

MIDDLE
ATLANTIC
REGIONAL
ASSOCIATION
COASTAL
OCEAN
OBSERVING
SYSTEM

1000 km
Cape to Cape

CT RI MA
10 States and D.C
111 Congressional Districts

*Serving Marine-Related Users
in the Mid-Atlantic through
Ocean Observing and Forecasting*

Gerhard F. Kuska, Ph.D.

International Hydrographic Organization
Marine Spatial Data Infrastructure Forum

February 4, 2014

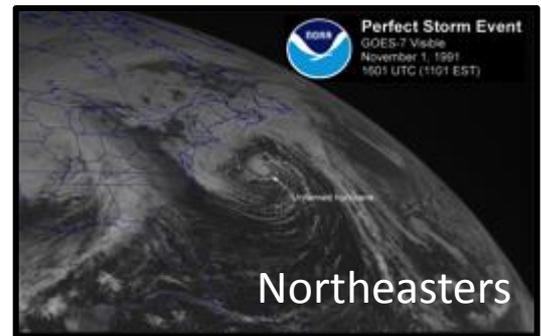
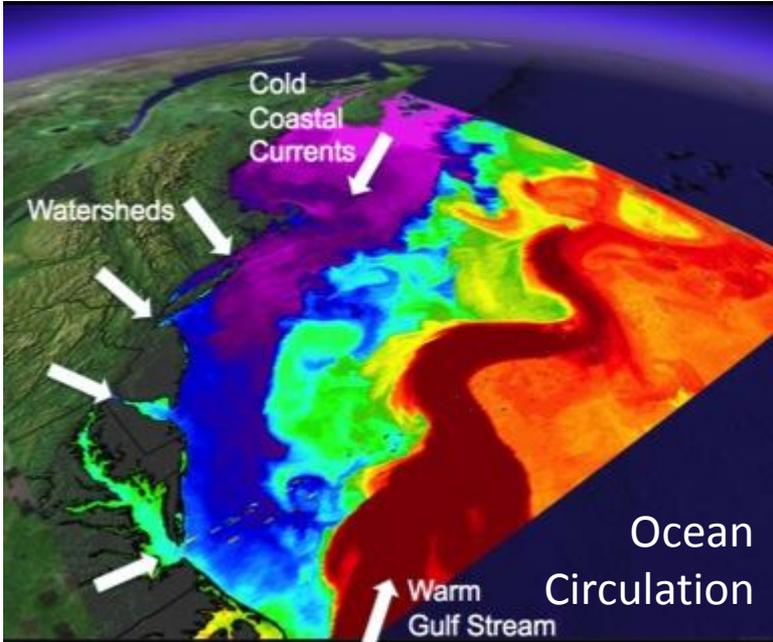
IOOS INTEGRATED OCEAN OBSERVING SYSTEM



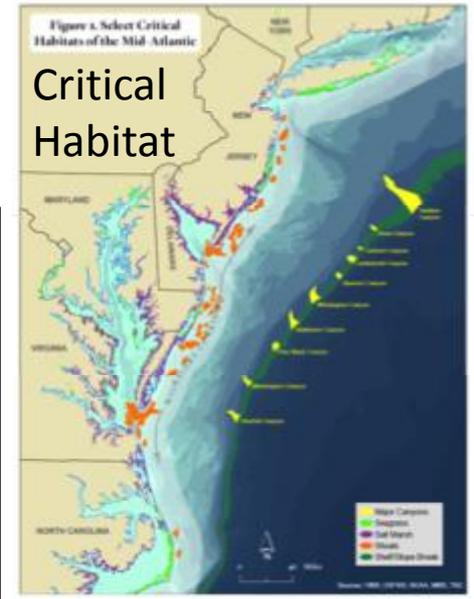
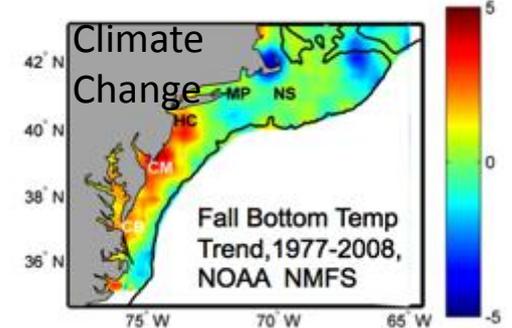
MARACOOS
Ocean Information for a Changing World

*To seek, discover, share and apply new knowledge
& understanding of our coastal ocean*

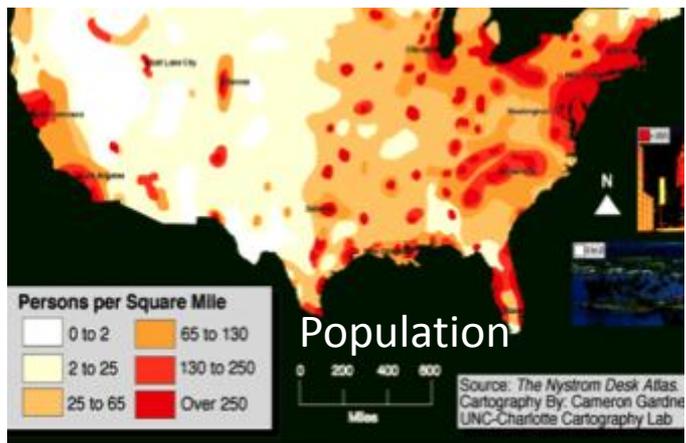
MID-ATLANTIC REGIONAL DRIVERS



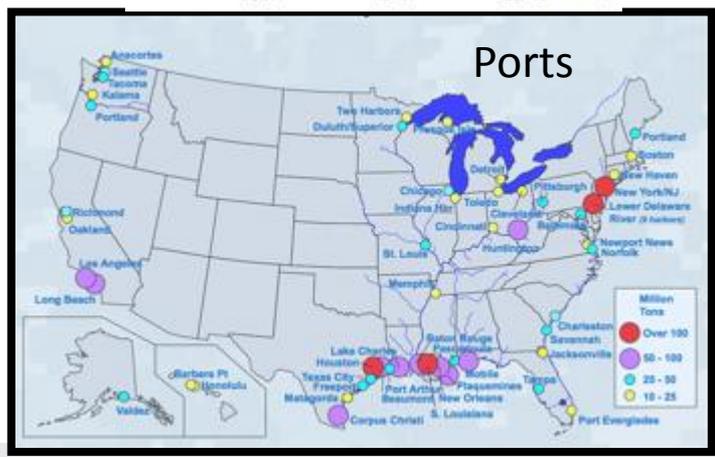
Tropical Storms



Critical Habitat



Population



The population of the United States is not distributed evenly. Instead, we tend to bunch up in communities, leaving the spaces in between more sparsely inhabited. Most Americans live in or near cities; today 52 percent live in the 20 largest cities. 75 percent of all Americans live in metropolitan areas.

This map shows population density. The relative height of each major city reflects its population in 1990.

Source: U.S. Census Bureau.

So West, Nevada is the fastest growing state, followed by Arizona, Idaho, Colorado, and Utah.

Wyoming has the lowest population density of all states in the lower 48 with an average of five people per square mile.

What happens in the empty spaces? Some of it is farm country. More than one quarter of America's crop land is used to grow corn. One third of what is produced is exported to other countries.

Chicago, the country's third largest city, has a population of about three million people. There are 27 states with populations smaller than this city.

Largest metropolitan area includes New York City and portions of New Jersey and Long Island with a total population of 20 million.

Population density is highest in New York City, where there are 23,000 people per square mile.

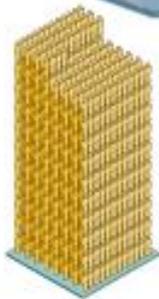
Wet. Some states are full of water. For example, Louisiana includes more than 5,000 square miles of lakes and wetlands. That's an area bigger than Connecticut and Rhode Island combined.

Coastal areas are home to more than half the U.S. population.

Approximately one in six Americans lives in the nation's most populous state—California. More than 25 million people live in the Los Angeles, Riverside, and Orange County metropolitan areas.



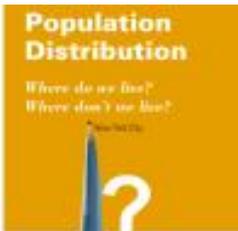
Distributing our population evenly would put an average of 76 people per square mile.



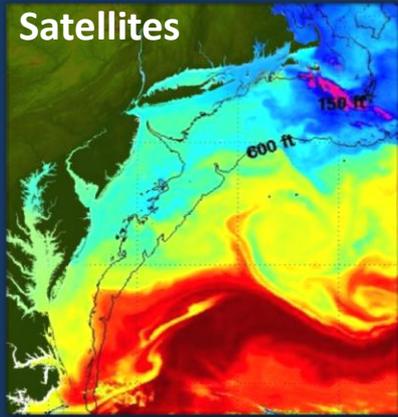
New Jersey is the most densely populated state with an average of more than 1,000 people per square mile.



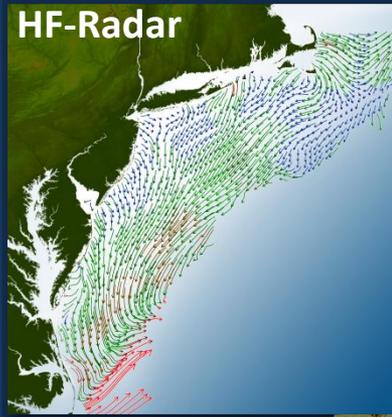
Alaska is a sparsely populated state with an average of one person per square mile.



Satellites



HF-Radar



Gliders

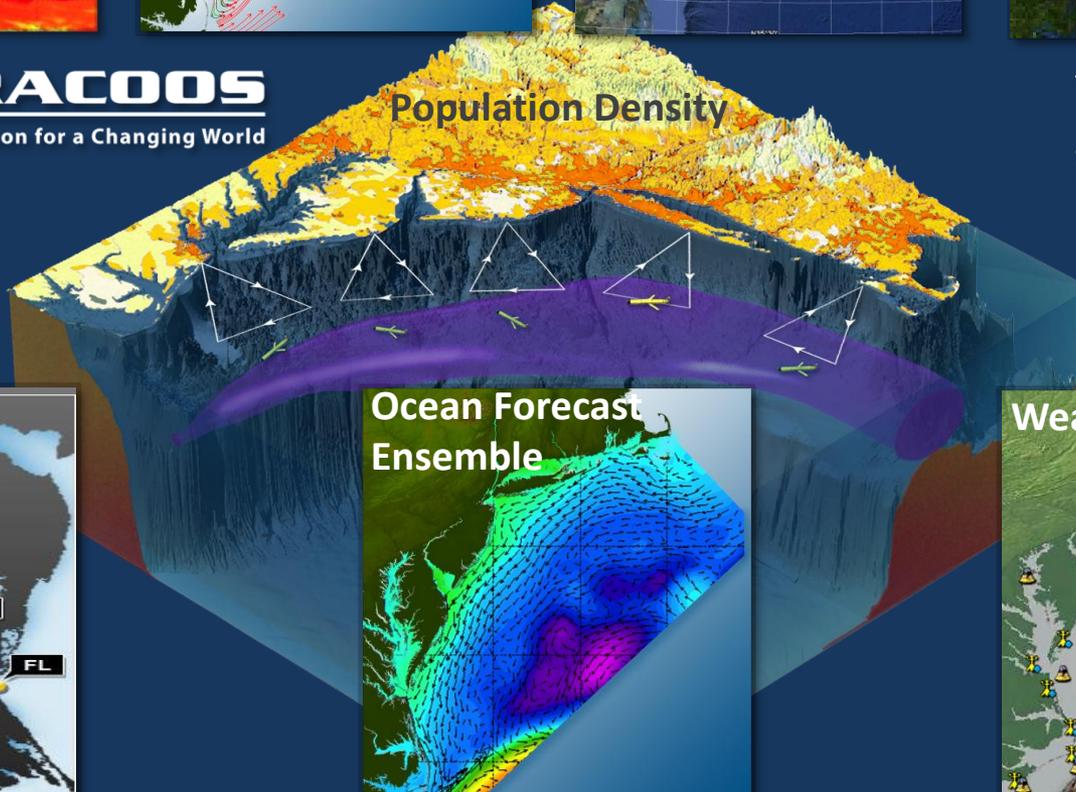


Drifters



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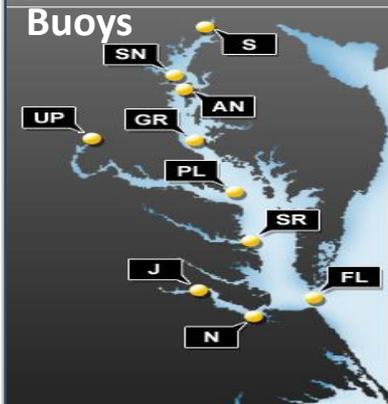
Population Density



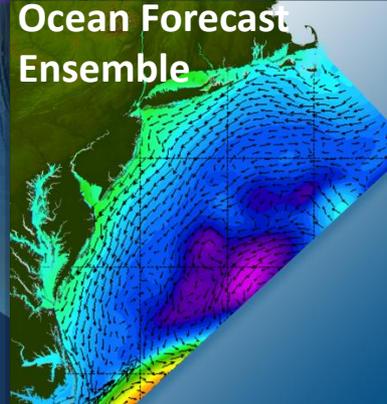
IOOS
INTEGRATED OCEAN OBSERVING SYSTEM

IOOS
ASSOCIATION

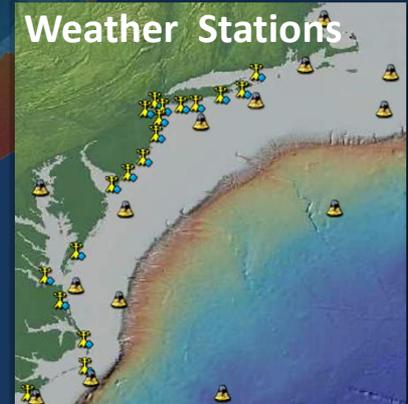
Buoys



Ocean Forecast Ensemble



Weather Stations



IOOS INTEGRATED OCEAN OBSERVING SYSTEM

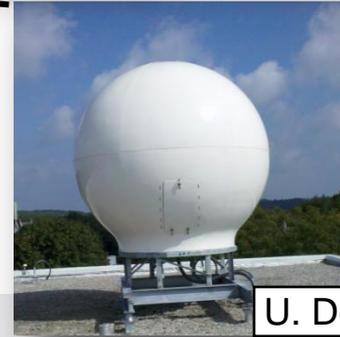
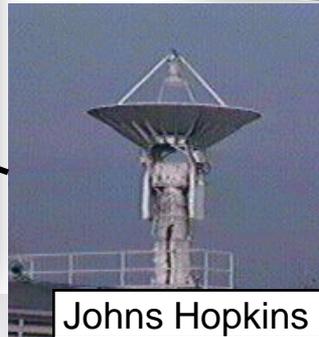
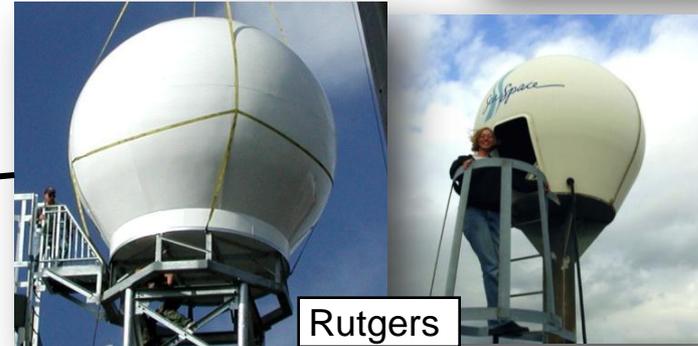
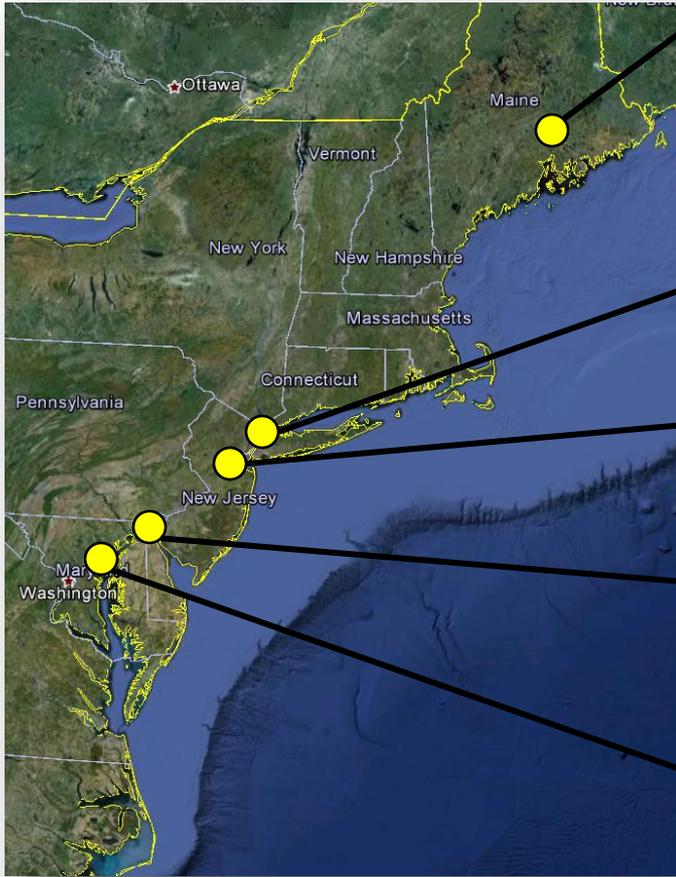


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Real-Time Satellite Ground Stations in the Northeast U.S.

Since 1992

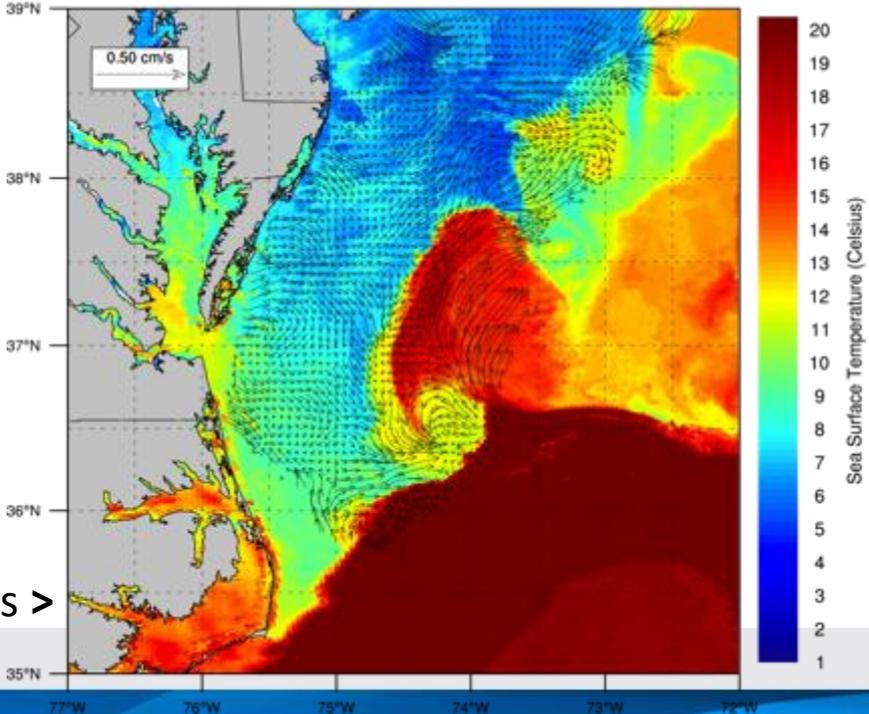
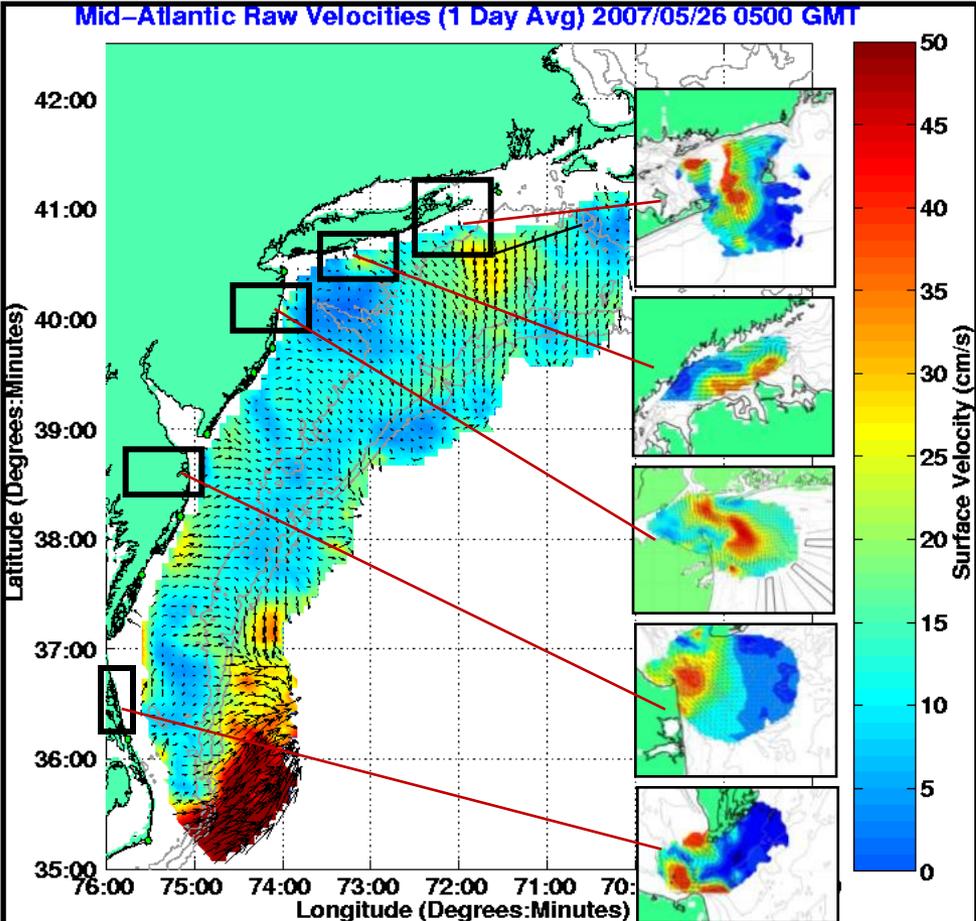
Satellites: NPP, Terra, Aqua,
NOAA Polar Orbiters, Metop &
GOES



High Frequency Radar – Since 1996



Corporate Partner:
CODAR Ocean Sensors

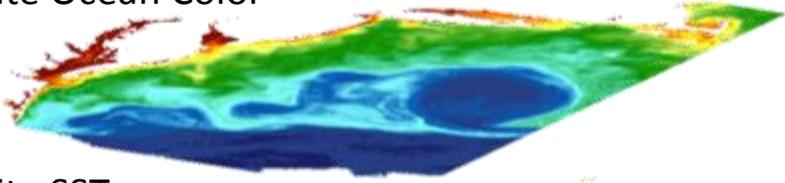


Nested Grids of Hourly Surface Current Maps ^

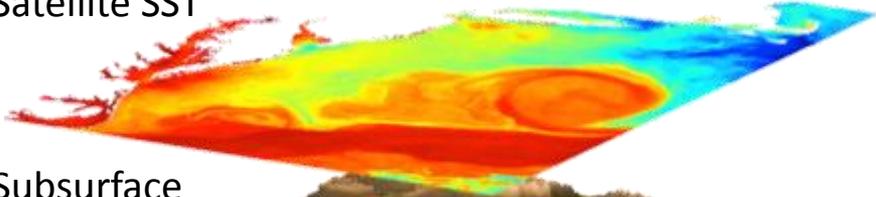
Combined CODAR & Satellite Products >

Autonomous Underwater Gliders – Since 1998

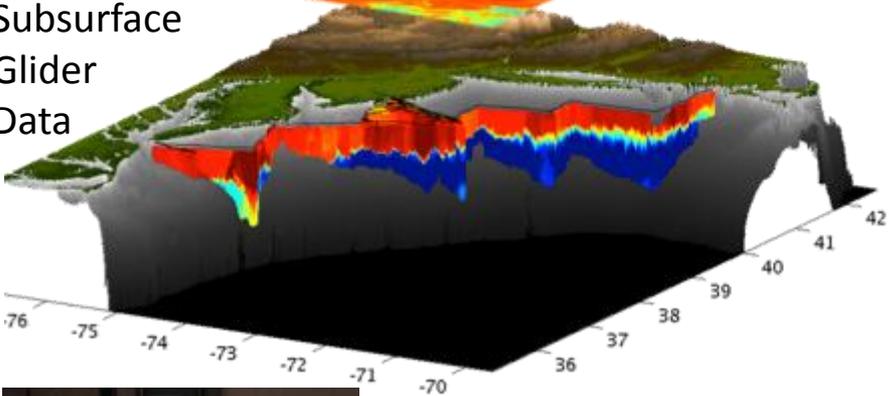
Satellite Ocean Color



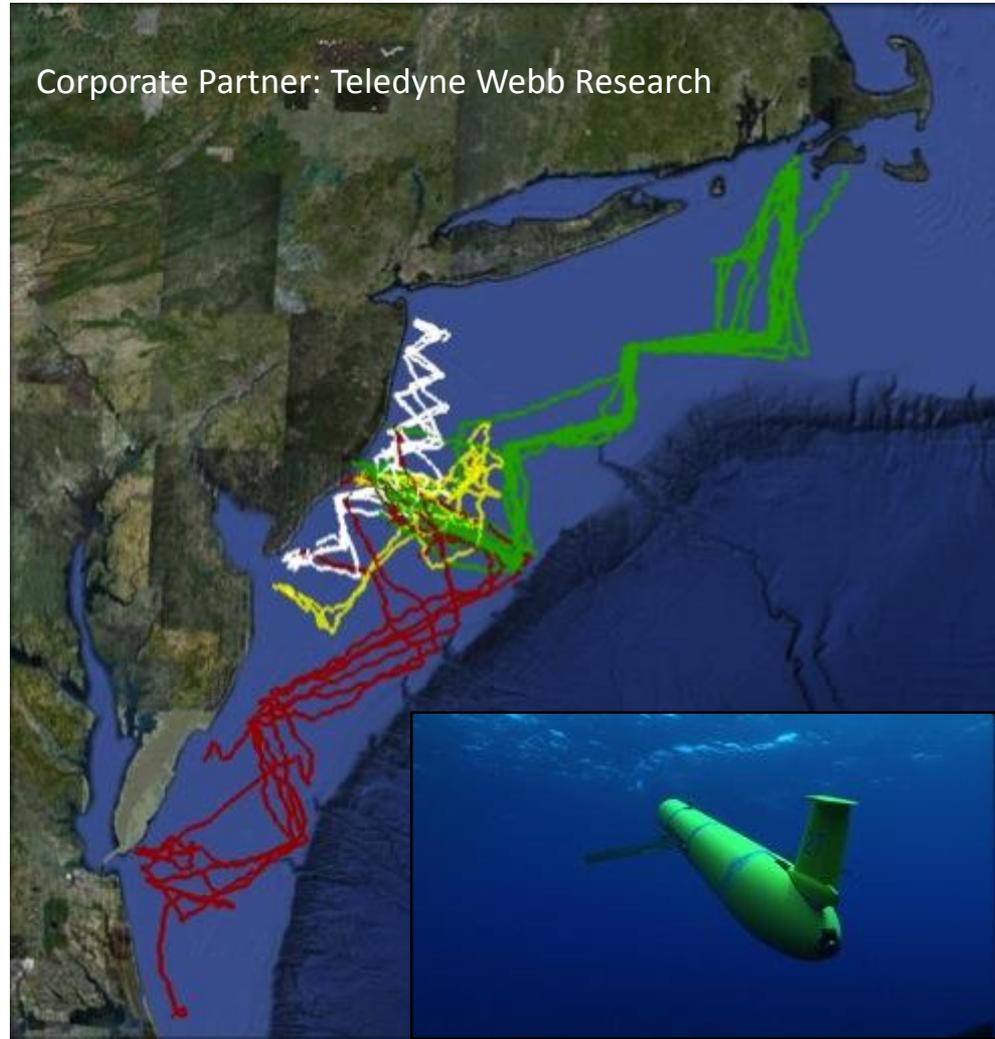
Satellite SST



Subsurface
Glider
Data



Corporate Partner: Teledyne Webb Research



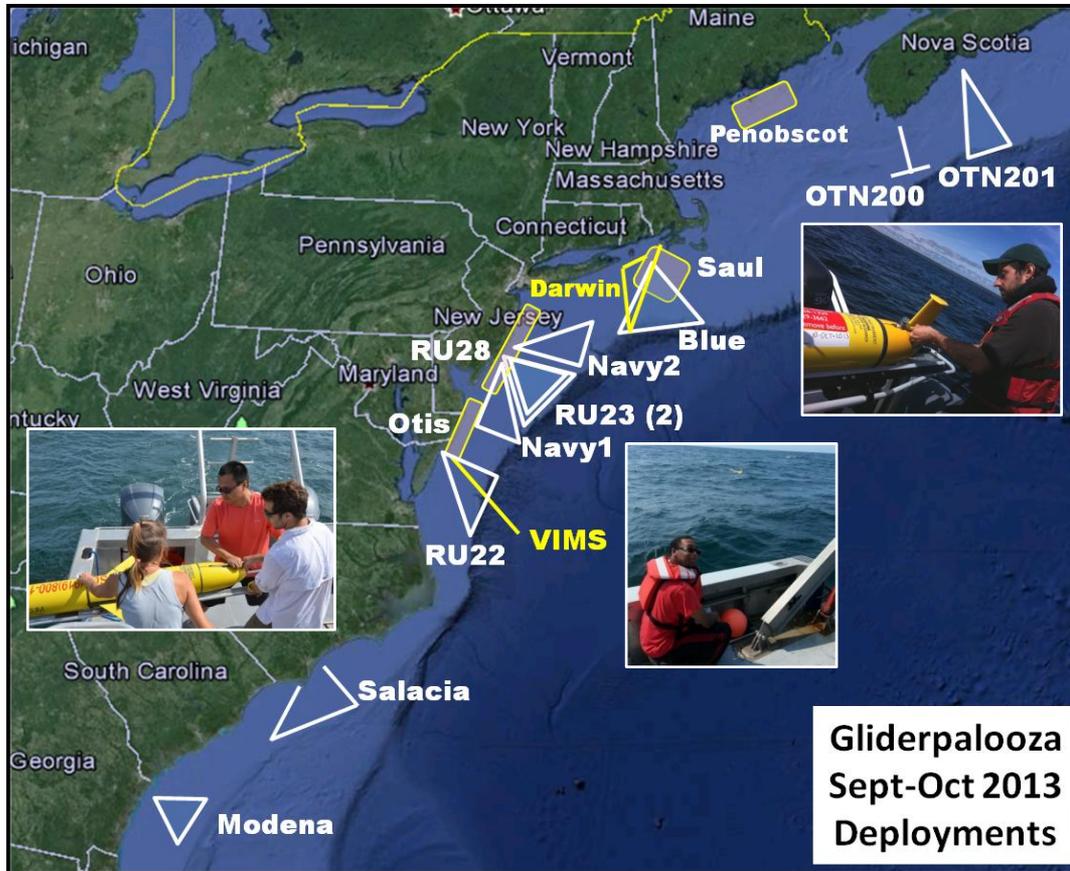
IOOS INTEGRATED OCEAN OBSERVING SYSTEM



MARACOOS

Ocean Information for a Changing World

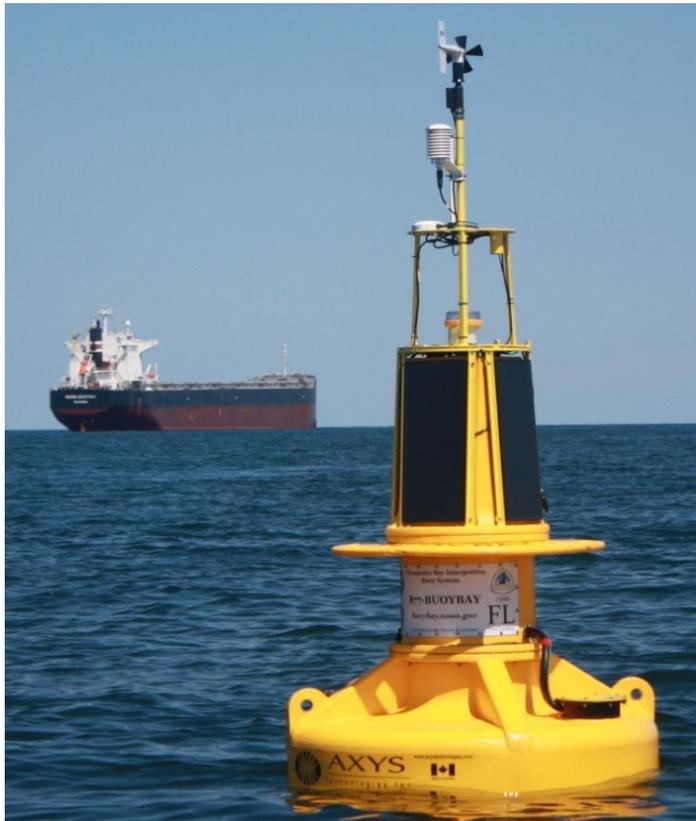
Gliderpalooza 2013: So much more than gliders



1. Provide a unique data set to modelers
2. Provide standardized dataset a over ecological scales and information on fish/mammal migrations
3. Provide a 3-D snapshot of the MAB cold pool
4. Provide an extensive distributed network through the peak period of fall storms, demonstrating "surge" capacity
5. Demonstration of a national glider network
6. Proof of data flow through IOOS to NDBC via DMAC
7. Engage undergraduates in ocean observing efforts.



CBIBS: MARACOOS partners with NOAA to enhance utility of CBIBS



MARACOOS partners will

- Integrate CBIBS data into MARACOOS data management system, including IOOS DMAC standards and services and QARTOD QA/QC procedures.
- Integrate CBIBS data feeds into NOAA PORTS system.
- Support CBIBS planning, operations, and maintenance activities.
- Expand CBIBS system
- Support Research and Development applications (e.g., Nutrient Monitoring, Ocean Acidification)



Chesapeake Bay
INTERPRETIVE BUOY SYSTEM

IOOS INTEGRATED OCEAN OBSERVING SYSTEM

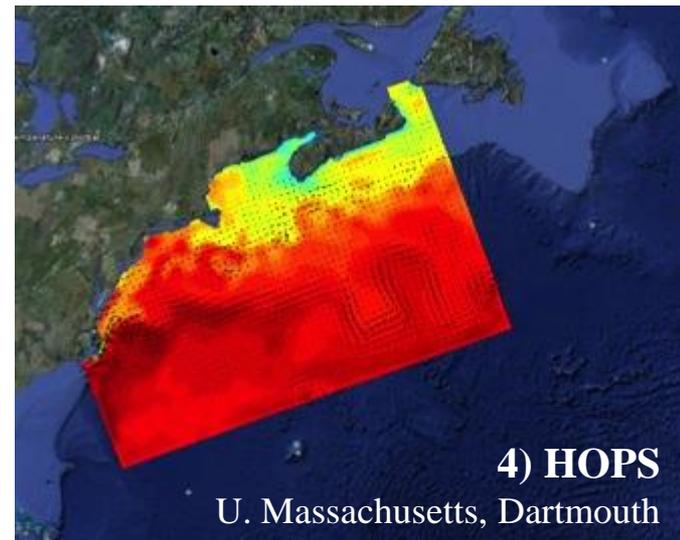
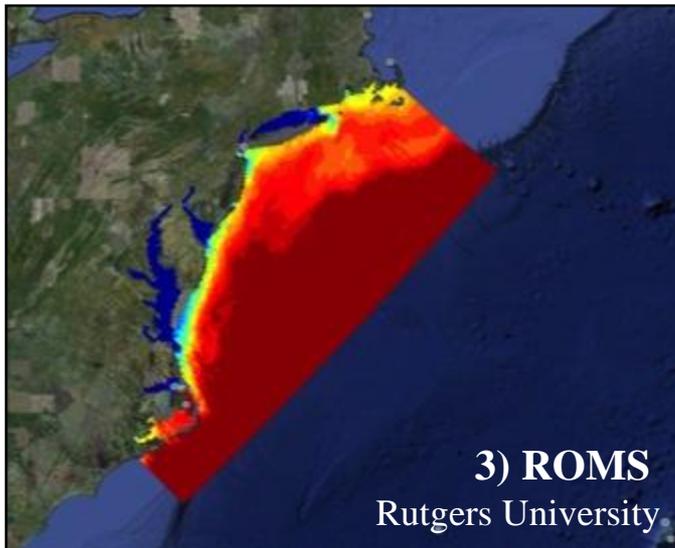
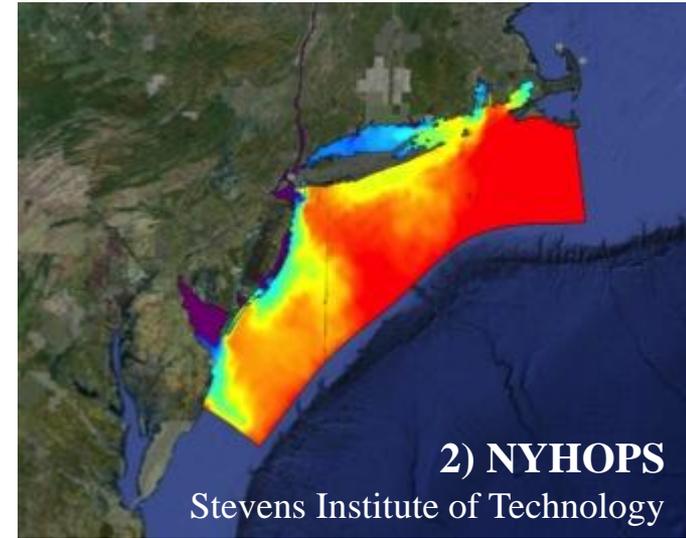
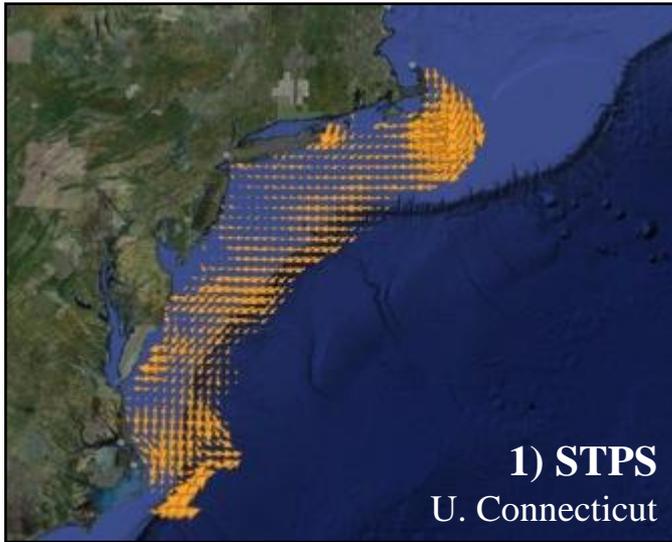


MARACOOS

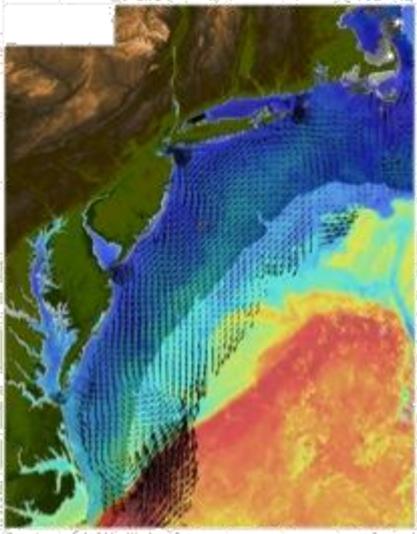
Ocean Information for a Changing World

The Mid-Atlantic Regional Coastal Ocean Modeling System

Established 2007

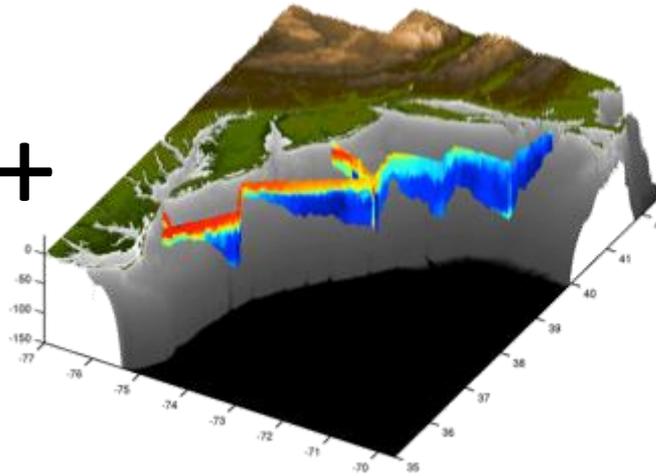


Composite Data & Forecast Products



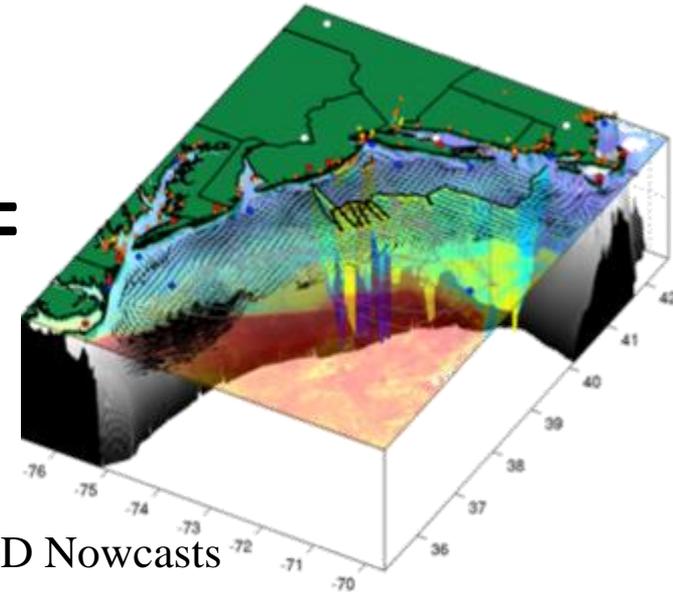
Remote Sensing

+

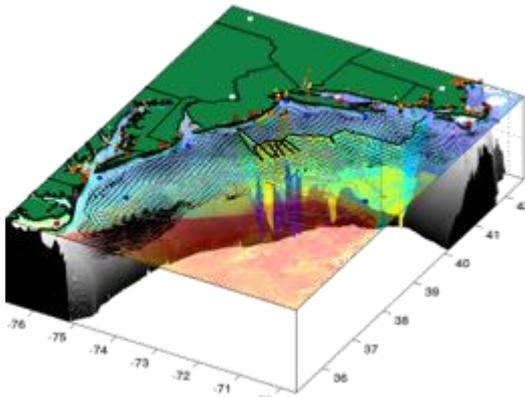


Gliders

=

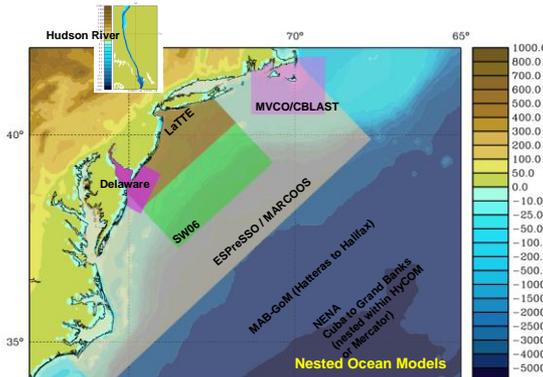


3-D Nowcasts



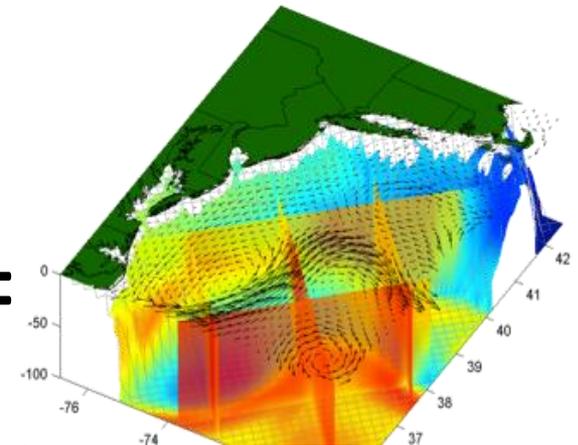
3-D Nowcasts

+



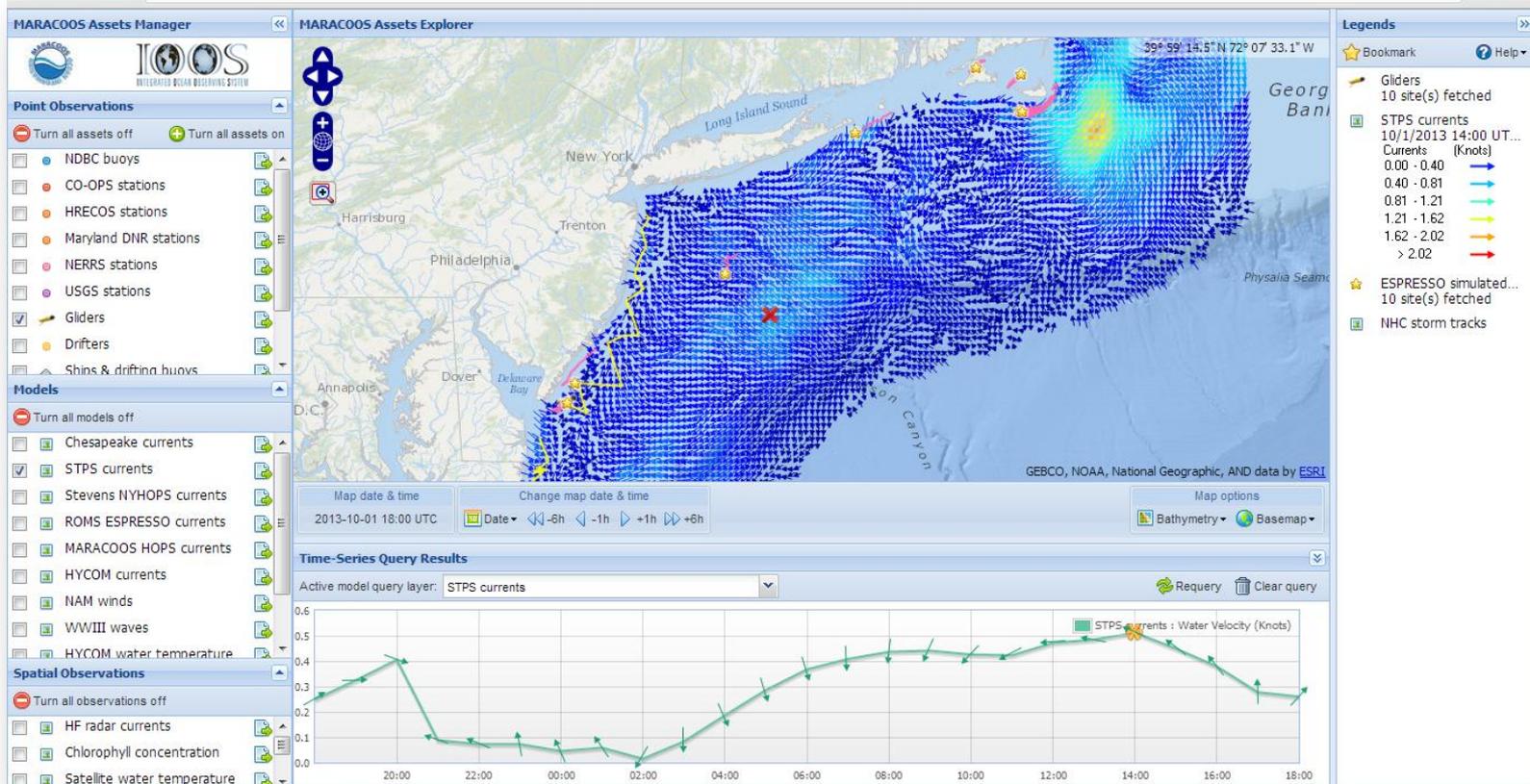
Nested Models

=



4-D Forecasts

MARACOOS Asset Map

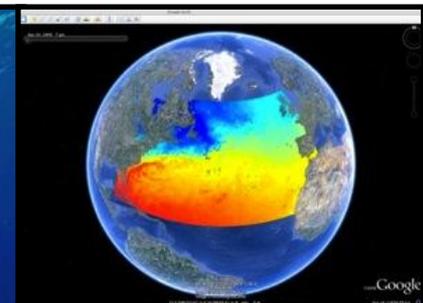


- Regional Data
- Federal Data
- In-Situ
- Gliders
- Satellite
- Radar
- Models
- IOOS Standards



MARACOOS Operations Center

(@Rutgers University - Coastal Ocean Observation Lab)



Satellite Data Acquisition Stations

CODAR Network

Glider Fleet

3-D Forecasts

 **IOOS** INTEGRATED OCEAN OBSERVING SYSTEM

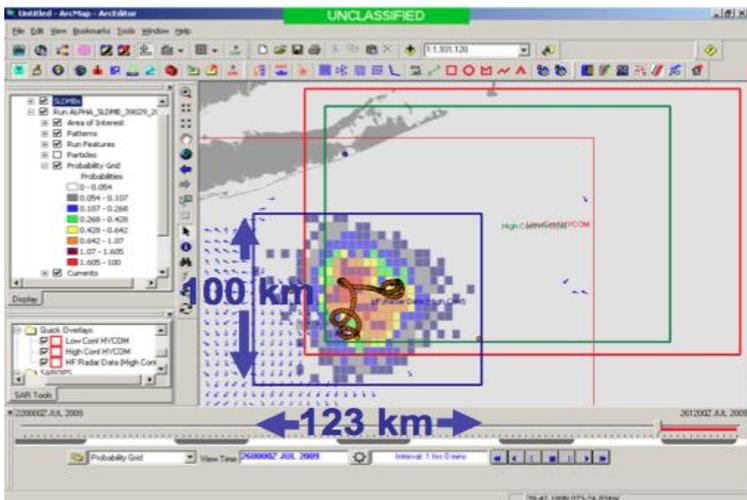


MARACOOS

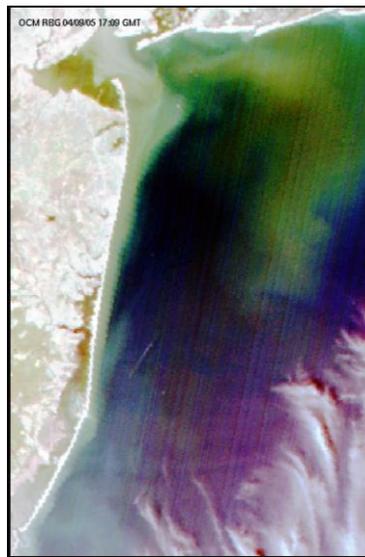
Ocean Information for a Changing World

REGIONAL THEMES & SUCCESS STORIES

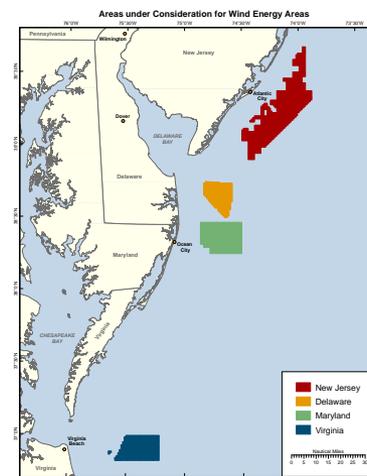
1) Maritime Operations – Safety at Sea



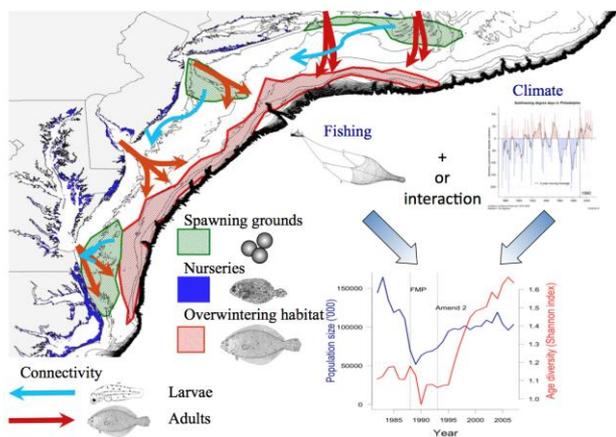
2) Water Quality – a) Floatables, b) Hypoxia, c) Nutrients



5) Energy – Offshore Wind



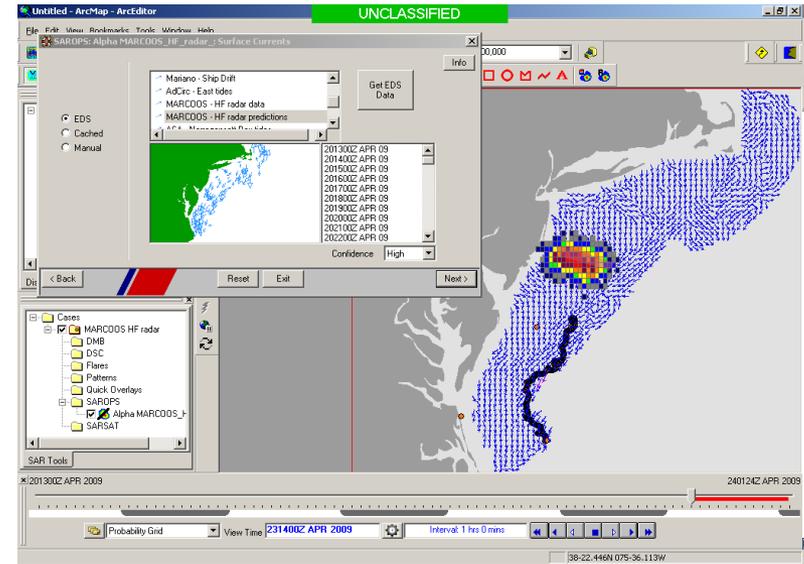
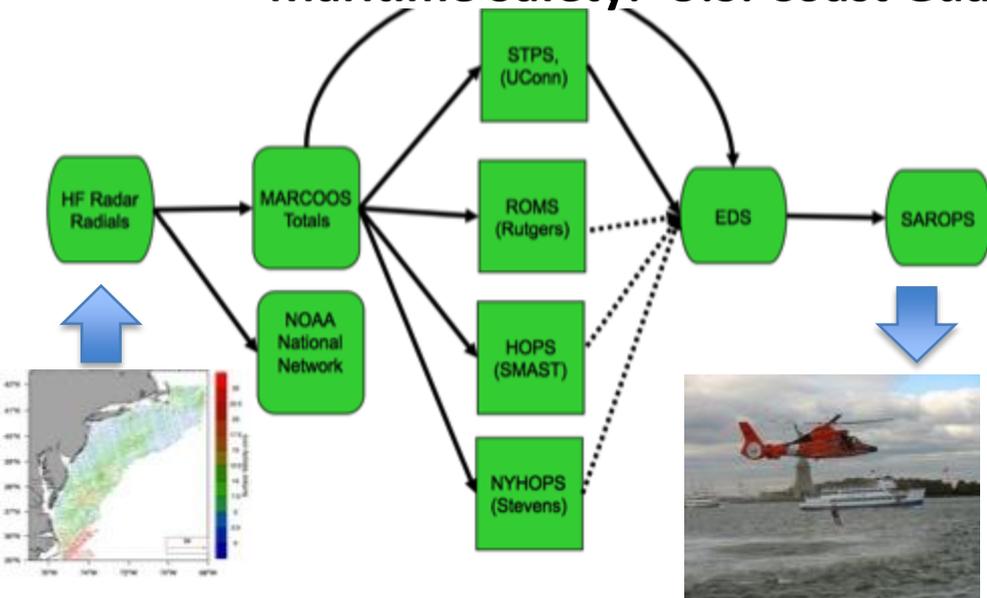
3) Ecosystem Decision Support - Fisheries



4) Coastal Inundation - Flooding

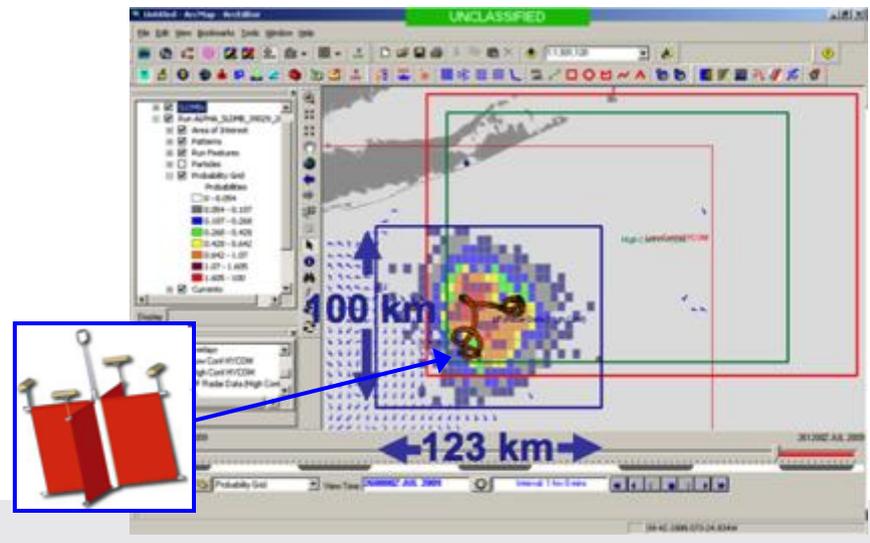
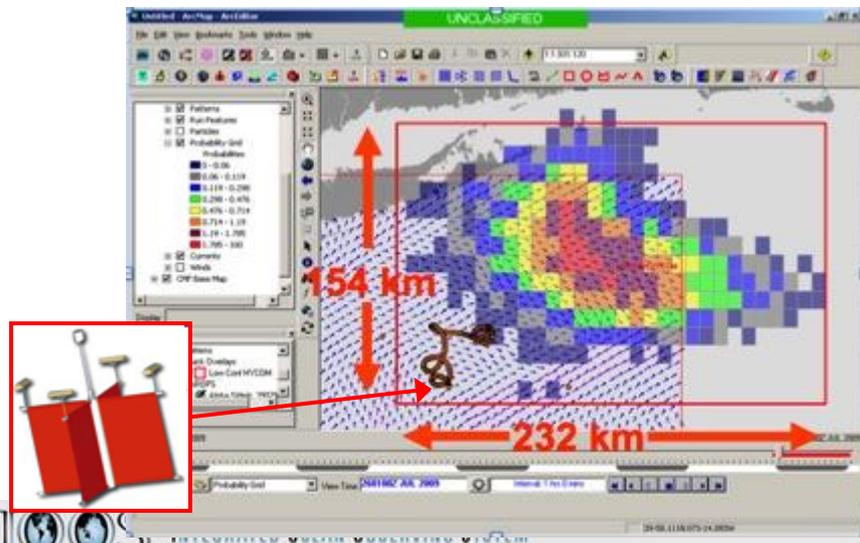


Maritime Safety: U.S. Coast Guard Search and Rescue example



Mid-Atlantic Operational Data Flow to SAROPS

SAROPS User Interface



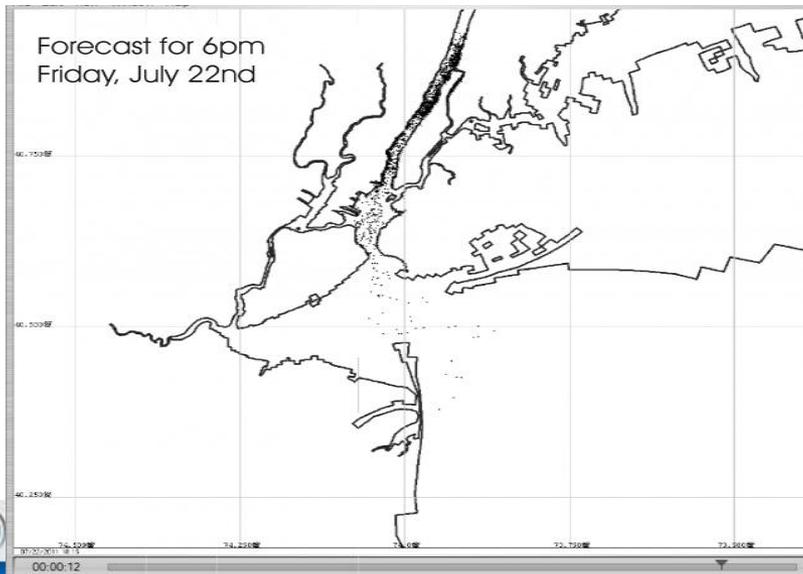
SAROPS 96-Hour Search Area: **HYCOM = 36,000 km²**

SAROPS 96-Hour Search Area: **HF Radar = 12,000 km²**

Water Quality



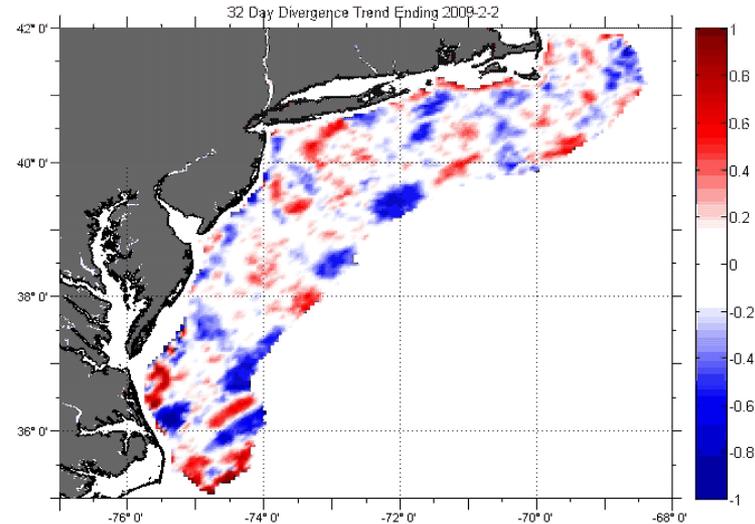
Data and Modeling to respond to 120+ million gallons of sewage released into the Hudson River following North River Wastewater Treatment Plant fire in NYC, July 2011



MARACOOS

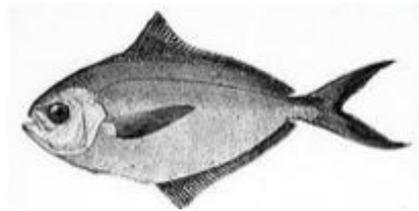
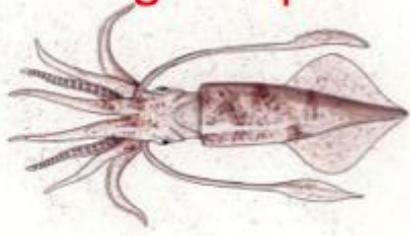
Ocean Information for a Changing World

Ecological Decision Support – Fisheries



Long fin squid

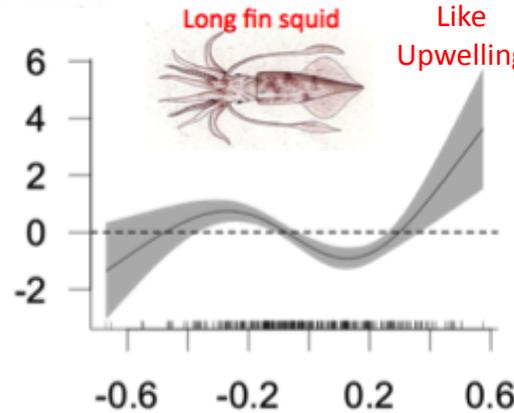
Butterfish



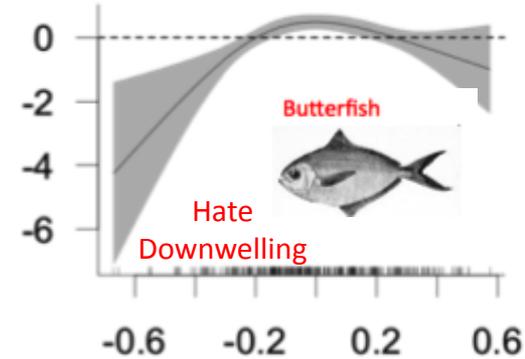
Our Approach:

Develop statistical models using bottom trawl surveys and MARACOOS 3-D data to predict species distribution based on observed or forecasted MARACOOS 3-D fields.

Divergence index



Downwelling Upwelling



Downwelling Upwelling



Sandy Surge Prediction based on Rutgers WRF model



Urban Ocean Observatory at the Center for Maritime Systems

Present Conditions

NYHOPS Forecast

NJ Coast (CMN)

Storm Surge

Mobile Stations

CMS Partners

Data & Time Series



Storm Surge Warning System

Plot Series or Download Data

Station:

Stations are listed from North to South

Start

Date:

End

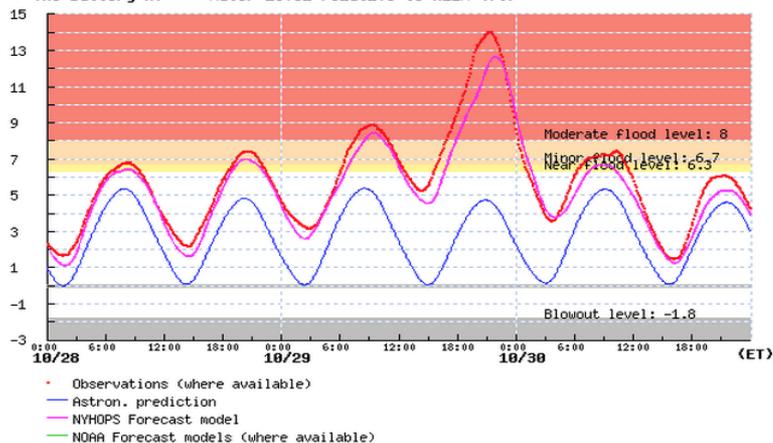
Date:

Datum:

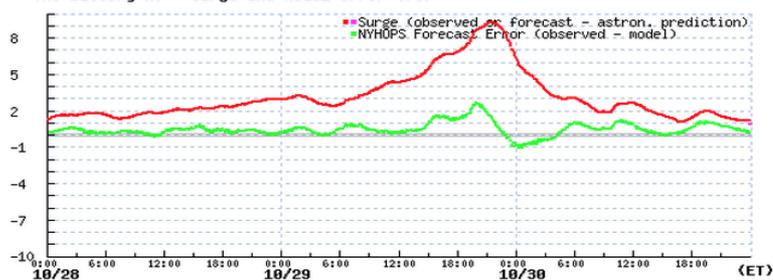
Units:

Time Zone:

The Battery NY - Water level relative to MLLW (ft)

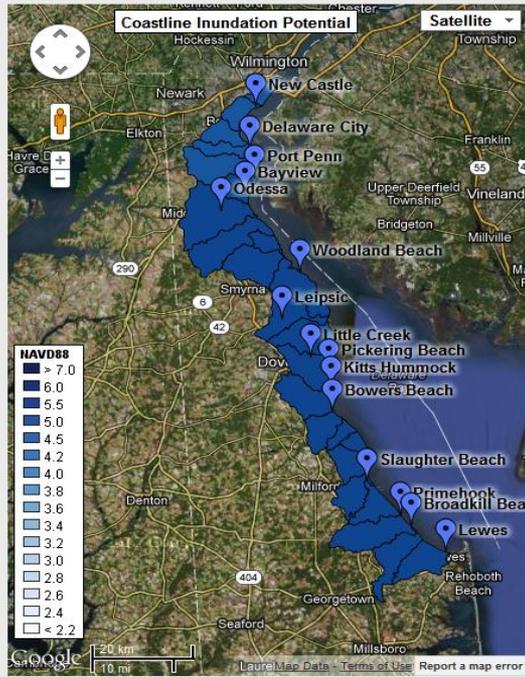


The Battery NY - Surge and model error (ft)



Delaware Coastal Flood Monitoring System

Home Community Flood Maps Current Conditions Storm Tide Forecast Weather Forecast Educational Resources FAQ

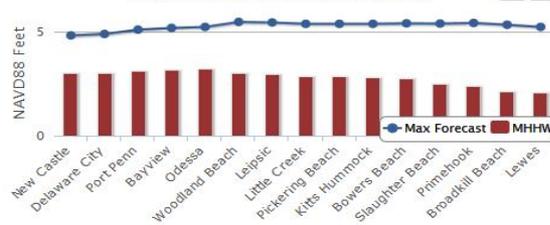


March 6, 2013 - 48hr Coastal Conditions



7 active NWS warning(s)

Maximum Forecasted Water Levels



Current Moon Phase



Waning Crescent

Upcoming High Tides

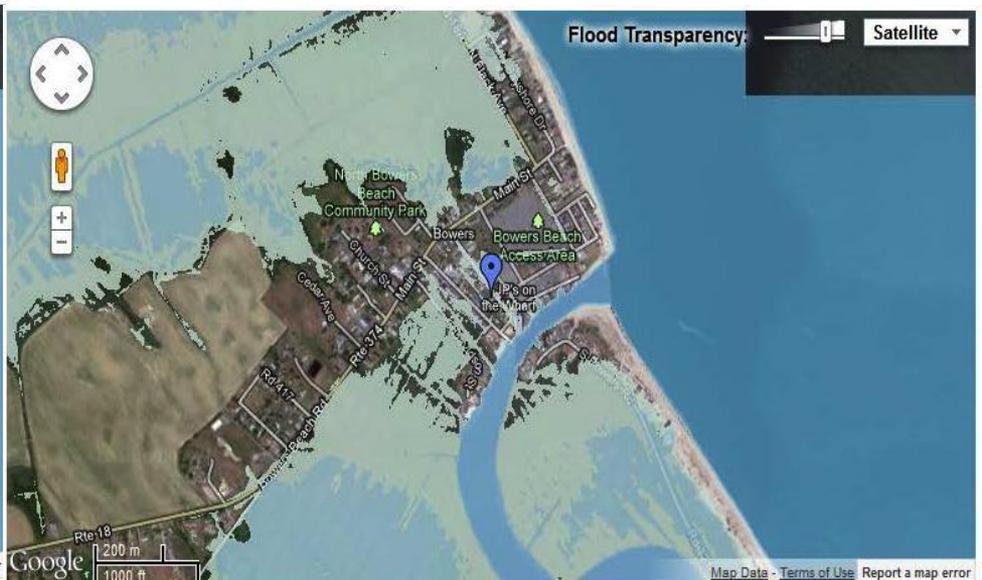
Reedy Point

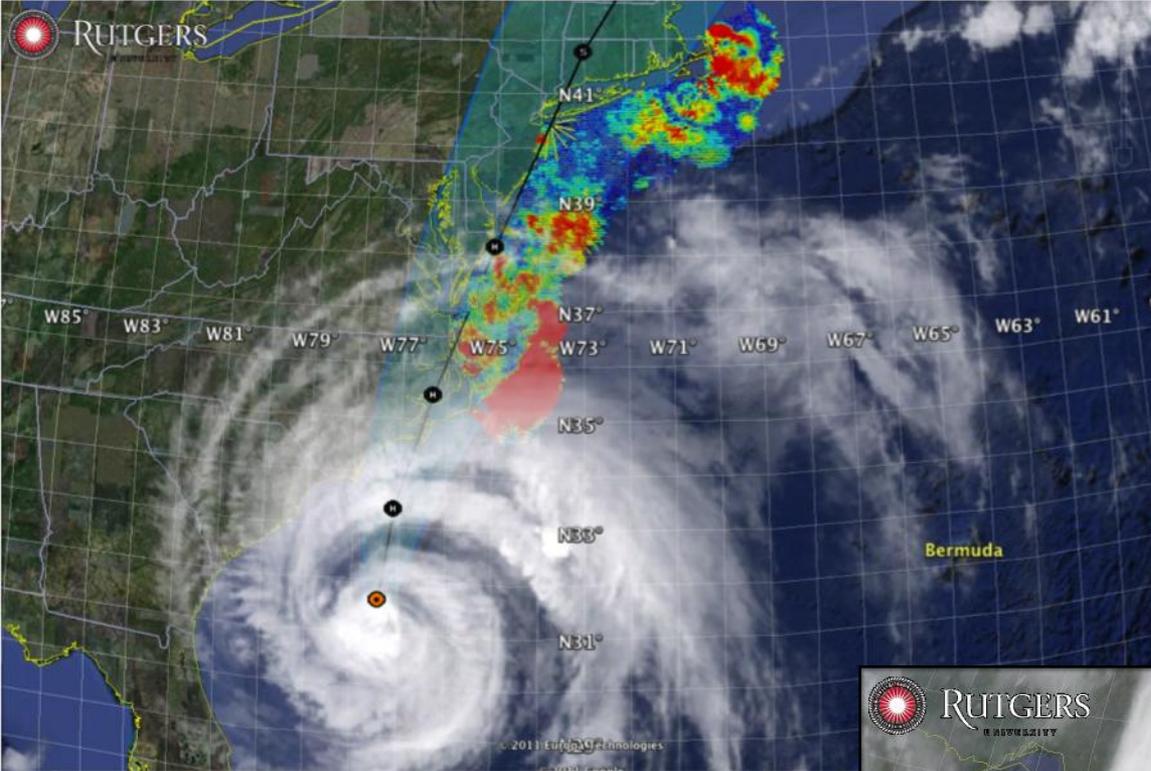
Wed 03/06 06:30 PM
 Thu 03/07 06:57 AM
 Thu 03/07 07:34 PM
 Fri 03/08 08:00 AM

Lewes

Wed 03/06 03:55 PM
 Thu 03/07 04:34 AM
 Thu 03/07 05:04 PM
 Fri 03/08 05:38 AM

Show inundation map and more details for:





← **Hurricane Irene**
 August 26, 2011
 Damage: >\$15 Billion
 Track Accurate;
 Intensity Over-predicted

Superstorm Sandy
 October 29, 2012 →
 Damage: >\$60 Billion
 Track Accurate;
 Intensity Under-predicted



IOOS INTEGRATED OCEAN OBSERVING SYSTEM

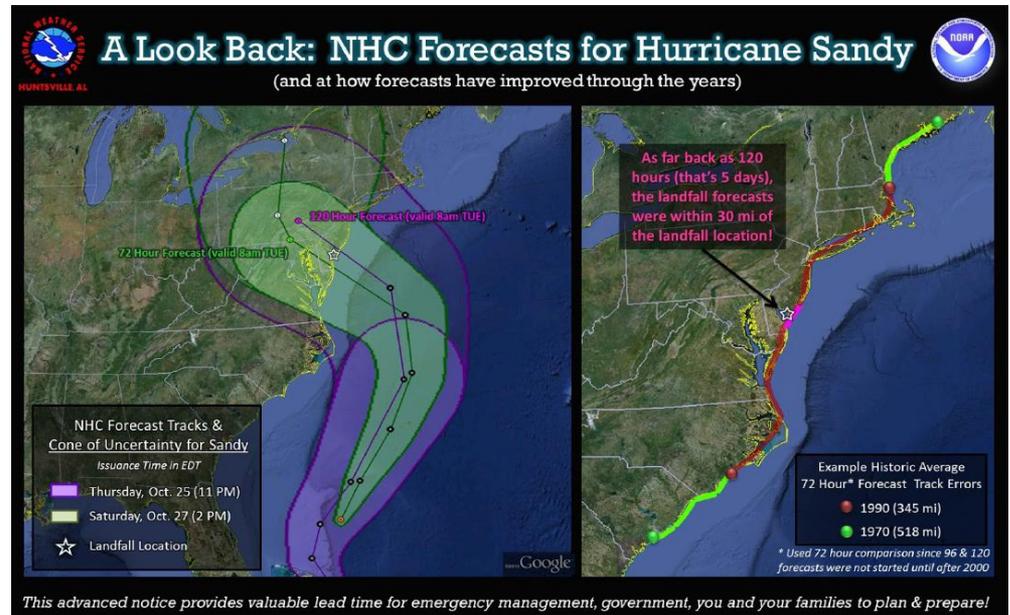


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 Ocean Information for a Changing World

Google

Reduced Impacts from Sandy

- Navy: “...80 ships sortied, saving \$500M...”
- Shipping: “...Christmas 2012 was saved...”
- Hoboken: IOOS high resolution surge forecasts saved lives & property
- Oil and Gas: “...relied exclusively on US IOOS products and services...”



Offshore Wind Energy

High Resolution Atmospheric Forecast validated with HF radar

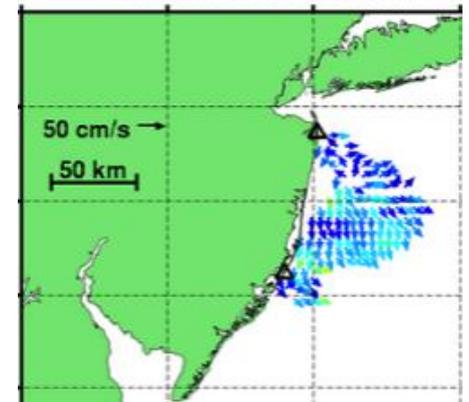
Spatial validation of Atmospheric Model with 13 MHz Multi-static HF Radar Array



Additional Radar Sites

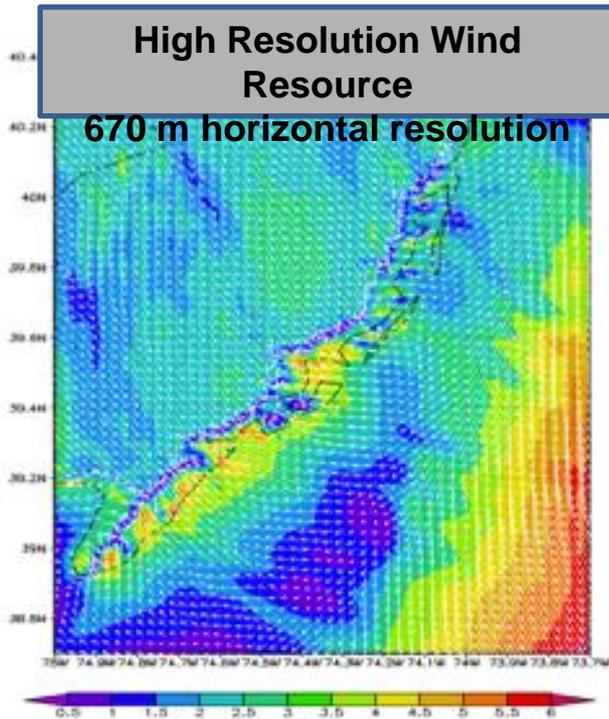


2-Site Mono-static Coverage

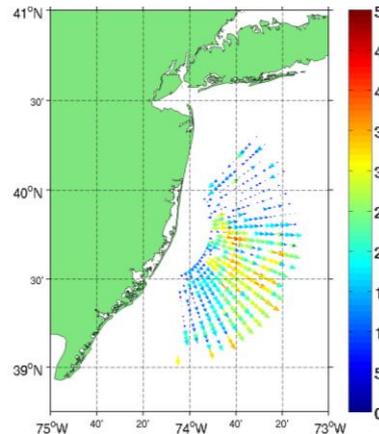


High Resolution Wind Resource

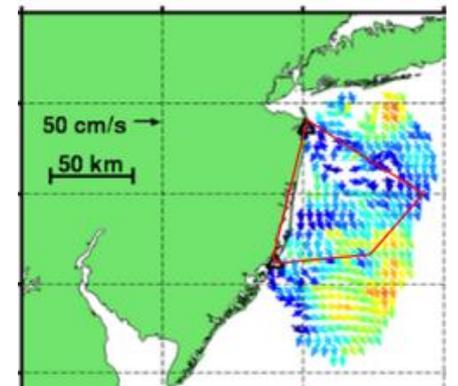
670 m horizontal resolution



Bi-static Geometries



2-Site Multi-static Coverage



A Few Lessons Learned

- ✧ Not 'operational' in the same sense as NWS
- ✧ MARACOOS = Real-time with operational aspirations
- ✧ Hardening not yet where it needs to be
- ✧ MARACOOS supports the operational system



Are we able to successfully execute R2O?

1. Research  Operations/Application
2. Research ?  Operations/Application
3. Research  Operations/Application



Product Development Infrastructure



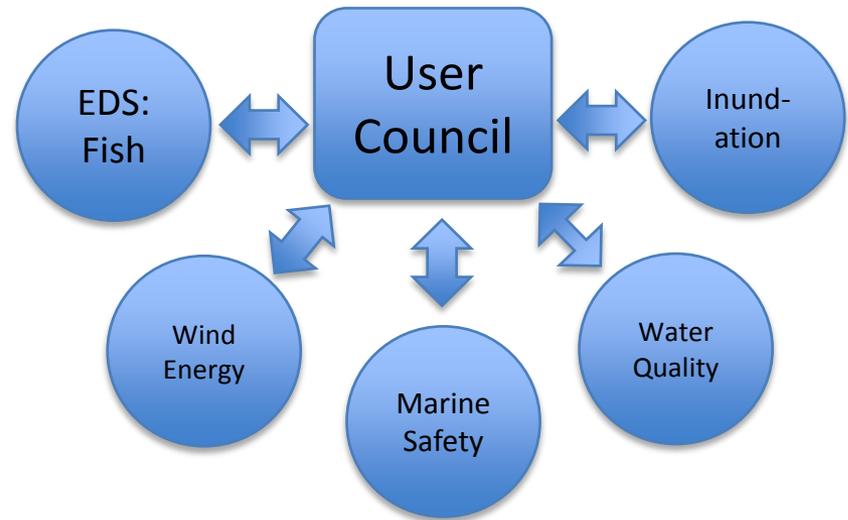
- User/Stakeholder Infrastructure

- User Council
- Product Groups

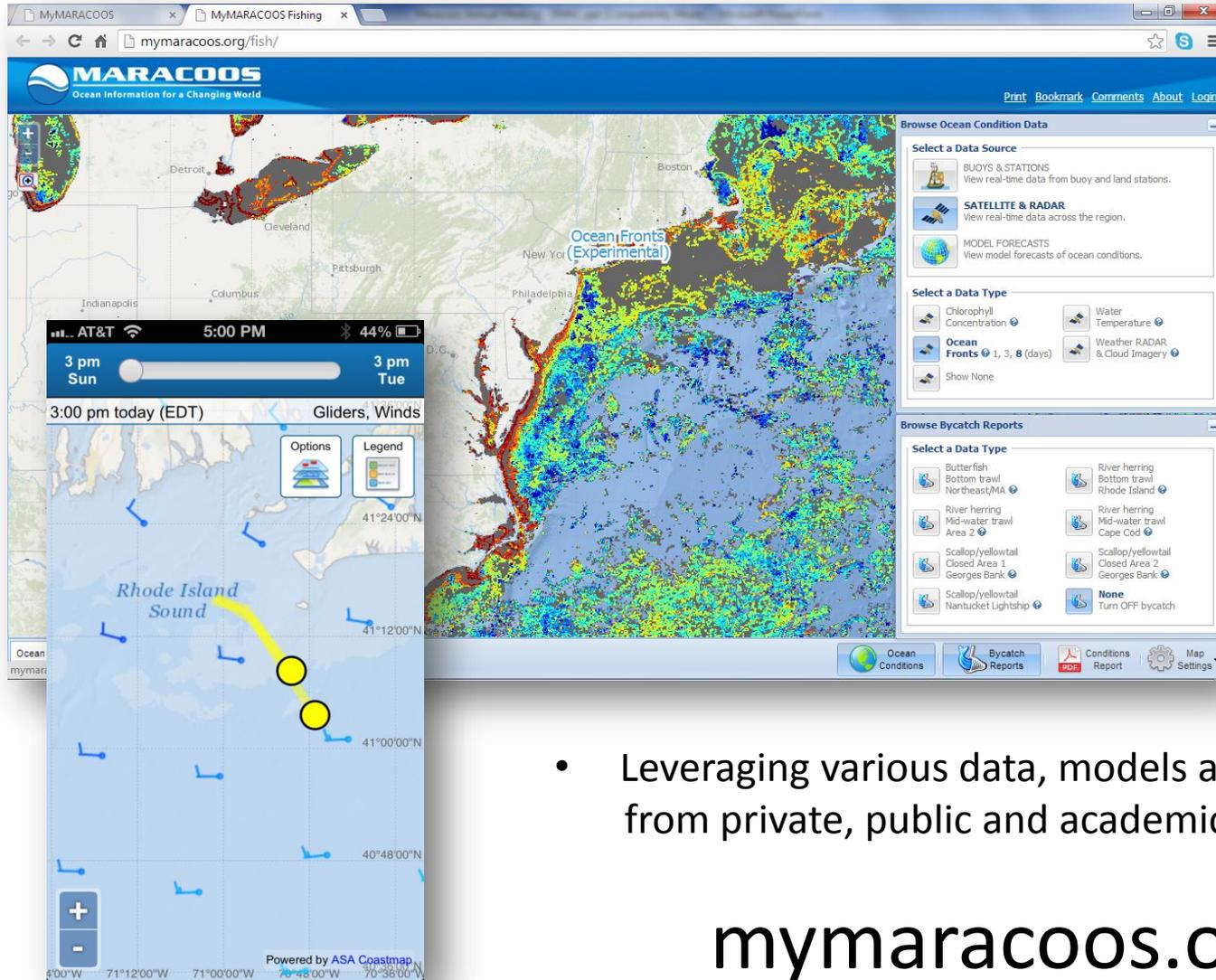
- Stakeholder Liaison Service

(Geographic and Theme-focused, and leveraged through partnerships)

- Enhanced Cross-Regional focus — Regionally and through IOOS Association



MyMARACOOS Fishing



- Web Site
- Mobile Site
- Extensive outreach activities
- Customized to meet user needs
- IOOS Standards

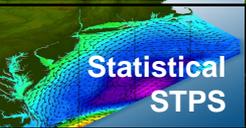
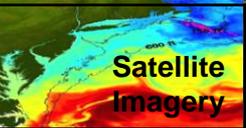
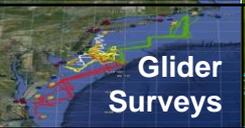
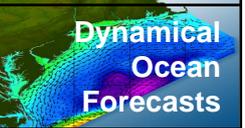
- Leveraging various data, models and expertise from private, public and academic sectors

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Regional Observation & Modeling Capabilities

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 floatables, bacteria, spill response	Surface currents for floatables, 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



Crowdsourced Bathymetry



- MARACOOS partners
- Leverage existing infrastructure
- Low-cost bathymetry

SURVICE

caris®



→ Entrepreneurship of MARACOOS partners

→ Not MARACOOS funded; but now promoted



Some successes, but...

Big challenges lie ahead:

1. Growing needs of the stakeholders 
2. Expectation to continue to build out the system (10-year BOP) 
3. Fiscal future? (in & out of government) 
4. Pressure to demonstrate value 



However...

Clear added value for society through MARACOOS:

- Stakeholder user relationships and interactions
- Serving as the gold standard for data →
One-stop-shop for high quality regional data & stds.
- Venue for drawing in and promoting product developers and collaboration
- Neutrality
- Flexibility and greater freedoms
- Great return on investment



In the present funding environment, it is **IMPOSSIBLE** to evolve and function alone.

A key way of moving forward is with collaborative and practical **PARTNERSHIPS.**



"Congress, and your mother and I are cutting off your funding."





THANK YOU



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IOOS INTEGRATED OCEAN OBSERVING SYSTEM



MARACOOS

Ocean Information for a Changing World