

## The United States Integrated Ocean Observing System (IOOS):

*A national-regional partnership working to provide new tools, observations, and forecasts to understand, manage, and protect our coastal environment*

Josh Kohut  
Rutgers University/MARACOOS

Chris Kinkade  
NOAA National Ocean Service



Enhances science and improves decision making

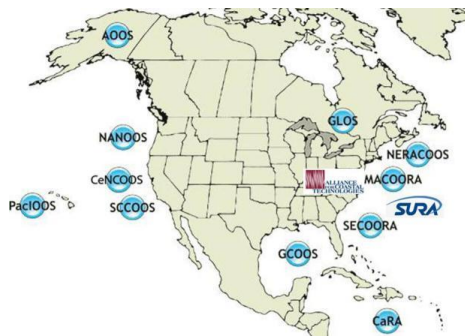
## U.S. IOOS®: Program Overview

### WHO



### WHAT

- Observations
- Data Management
- Modeling and Analysis



### WHY: 7 Goals, 1 System

Weather and climate change  
Maritime operations  
Natural hazards  
Homeland security  
Public health risks  
Healthy coastal ecosystems  
Sustain Living Marine Resources

### WHERE: Global and Coastal Components



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# U.S. IOOS®

## US IOOS: a National Endeavor

### *Federal Players*

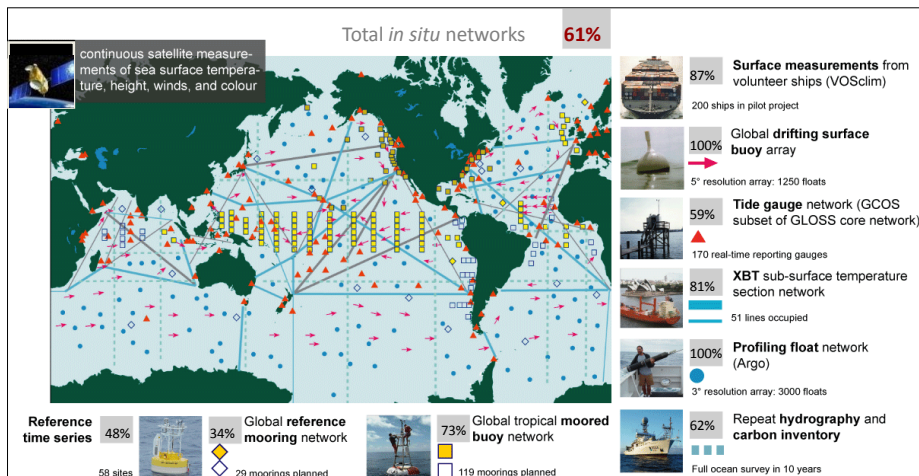


## But Part of a Global Framework



**Enhances science and improves decision making**

## Global Component: Global Ocean Observing System for Climate



GCOS  GOOS  jcomm   
OCEANOGRAPHY & MARINE METEOROLOGY



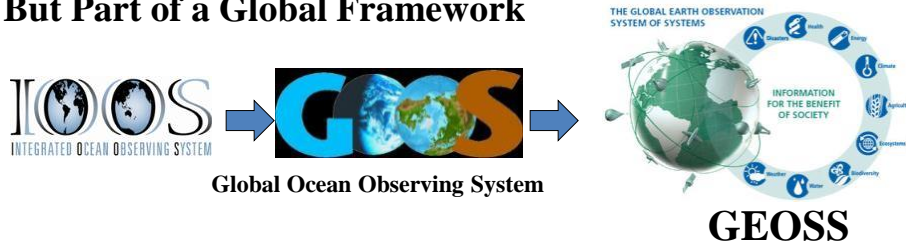
**IOOS<sup>®</sup> Enhances science and improves decision making**

# U.S. IOOS®

## US IOOS: a National Endeavor



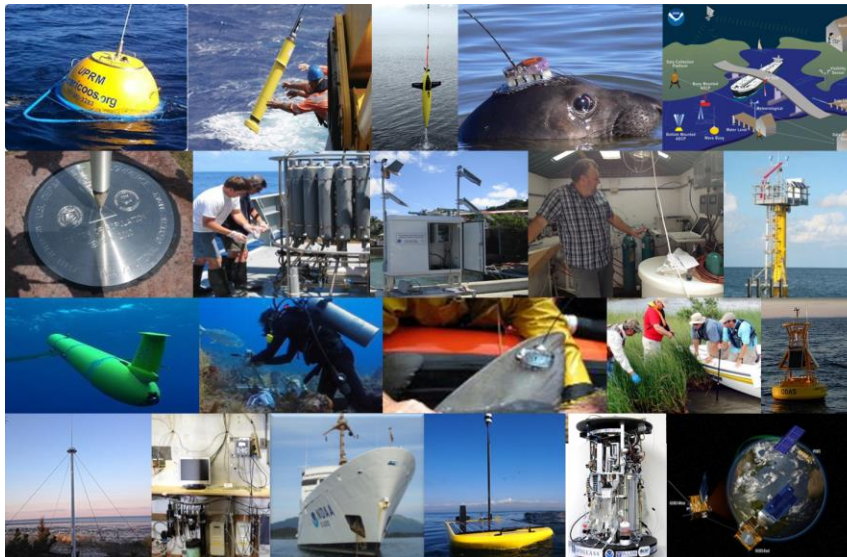
## But Part of a Global Framework



**IOOS® Enhances science and improves decision making**

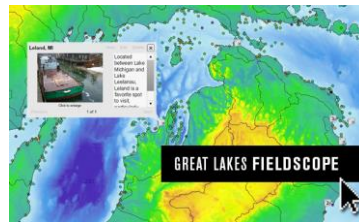
## 26 coastal and ocean variables within IOOS' mission

*Sampled through a range of platforms and sensors*



**IOOS® Enhances science and improves decision making**

## U.S. IOOS®: Education and Outreach



## Data Management & Communication (DMAC)

DMAC is the IOOS sub-system (standards, protocols and best practices, software, and hardware) that ensures ocean observation data can be discovered, accessed and utilized in applications to meet user needs.

- **DMAC Guiding Principles:**
  - Ensure Open Data Sharing: Full and open exchange of data
  - Employ a Standards-based Approach: Use community-based best practices and standards for data management
  - Use Web Services: Enable discovery & access of data
  - Ensure Data Stewardship
  - Conduct Quality Control/Quality Assurance on all data





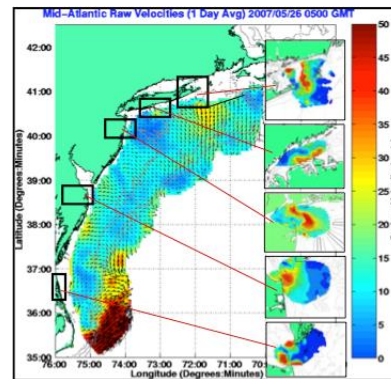
## Examples of National Observing Networks

### Stakeholders

- > 30 institutions operate HF Radars; represents a Federal/State investment of \$55M in last 15 years
- Used by >40 government/private entities
- Partnership with Industry: US-based CODAR Ocean Sensor

### Who Depends on it

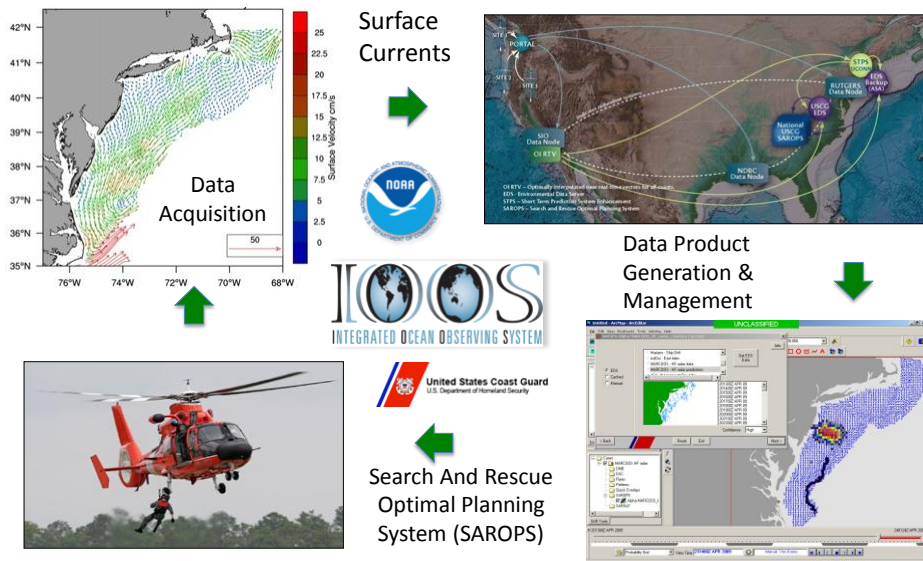
- USCG Search and Rescue: Oil spill response
- Water quality; Criminal forensics
- Commercial marine navigation
- Offshore energy; Harmful algal blooms
- Marine fisheries
- Emerging - Maritime Domain Awareness
- Emerging – Tsunami



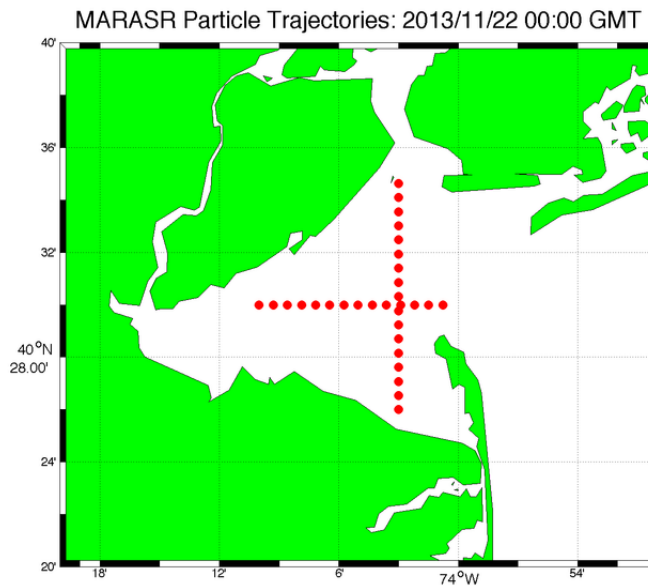
**IOOS®** Enhances science and improves decision making

## Surface Currents guide Search And Rescue

*Decreases search area by 66% in 96 hours*



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## U.S. IOOS®: Regional Component

### IOOS Regional Component

Focused on:  
Marine Operations  
Coastal Hazards  
Climate Variability & Change  
Ecosystems,  
Fisheries, Water  
Quality

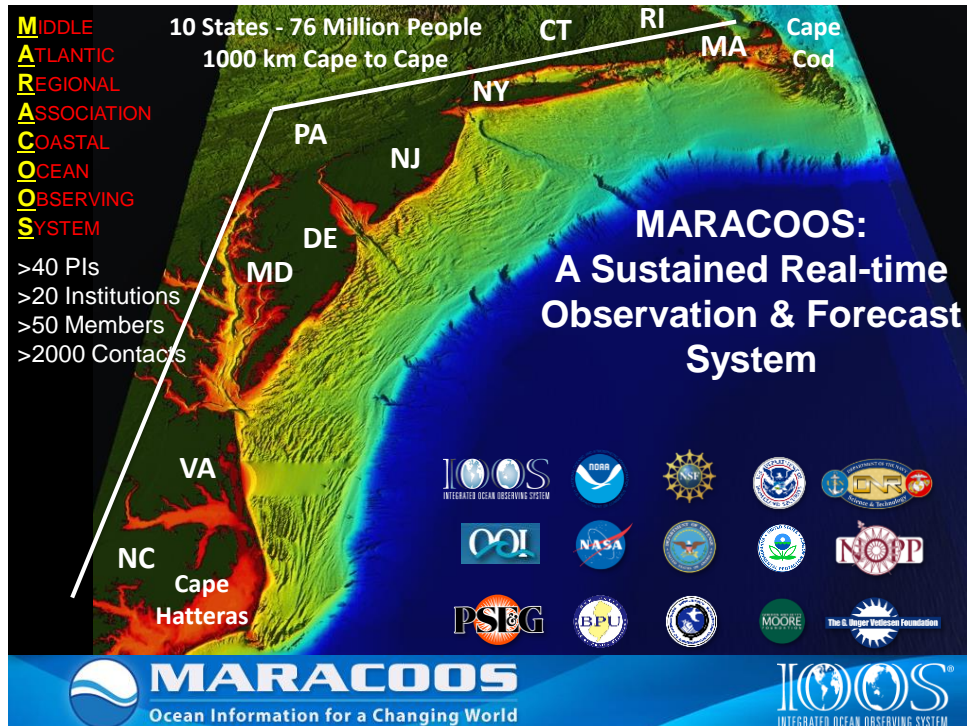
Comprised of State,  
Local Tribal  
governments;  
Academia; Private  
Sector



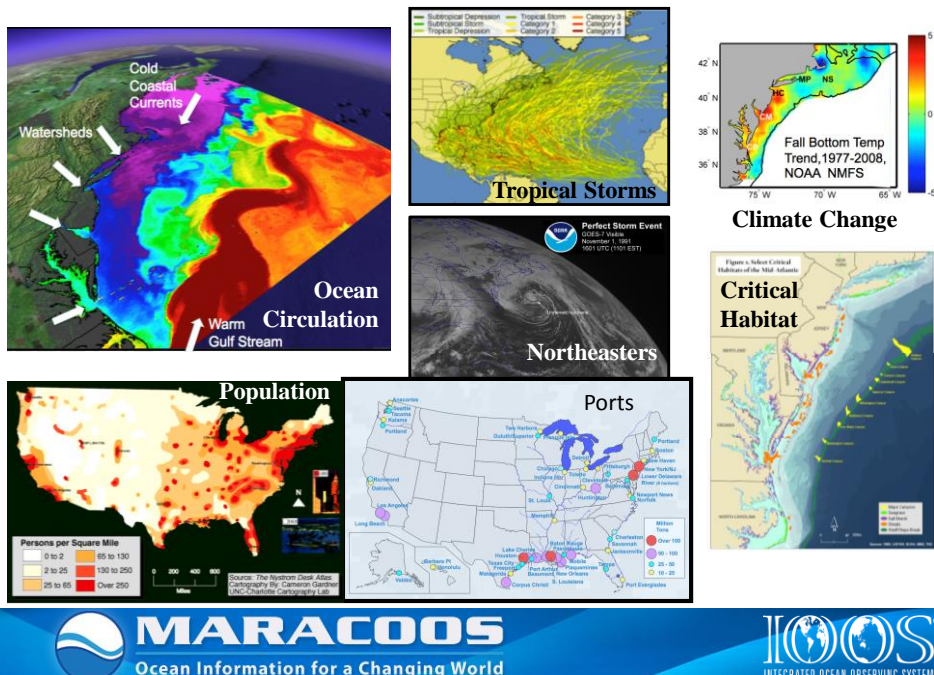
- Meeting National missions through...
  - Expanded observations and modeling capacity
  - Connections to users and stakeholders
  - Implementation of national data standards
  - Products transitioned to other regions and to National operations



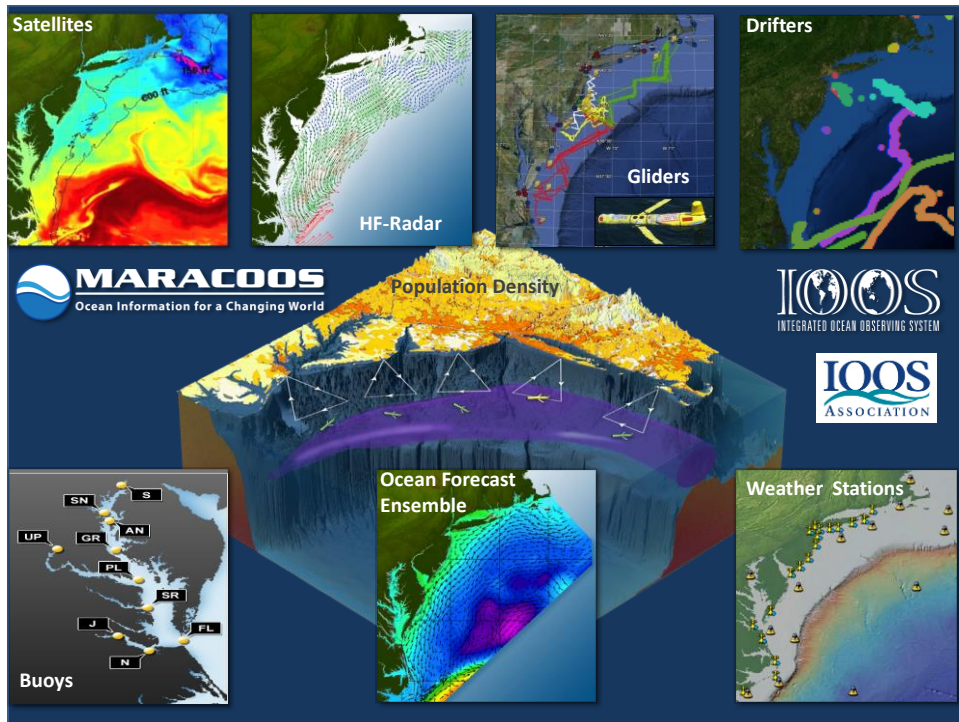
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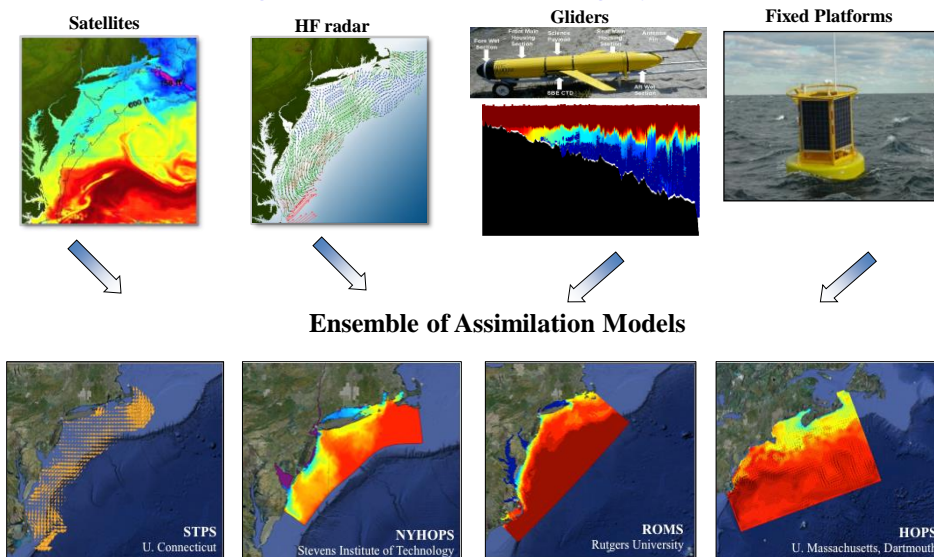
## REGIONAL DRIVERS







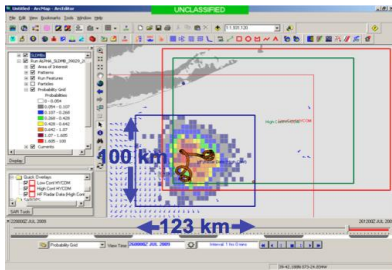
## Regional Ocean Observing System



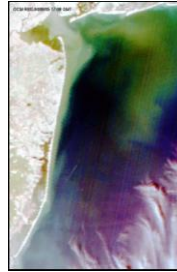


## REGIONAL THEMES

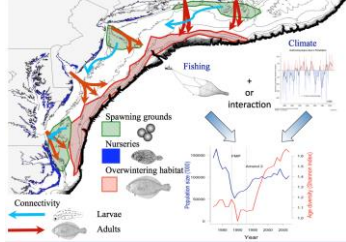
### 1) Maritime Operations – Safety at Sea



### 3) Water Quality – a) Floatables, b) Hypoxia, c) Nutrients



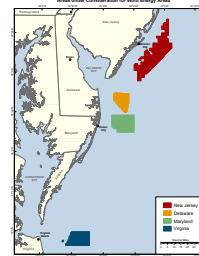
### 2) Ecosystem Decision Support - Fisheries



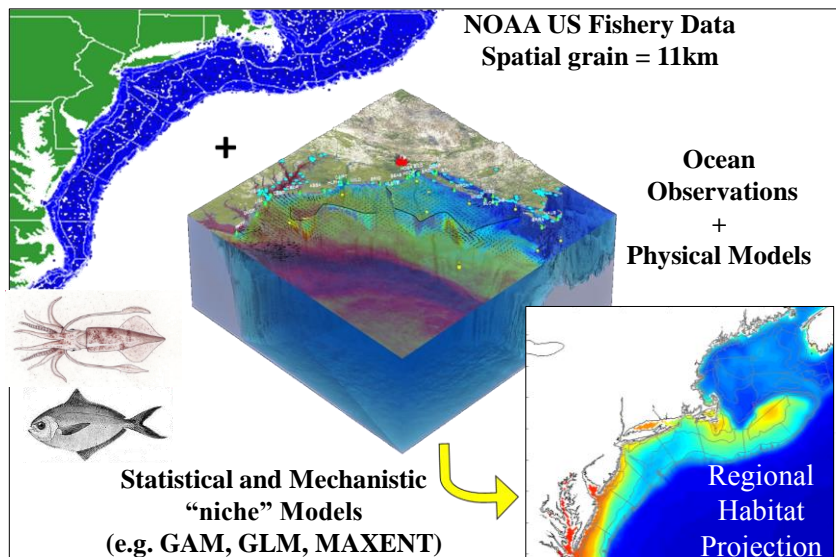
### 4) Coastal Inundation - Flooding



### 5) Energy – Offshore Wind



## Approach: Regional Habitat Models



## OpenOcean Study Group



### Industry/Outreach

Chris Roebuck  
Dan & Lars Axelsson  
Hank Lackner  
Geir Monsen (Seafreeze)  
Greg DiDomenico  
(Garden State Seafood)  
Lunds Fisheries  
Eleanor A. Bochenek (Rutgers)  
John Hoey (NOAA/NEFSC)

### Fishery Scientists/Ecologists

**John Manderson**  
(NOAA/NEFSC)  
Laura Palamara (Rutgers)  
Olaf Jensen (Rutgers)  
Tim Miller (NOAA/NEFSC)  
Chuck Adams (NOAA/NEFSC)  
Howard Townsend (NOAA/NEFSC)  
John Quinlan (NOAA/NEFSC)  
David Richardson (NOAA/NEFSC)

### Fisheries Management

Jason Didden (MAFMC)  
Rick Seagraves (MAFMC)

### Human Dimensions

Steven Gray (U Mass.)

### Physical and Biological Oceanographers

Josh Kohut (Rutgers)  
Matt Oliver (U. Delaware)  
Andre Schmidt (SMAST)  
Nickitas Georgas (Stevens Inst.)  
Enrique Curchitser (Rutgers)

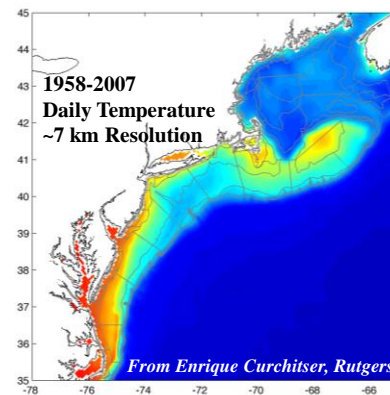
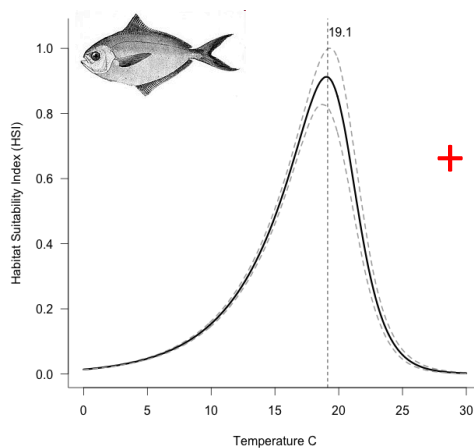


NMFS Northeast Cooperative Research  
NMFS Office of Science and Technology

## Mechanistic Model v. 3.0

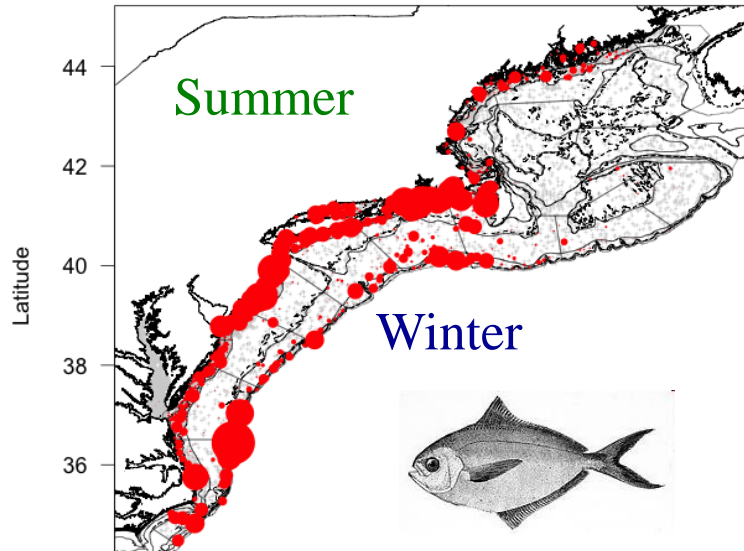
Niche model: nonlinear extension of  
Boltzmann-Arrhenius equation  
(mechanistic basis in enzyme kinetics)

Water temperature  
hindcast from  
oceanographic model



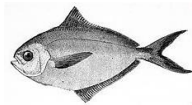
## Why focus on availability ( $\rho$ )?

Temperature dependent seasonal migrations spring & fall  
between under-sampled coastal zone & shelf break habitats

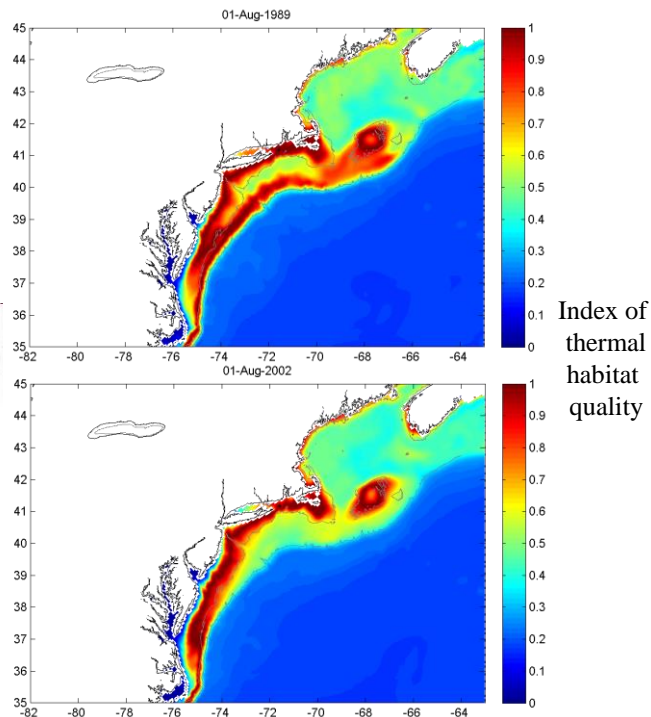


### Mechanistic Habitat Model *Daily: 1958-2007*

1989-1992



2002-2004





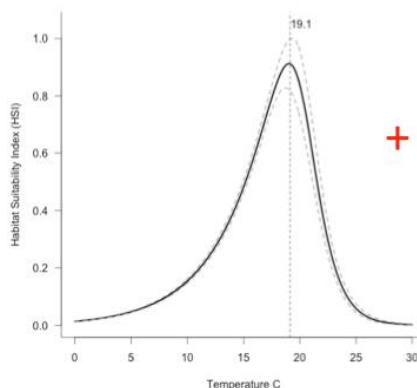
## From the Mid Atlantic Fishery Management Council (MAFMC) draft 2014 Environmental Assessment for the Butterfish and Longfin Squid fishery specifications:

- “The butterfish fishery has mostly been an **incidental fishery** since 2002.
- 2014 is the first year of a small directed fishery, with a landings limit of **3,200 mt.**
- If that limit is caught at 2013 average prices (\$1,481 mt), the resulting revenues would be about **\$4.7 million.**
- Under the proposed 2015 specifications, the average landings limit for 2015-2017 would be **21,408 mt.** This could potentially translate into **\$31.7 million** additional ex-vessel revenues at 2013 prices.”
- It is not clear that the fishery will actually land such higher amounts or if the price would remain near \$1,481/mt at higher landings levels, so the **\$31.7 million** value is likely an **“upper end” possibility.**”

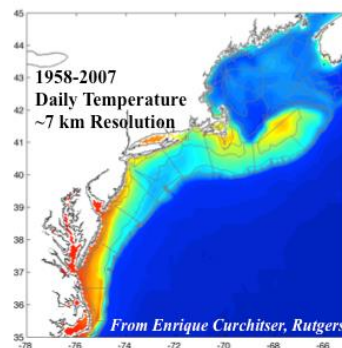
## Ecological Decision Support: Opportunities



*2015 Bluefish Assessment*



*2015 Scup Assessment*



# USING SATELLITES AND AUVS IN AN INTEGRATED OCEAN OBSERVATORY TO IDENTIFY ATLANTIC STURGEON HABITAT



Matthew Breece<sup>1</sup>, Keith Dunton<sup>2</sup>, Dewayne Fox<sup>3</sup>,  
Matthew Oliver<sup>1</sup>

1. University of Delaware, 2. Stony Brook University, 3. Delaware State University

## Acknowledgements



**NOAA FISHERIES**  
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION



**clear into the future**  
A DUPONT COMMUNITY-BASED CONSERVATION PROGRAM



**MARACOOS**  
Ocean Information for a Changing World

**RUTGERS**

Coastal Ocean  
Observation Lab

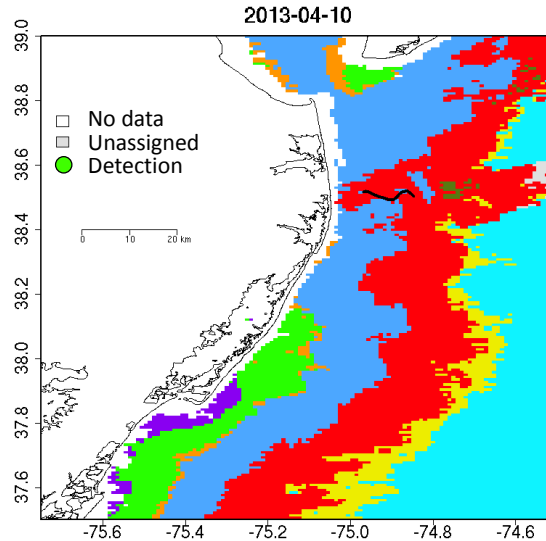


**The Atlantic Cooperative  
Telemetry Network**



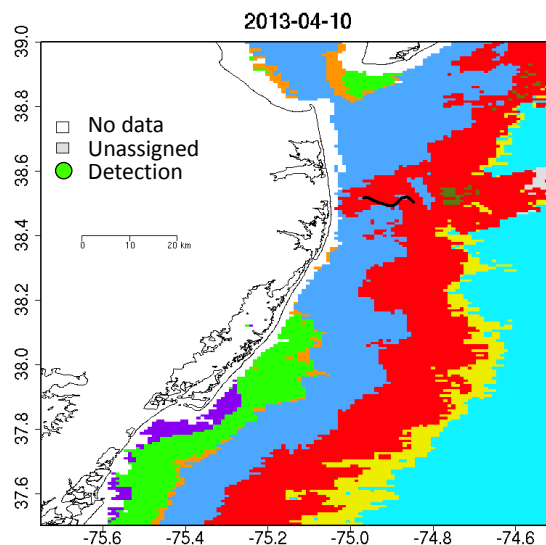
## Sturgeon Mission (2013)

- 79 Days at sea
  - 10 April – 28 June
- 1,420 km
- 71,000 Profiles
  - Salinity
  - CHL
  - CDOM
  - Temperature
  - Oxygen
- 62 Sturgeon
- 187 Detection Hours



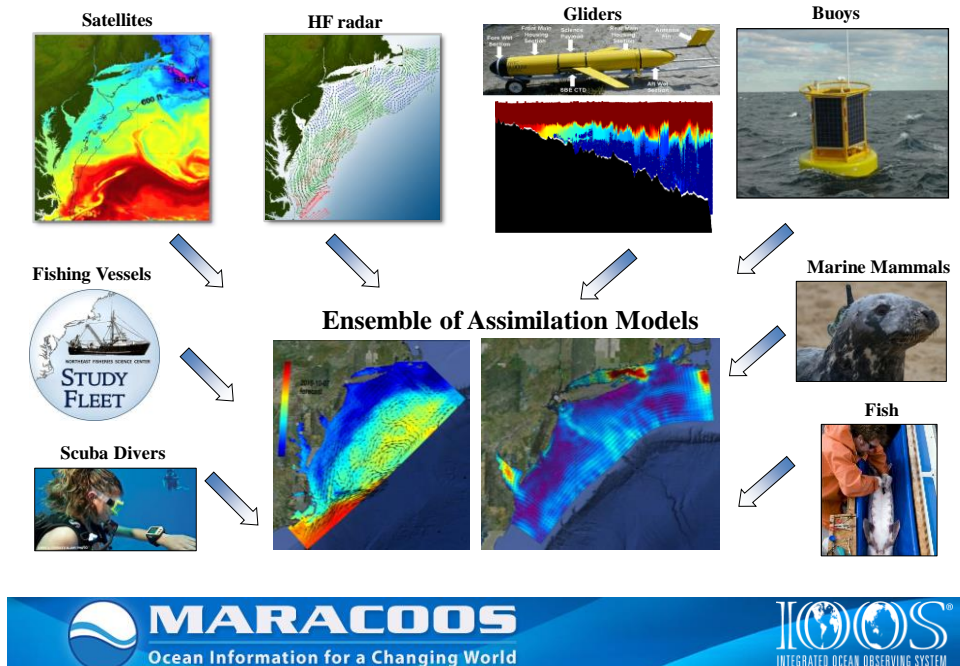
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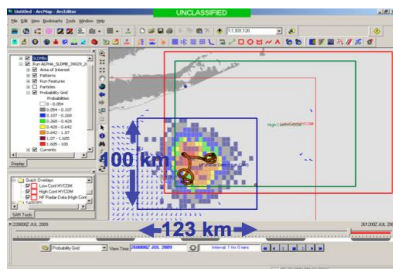


## Regional Ocean Observing System: Networked Ocean World

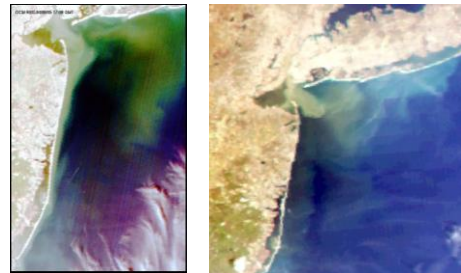


## REGIONAL THEMES

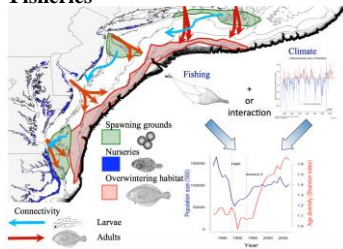
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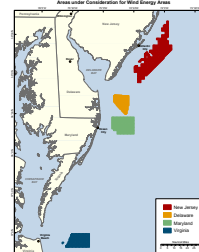
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### 4) Coastal Inundation - Flooding



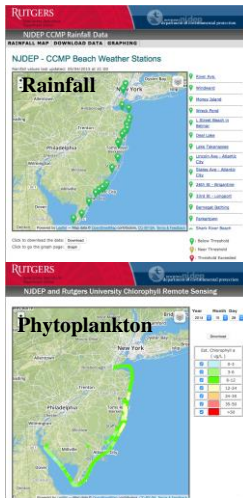
### 5) Energy – Offshore Wind



## Coastal Water Quality: New Jersey Partnerships



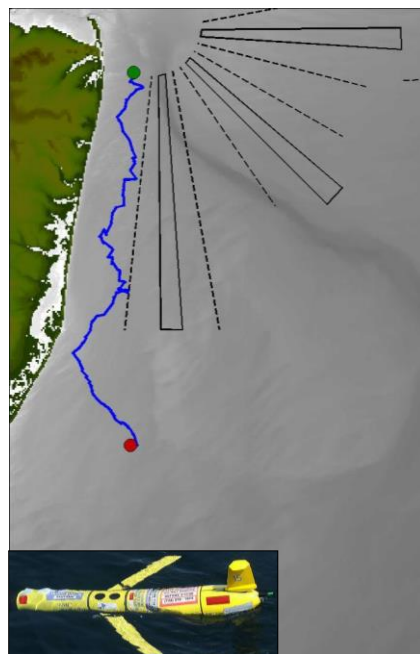
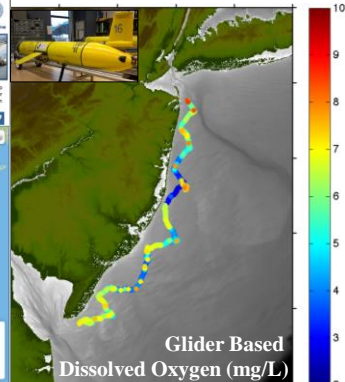
### Data Sharing



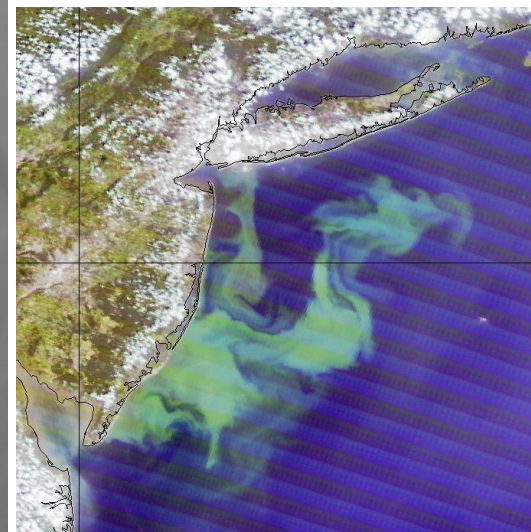
### Beach Monitoring and Public Outreach



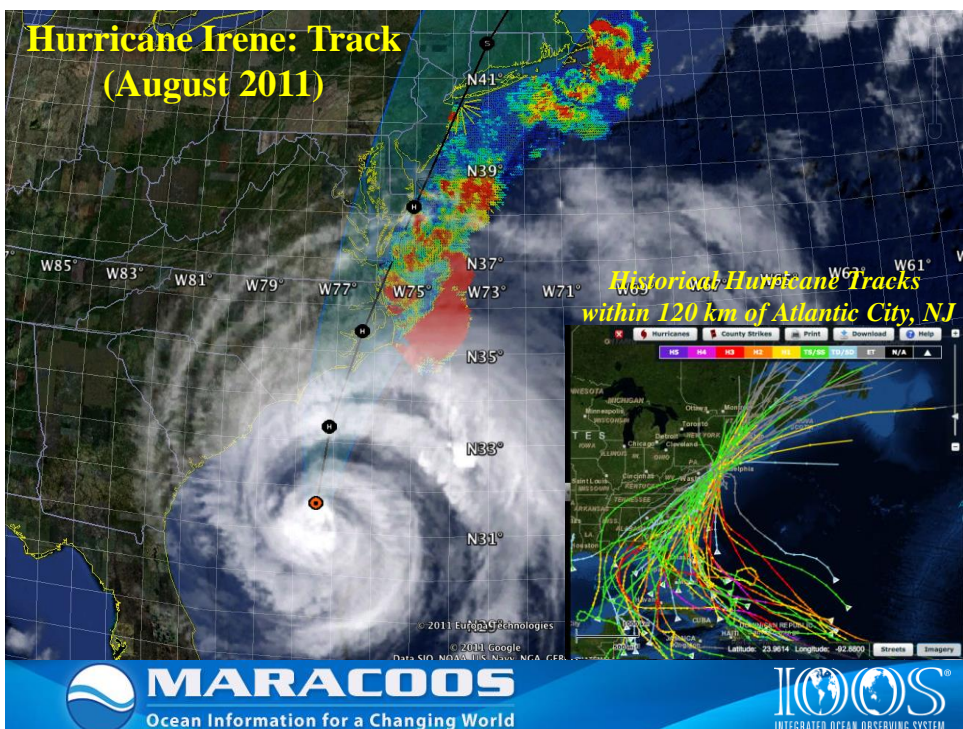
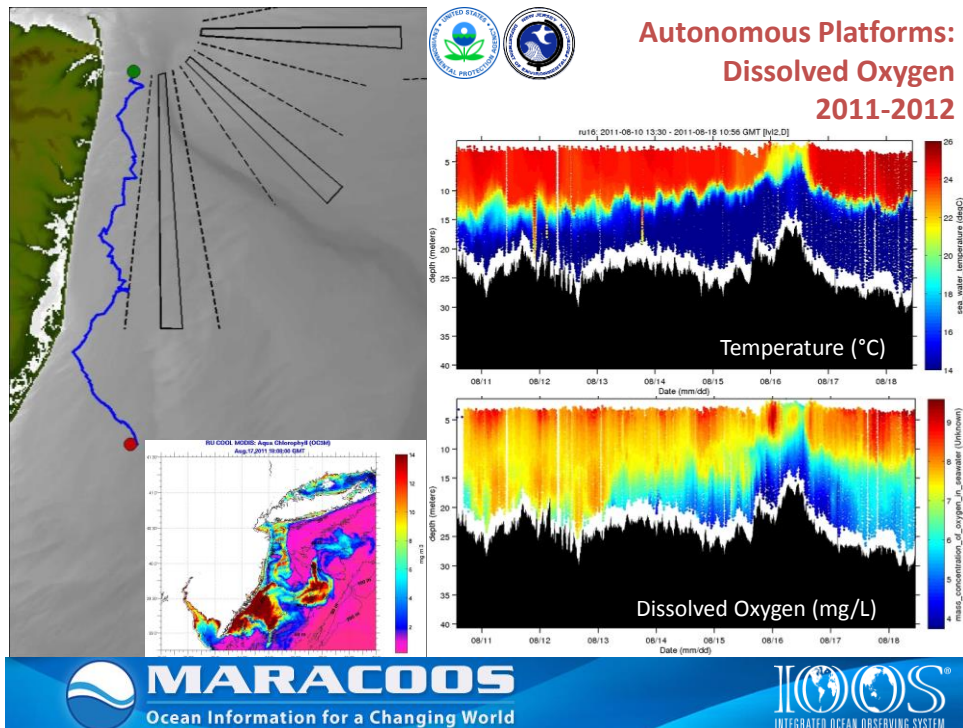
### Hypoxia Monitoring



### Autonomous Platforms: Dissolved Oxygen 2010-Present

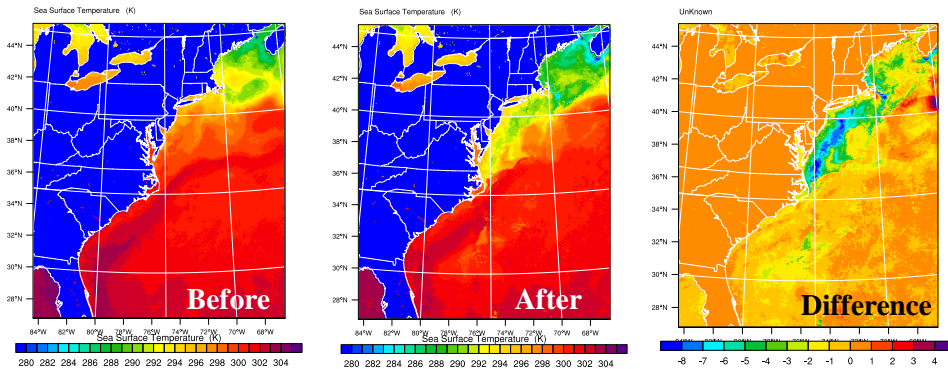






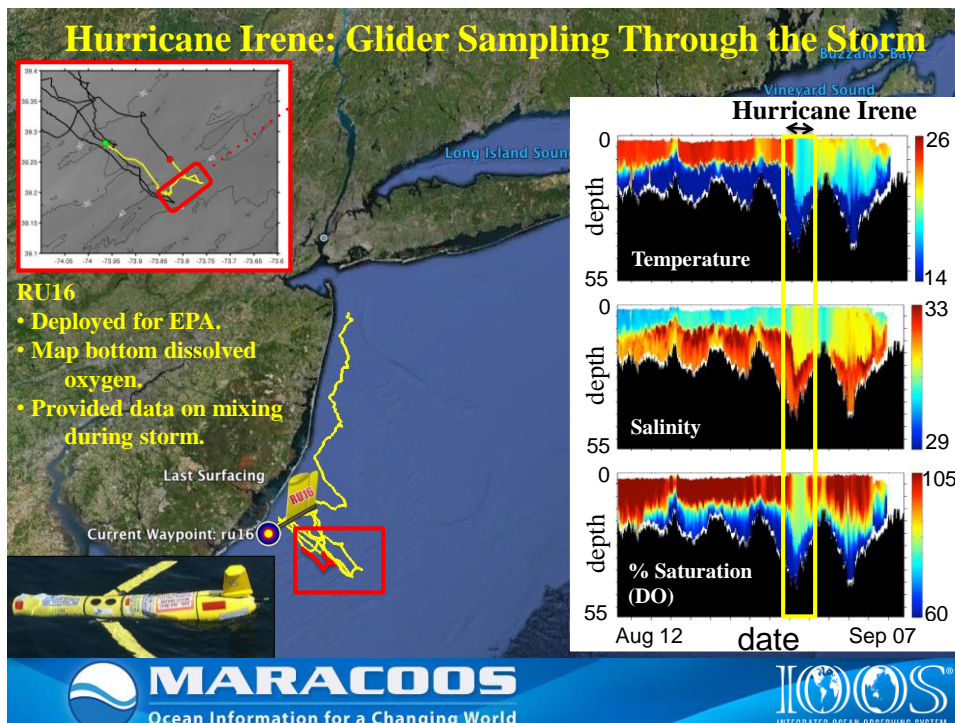


## Pre- and Post-Hurricane Irene Sea Surface Temperatures

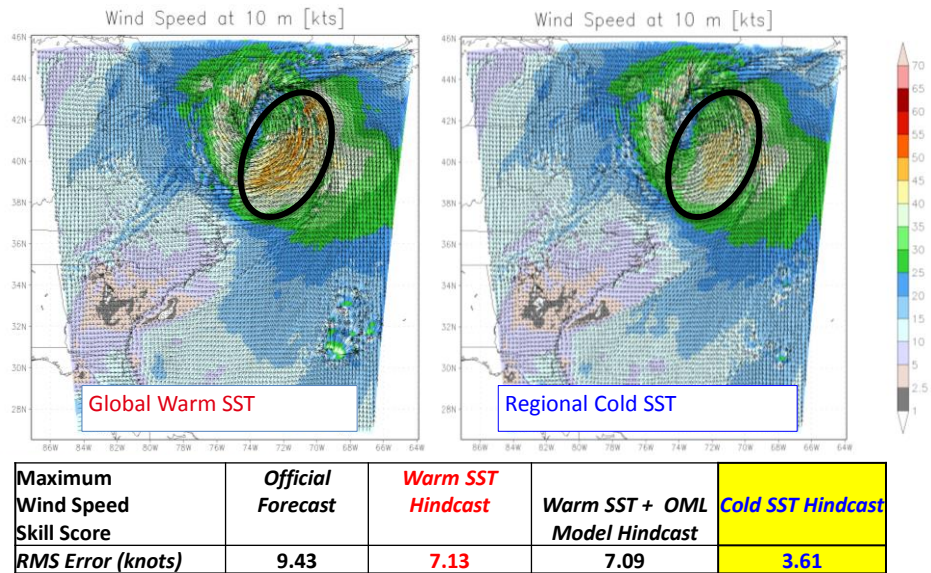


The 6C -10C Cooling occurred:

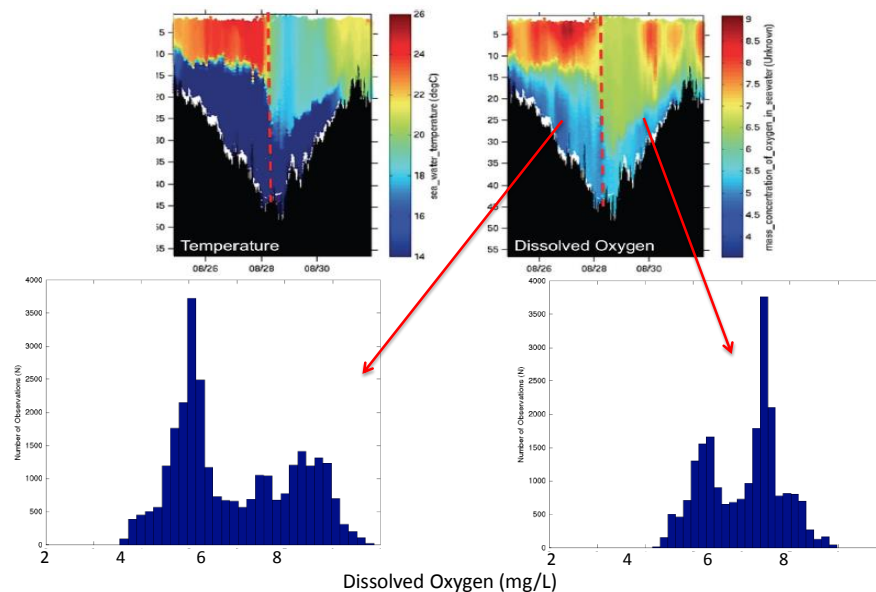
- With the outer wind bands
- Before the eye passed over



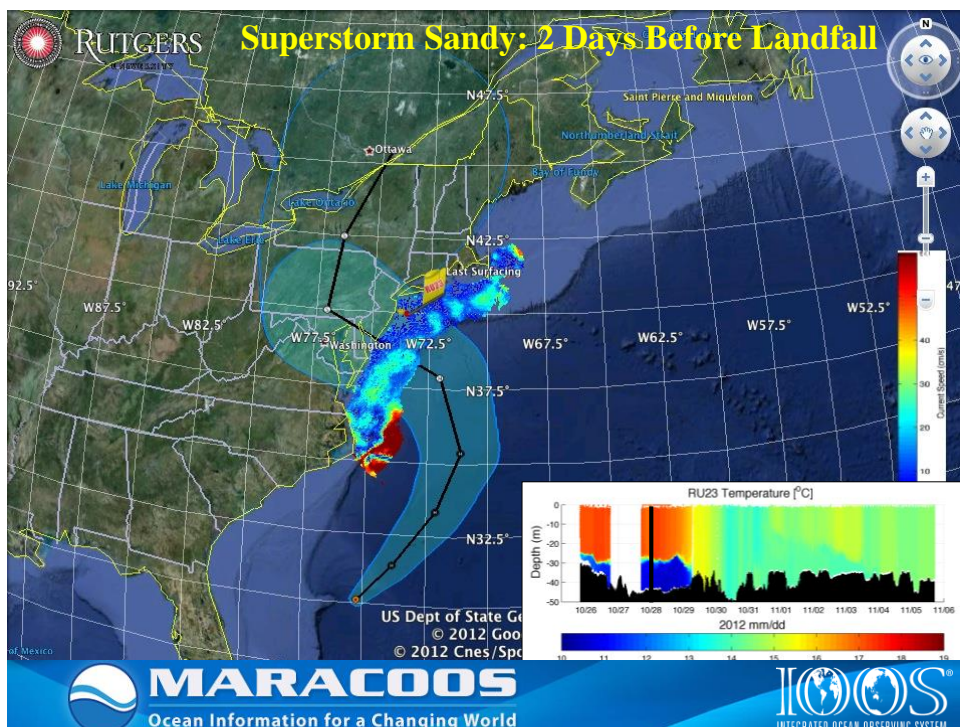
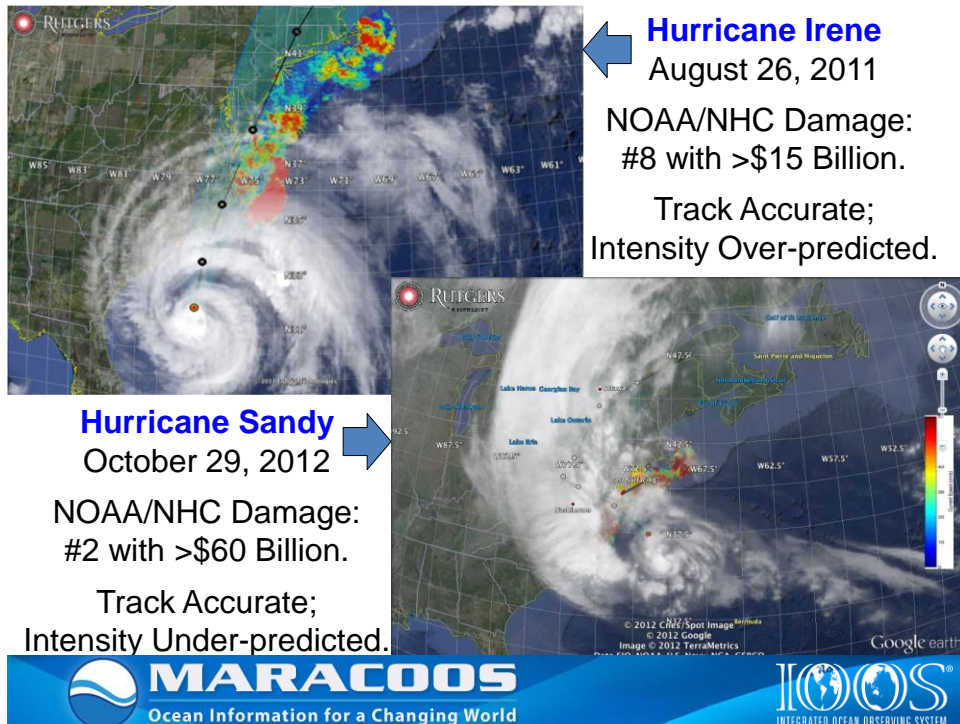
## Hurricane Irene SST Sensitivity Hindcast



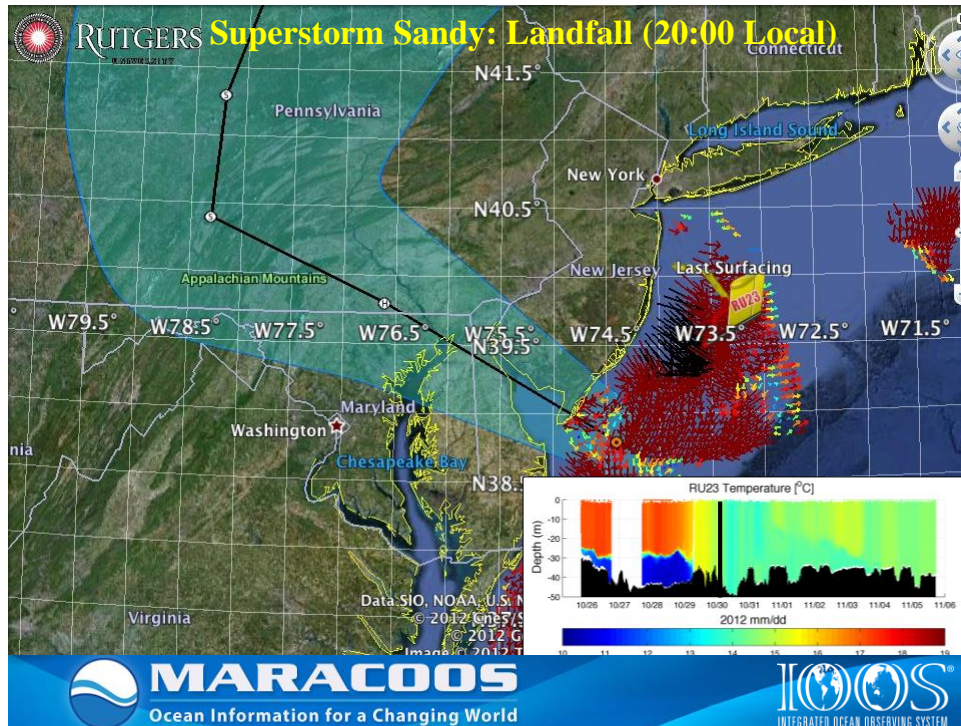
## Water Quality – Tracking Hurricane Irene









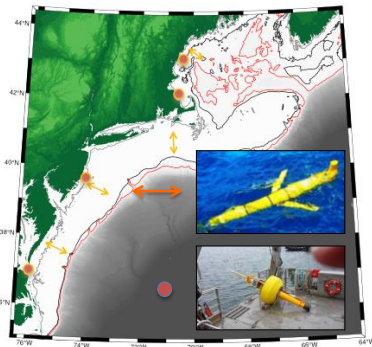


## CINAR TEMPESTS



**The Experiment to Measure and Predict East coast STorm Strength**

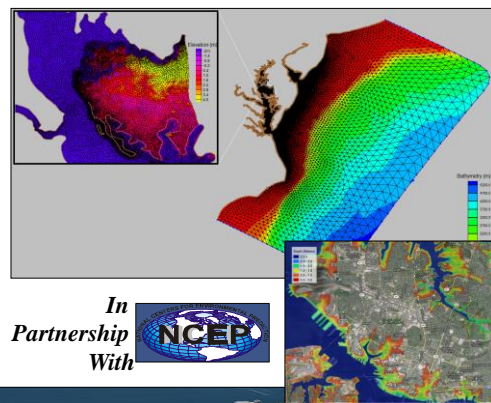
### Responsive Observing System



### Partner Institutions:

Woods Hole Oceanographic Institution  
University of Maine  
Rutgers University  
University of Maryland  
University of Massachusetts, Dartmouth  
Gulf of Maine Research Institute

### Nested Prediction



In Partnership With



## Summary

- Ocean observatories capture the dynamics of coastal systems
- Products **co-developed with scientists, managers, and the private sector** can support greater scientific understanding, management, and assessment.
- Through these partnerships, interaction can yield useful and timely products in support of ecosystem based management and assessment.
- Significant opportunity exists with leveraged effort to better link the coastal ocean resources to those within the watersheds.

*For more information:*

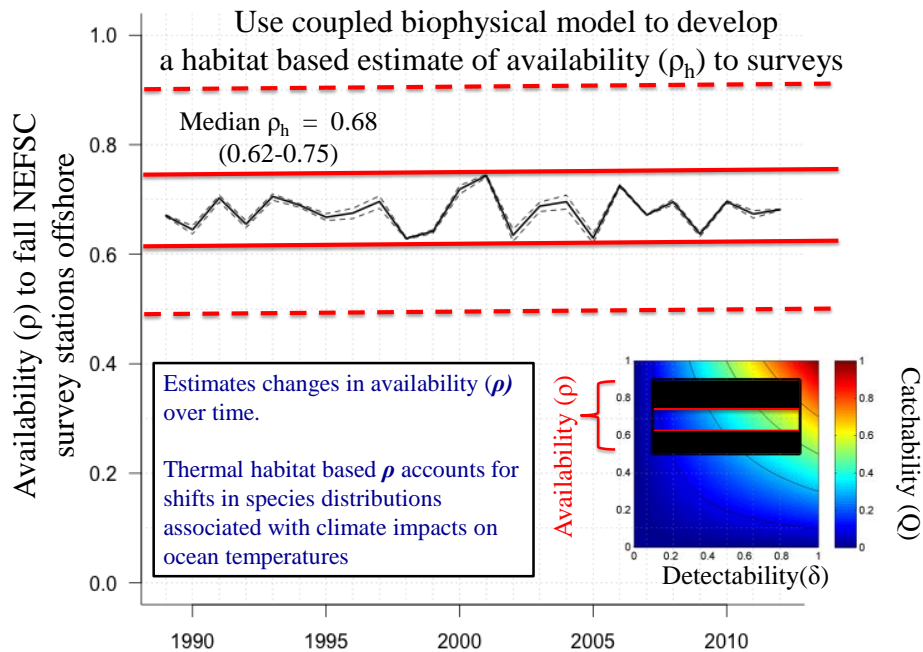
*[ioos.noaa.gov](http://ioos.noaa.gov)*

*[maracoos.org](http://maracoos.org)*



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## Approach:



## Examples of National Observing Networks

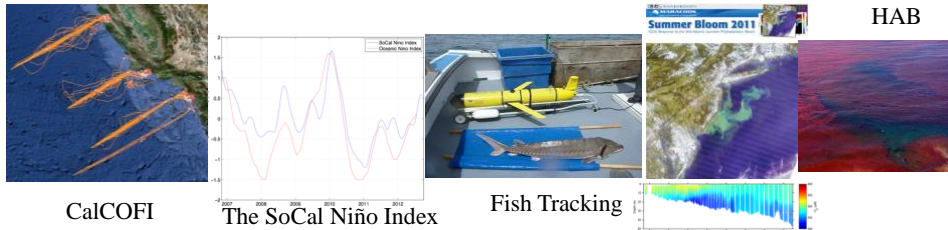


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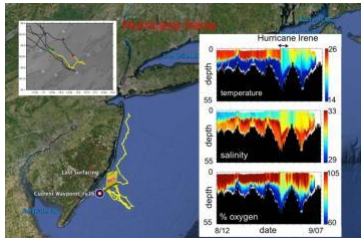


# Glider Missions

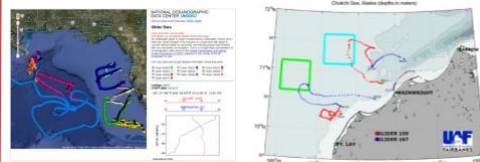
Climate/Ecosystem/Fisheries Management/Water Quality



## Hurricane Prediction



## Response to Oil Spill



Deep Water Horizon

Alaska



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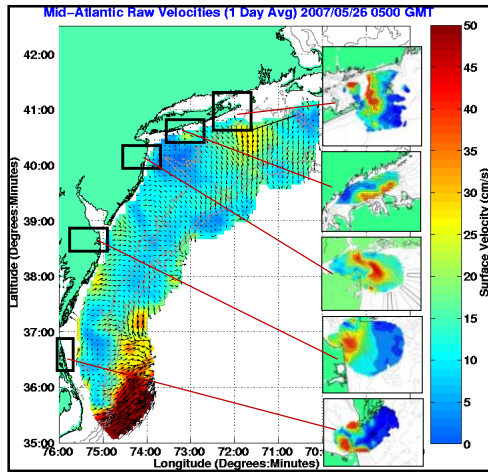
## DATA & PRODUCTS

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





## High Frequency Radar – Since 1996



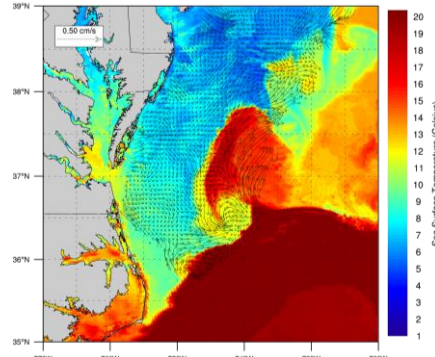
Nested Grids of Hourly Surface Current Maps ^

Combined CODAR & Satellite Products >



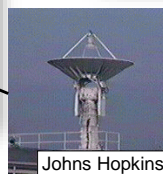
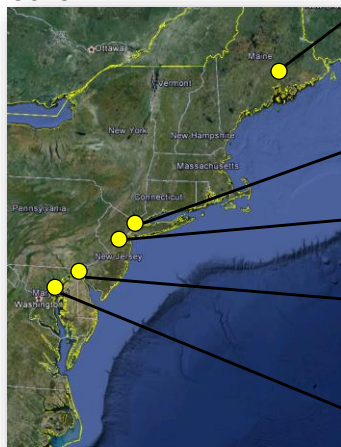
Corporate Partner:

CODAR Ocean Sensors

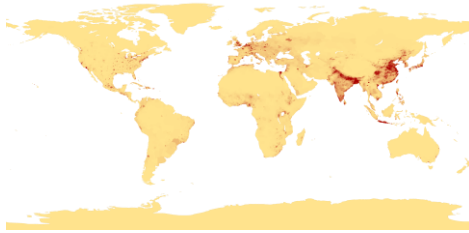


## Real-Time Satellite Ground Stations in the Northeast U.S.

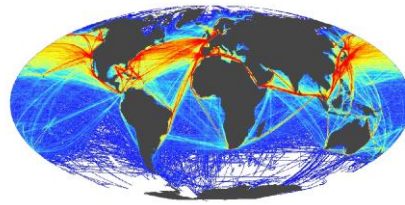
Satellites: NPP, Terra, Aqua,  
NOAA Polar Orbiters, Metop &  
GOES



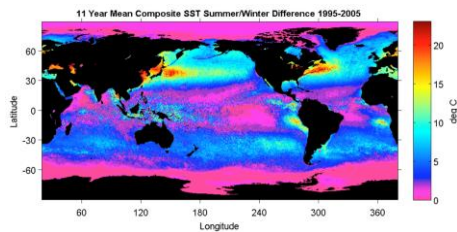
## Global Drivers



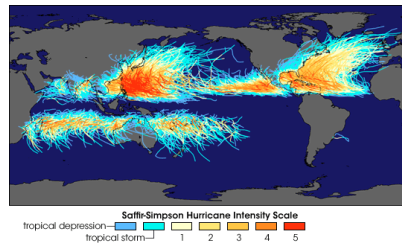
Coastal Population Centers



International Commerce



Ocean Seasonality

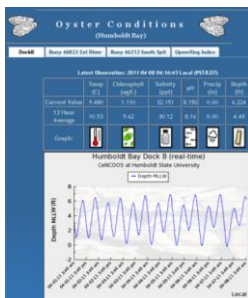


Tropical Cyclones



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## Selected Products: Climate Variability & Change



### Ocean Acidification

#### Partnership with shellfish growers



**Observations:** Single system; multiple uses - NOAA PMEL working with RAs to deploy CO<sub>2</sub> sensors

Protocols for Demonstrating the Performance of In Situ pCO<sub>2</sub> Analyzers  
May 22, 2009



ALLIANCE  
FOR COASTAL  
TECHNOLOGIES

### Validating Sensors

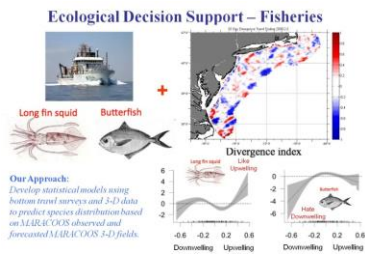
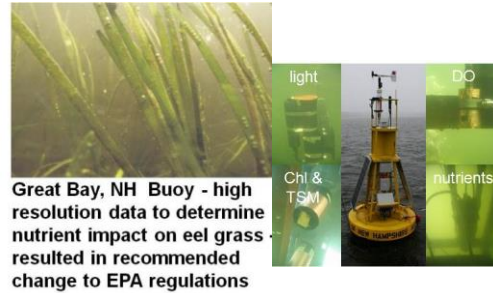
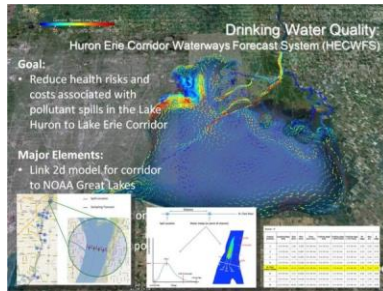


*Integrated Coral Reef Monitoring*



Enhances science and improves decision making

## Selected Products: Ecosystems, Fisheries & Water Quality



Enhances science and improves decision making