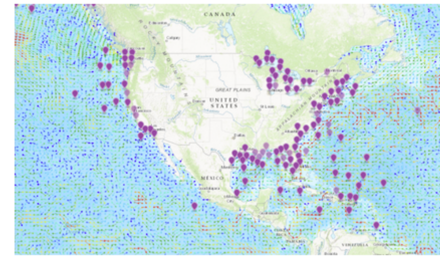
Regional Association Data Portals

All 11 IOOS Regional Associations offer data collected in their region through their website data portals. The data offered at each portal is different and focuses on the regional associations specific strengths and local partnerships. For direct access to data in a particular region please visit the **IOOS Regional Portal Map.**

IOOS Regional Portal Map



Environmental Data Server Model Viewer



The IOOS
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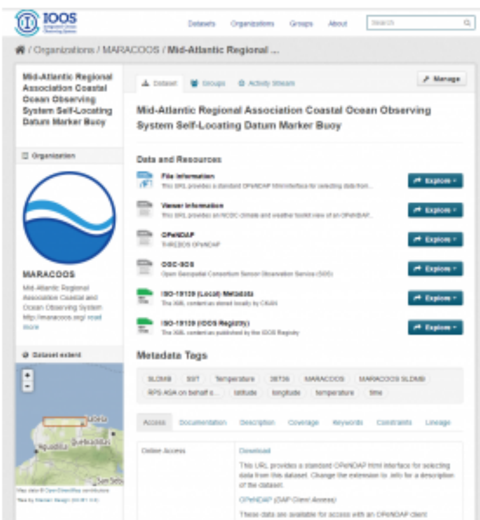
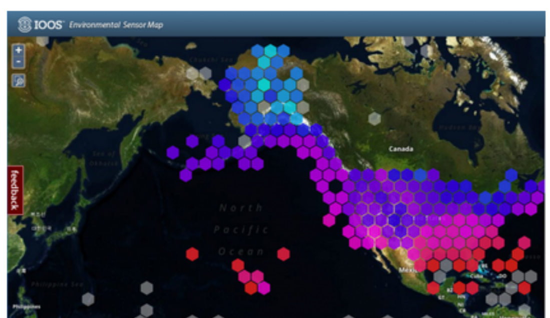
EDS Model Viewer

The IOOS Catalog



IOOS Data Catalog

The Environmental Sensor Map



Environmental Sensor Map

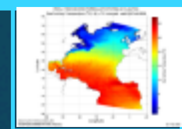
Modeling

Global Forecast System

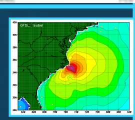
Hurricane
GFDL
HWRF

Coupled

Oceans
HYCOM

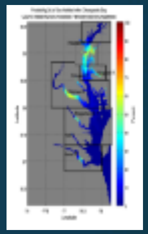


WaveWatch III



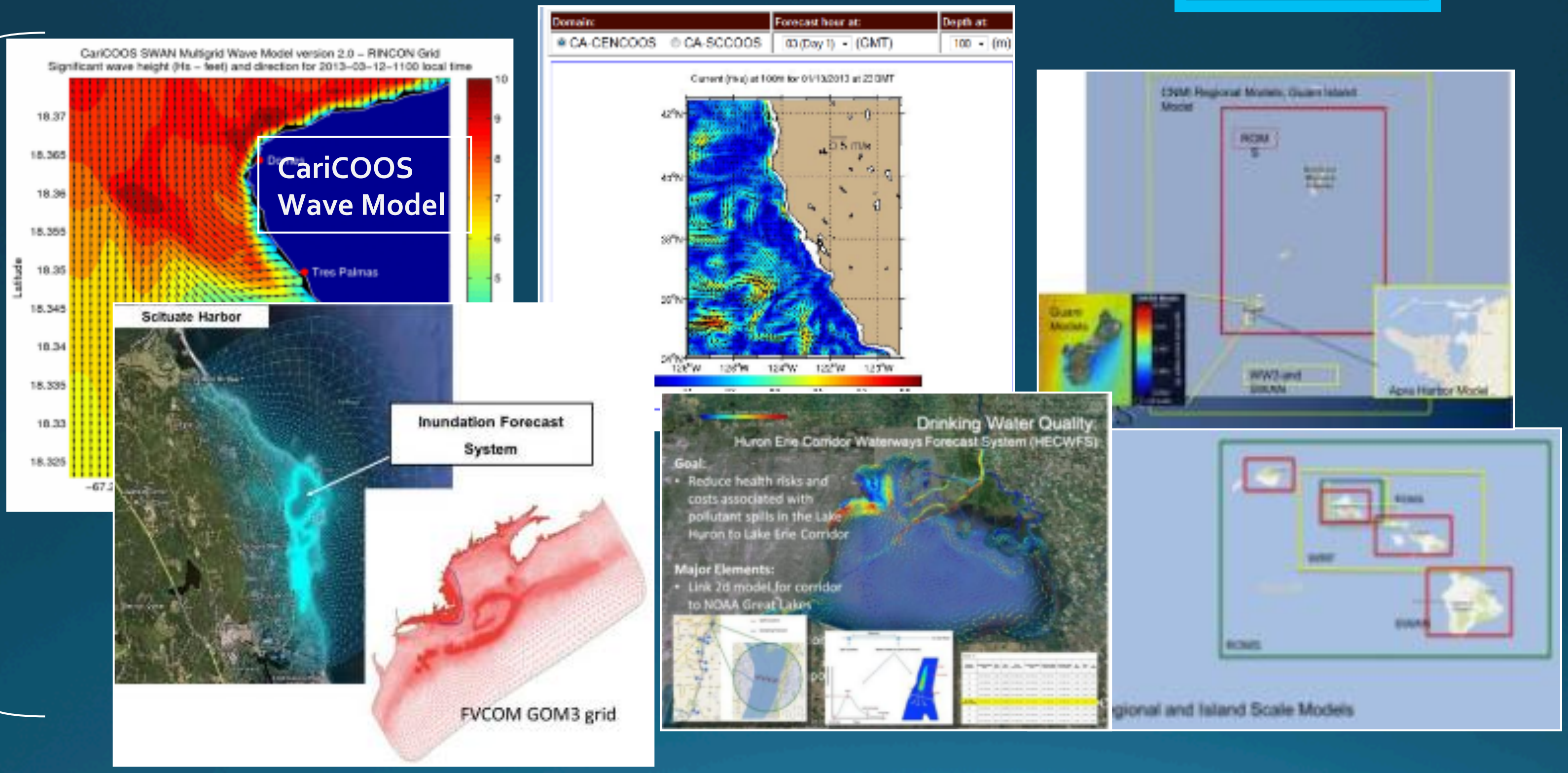
NOS – OFS
- **Great Lakes**
- **Northern Gulf of Mex**
- **Columbia R.**

Bays
- **Chesapeake**
- **Tampa**
- **Delaware**

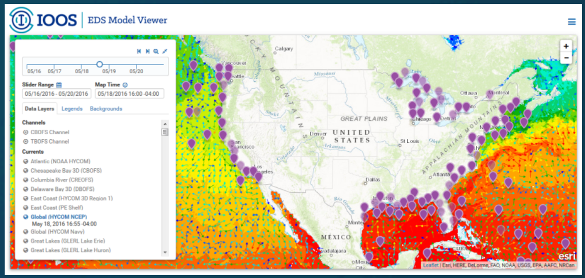


Sea Nettle Forecast

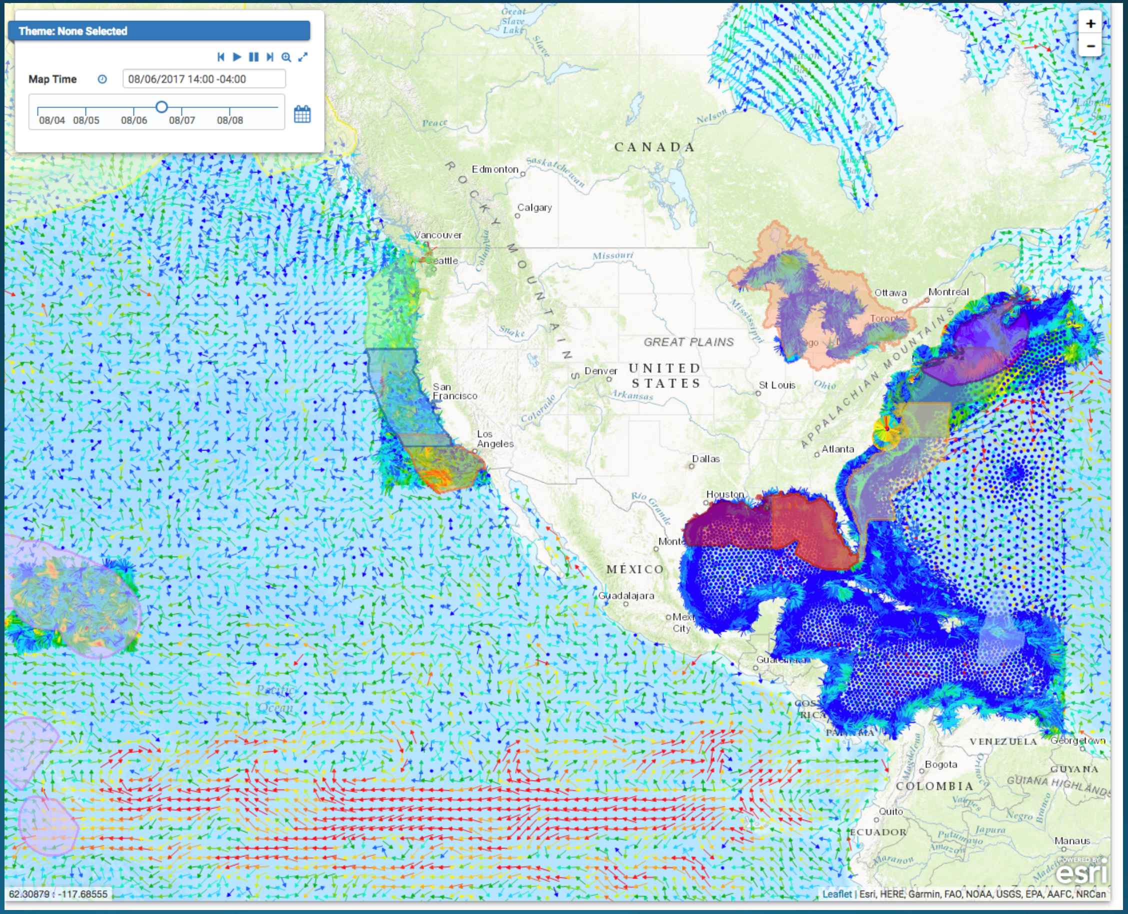
Regional Modeling



Environmental Data Server



- Requirement for publicly accessible integrated model information
- IOOS invested in a capability; provides platform for collaboration opportunities with other NOS offices
- Provides RAs a solution for hosting model output
- Demonstrates RA modeling capabilities



Local ↔ National

MARACOOS

Themes:

- Maritime safety
- Ecological decision support
- Water quality
- Coastal inundation
- Offshore energy

Regional Priority Themes	Regional Observation & Modeling Capabilities: Weather Mesonet	HF Radar Network	Statistical STPS	Satellite Imagery	Glider Surveys	Dynamical Ocean Forecasts
Theme 1. Maritime Safety	Operational Input to USCG SAROPS	Operational input to USCG SAROPS	Operational input to USCG SAROPS	SST for survivability planning	Assimilation dataset for forecast models	Surface currents for SAROPS
Theme 2. Ecological Decision Support	Weather forecast ensemble validation	Circulation and divergence maps for habitat		SST & Color for habitat	Subsurface T & S for habitat	3-D fields of T, S, circulation for habitat
Theme 3. Water Quality	Winds for transport, river plumes, & upwelling	Surface currents for flotables, bacteria, spill response	Surface currents for flotables, bacteria, spill response	Ocean color for river plumes	Nearshore dissolved oxygen surveys	Surface currents for floatables, bacteria, spill response
Theme 4. Coastal Inundation	Weather forecast ensemble validation	Current forecast model validation		SSTs assimilation into forecast models	Assimilation dataset for forecast models	Nested forecast ensembles
Theme 5. Offshore Energy	Historical analysis & wind model validation	Historical current analysis & wind model validation		Historical analysis surface fronts & plumes for siting	Historical analysis of subsurface fronts & plumes	Coupled ocean-atmosphere models for resource estimates

GCOOS

major societal goals of the GCOOS-RA are:

- Safe and Efficient Marine Operations
- Mitigation of Effects of Coastal Hazards
- Public Health and Safety
- Healthy Ecosystems and Water Quality

Table 3.1 Variables for recommended initial monitoring from moorings and AUVs

Phase I = existing; Phase II = years 1-3; Phase III = years 4-10

Variable	Phase II Moorings	Phase III Moorings	Phase I AUVs	Phase II AUVs	Phase III AUVs
Water Properties					
Temperature	X	X		X	X
Conductivity/Salinity	X	X		X	X
Sub-surface Currents	X	X			
Pressure	X	X		X	X
Dissolved Oxygen (esp., Hypoxia areas)	X	X		X	X
Backscatterance		X			
Colored dissolved organic matter (CDOM)	X	X		X	X
Acidity (pH)		X			X
Partial pressure of carbon dioxide (pCO_2)		X			
Dissolved Nutrients (Nitrogen)	X	X			X
Dissolved Nutrients (Phosphorus)		X			
Dissolved Nutrients (Other; e.g., urea)		X			
Light and optical conditions					
Light attenuation/transmission		X		X	X
Fluorometry (including chl-a)	X	X		X	X
Turbidity	X	X		X	X
Marine Meteorology					
Wind speed and direction	X	X			
Air Temperature	X	X			
Barometric Pressure	X	X			
Humidity	X	X			
Other					
Real-time telemetry	X	X		X	X
OPD or flow-cytobot (HAB-prone areas)	X	X		X	X
Sampling for HABs at selected piers	?	X			
Hydrocarbon detectors	?	X		?	X
Passive acoustic listening for animal tracking		X			?

NERACOOS

- Maritime Safety and Security
- Ocean and Coastal Ecosystem Health
- Ocean Energy
- Coastal Hazards Resiliency

All Data From Station
View all data - surface/subsurface - from each station

Graphing and Download
Query, graph and download historical data from all stations

Ocean Climate
Compare recent conditions to historical normal at buoy locations

Wave Forecast
Graphical forecasts of waves over next 48 hours

Wave & Water Level Forecast
Compare forecasts to observations for water level and wave height

Wind and Wave Forecast
Graphical forecasts of winds and waves over next 48 hours

Coastal Flooding & Erosion Forecast
Forecasts of water level and waves to predict splashover and erosion events

Compare Stations
Compare real-time observation data between stations

Dial-a-Buoy
Latest buoy conditions available via touch-tone or cell phone

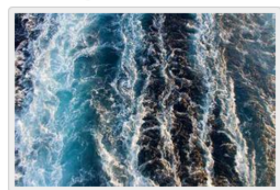
ERDDAP Server
Visualize and download subsets of data in common file formats

Hourly Buoy Data
Latest hourly ocean observations from the region

Ocean Forecasts
Graphical forecasts of waves, temps, water level and more

Region Wide Buoy Conditions
Map of region-wide conditions at a glance

Sea Surface Temperature - Satellite
High resolution daily sea surface temperature images from the region



Surface Currents
Maps of speed and direction of currents from high-frequency radar stations

Text-a-Buoy
Latest buoy conditions delivered via text message to your phone

Regional commonalities:

- Maritime safety
- Ecosystems/water quality – in different flavors
- Coastal inundation
- Highly leveraged funding

Regional Differences:

- Emphasis on energy
- Technologies: buoy vs glider etc.
- Strategy: opportunistic vs monitoring
- Level of implementation

Potential gaps:

- Leveraged funding means that new investigators may be disadvantaged
- Many regional groups are highly dependent on individual PI's (funding, priorities). Planning for succession?
- Lack of standardization in model skill assessment – but multiple models in each region.

Opportunities:

1. Gap in communication: CLIVAR <-> coastal oceanographers – would increase potential for linking CLIVAR to coastal concerns and vice versa. (CERF Nov 9, 2017 Providence, RI)

2. Differences in regional programs allow them to address diverse and differing priorities. Connecting to CLIVAR community more challenging possibly.

3. Multiple regional models and missing standardized skill assessment make assessing model design decisions challenging. Regional models could collaborate, e.g. share boundary conditions to enhance spatial coverage.