U.S. Integrated Ocean Observing System (U.S. IOOS)
Contributions To Marine Spatial Planning

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IOOS Association
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U.S. IOOS: The US Contribution to GOOS

Enables decision making and science

WHO:

WHY:

- 7 Societal Goals, 1 System
- Predictions of climate change
- Safety and efficiency of maritime operations
- Forecasts of natural hazards
- Improve homeland security
- Minimize public health risks
- Protect and restore healthy coastal ecosystems
- Sustain living marine resources

WHAT:

- Observation
- Data Management
- Modeling & Analysis
- Research & Development
- Education
- Management & Governance

WHERE:

- Global
- Coastal (EEZ to head of tide)

A National Endeavor

But Part of a Global Framework

Global Ocean Observing System

Global Earth Observation System of Systems
IOOS: Federal Regional Partnership

11 Regional Associations Dedicated to Meet Stakeholder Needs
Consortium of academia, tribes, states, fishermen, mariners, NGOs, private sector and the general public working together to provide information

Observations

Modeling & Analysis

Products

Bathymetry is the foundation
Exposing Ocean Information
Observing Systems
Glider Missions

Climate/Ecosystem/Fisheries Management/Water Quality

- CalCOFI
- The SoCal Niño Index
- Fish Tracking
- Hurricane Forecasting
- Response to Oil Spill
- Deep Water Horizon
- Alaska
- HAB
IOOS® High Frequency Radar

- HF radars measure speed and direction of ocean surface currents
- All-weather effectiveness
- Horizontal resolutions / ranges vary
  - Very high resolution – 15 miles
  - Medium resolution – 55 miles
  - Low resolution – 125 miles
- Paired HF radars cover 6,000 square miles of ocean surface
- Regional network increased to 132 radars in 2013 from 20 HF radars in 2002
- IOOS data management resulted in a national network
- Used operationally by Coast Guard for Search and Rescue
Coastal 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

Inundation Forecast System

FVCOM GOM3 grid

Sea Nettle Forecast
Data Management

- National standards to ease exchange of data
- Real-time distribution
- Quality control
- Archiving
- > 50% of NWS ocean data from non-federal sources through IOOS
Helping people find and use data

Data/Service Registry

Discover Data/Service

Register Data/Service

Use Data/Service

Data/Service Consumer

Data/Service e.g. Regional Association
Helping people find and use data
Meeting User Needs: Safe and Efficient Marine Commerce

- CDIP Point Reyes Buoy
- USACE disposal site
- NOAA 46026
- CDIP San Francisco Bar Buoy
- Short Period Seas
- USACE Project Site (Regional Sediment Management)

- Pilot boat
- Helicopter
- BOBR0050, State of Oregon, USA - 2010

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"I trust the weather buoys with my life. Thank you." - Maine Fisherman; "Love your service...I believe your service is a lifesaver. Thanks!" - Dave, Pilot; and "I would like you to know that information you are providing us not only aids us in our work, it almost certainly has saved lives." - Roy Atkinson, Fisherman.
IOOS RA’s Involvement in Water Quality

Observations, including support for partners

Data Services: Simplifying access to data

Plume Tracking

Customized Products

Real-time Water Quality Data for Shellfish Growers in the Pacific NW

A pilot project between NANOOS and the National Estuarine Research Reserve System
Drinking Water Quality:
Huron Erie Corridor Waterways Forecast System (HECWFS)

Goal:
- Reduce health risks and costs associated with pollutant spills in the Lake Huron to Lake Erie Corridor

Major Elements
- Link 2D model for corridor to NOAA Great Lakes Forecasting System
- Generate 3D public domain model
- Use 3D model to support water intake risk assessment work
Oysters on the Half Shell

Little wild set of oysters on US northwest
2008 Whiskey Creek Hatchery lost 100% of oyster larvae
Ocean Acidification was the cause
Real-time Observing System established
By 2010 productivity was back to 70%
IOOS® Response to Super Storm Sandy

- IOOS partners’ buoys, gliders and other sensors generated hourly updates
  - Wind velocities, wave heights and periods, water levels
  - Air and water temperatures
- 40+ High Frequency Radars
  - Ocean current data
- Information shared with National Hurricane Center
- Generated time critical warnings for local public officials
  - Storm path and flooding updates
Regional Approaches for MSP and IOOS

National Ocean Council:  
9 Regional Planning Bodies

U.S. IOOS:  
11 Regional Associations
Regional Data Portals

RAs enhancements to MSP:
- Data Integration
- Real-time data access
- Historic trends
- Model outputs
- Provides 4-D look at ocean – over time and throughout the water column

Oceans are complex
Northeast Data Management and Portal
(http://odpdx.neracoos.org)
Bathymetry enables IOOS

- IOOS depends on bathymetry for all its products
- US IOOS Program Office and Office of Coast Survey are now sister programs in NOAA’s National Ocean Service
- Nearshore bathymetry for flooding is critical need

Thank you!
A Clear View of Tomorrow

Education and Outreach

Graduate and Undergraduate students are integrated—good for IOOS now and good for industry for future employees.

Teaching the next generation—Puerto Rico Weather Camp 2012

Basic Observational Buoy (BOB)
Educational project for universities and high schools to address STEM disciplines

U.S. Integrated Ocean Observing System (IOOS)
Estuarine Hypoxia

- Transitioning information to federal agencies
- Model Comparison
- Conducting sensitivity experiments
- New, single term hypoxia model

Cyber Infrastructure

- Interactive Model and Observation Explorer
- Unstructured Grid Support
- NCToolbox
- Matlab as a Web Service
- Skill Assessment Tools
- Collaborative Web Site
Glider observations on the US coast

- Gliders’ role in ocean observing system is to patrol the boundaries, connecting the coastal and open ocean.
## Summary of Glider Days for 2008-2012

<table>
<thead>
<tr>
<th>Year</th>
<th>Glider-days of data collected annually by glider operators. (Glider-day = 1 glider in the water collecting data for 1 day)</th>
<th>Glider-days completed outside of the EEZ</th>
<th>Glider-days supported by IOOS PO</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>4007</td>
<td>890</td>
<td>349</td>
</tr>
<tr>
<td>2009</td>
<td>4739</td>
<td>1132</td>
<td>337</td>
</tr>
<tr>
<td>2010</td>
<td>4944</td>
<td>1329</td>
<td>990</td>
</tr>
<tr>
<td>2011</td>
<td>5740</td>
<td>1663</td>
<td>772</td>
</tr>
<tr>
<td>2012</td>
<td>6292</td>
<td>1793</td>
<td>715</td>
</tr>
<tr>
<td><strong>2008 – 2012 Totals</strong></td>
<td><strong>25722</strong></td>
<td><strong>6807</strong></td>
<td><strong>3163</strong></td>
</tr>
</tbody>
</table>

*Glider Days provided with support from Federal Agencies including NSF, ONR, NOAA, EPA, state and local governments and private foundations.*
Safety and Environment

IOOS uses HF radar to hasten response to oil spills and harmful algal blooms

Improves the quality of life at home and around the globe

Surface current data, continuous and in near real time, inform models

People lost at sea are found faster

Pollution can be tracked and ecosystems better assessed

U.S. Integrated Ocean Observing System (IOOS)
DIVERGENCE & CONVERGENCE (FRONTS)

- Divergence – regions of persistent surface divergence & upwelling due to wind-driven Ekman transport & flow past topography.
- Convergence – associated with flow past topography & fronts.
- Fronts represent high-productivity interfaces … aggregations of plankton, fish, birds, mammals.

Gough et al 2010 (CWO 2010)
Our Planet is Changing

We need advanced tools to understand and monitor our oceans, coasts & Great Lakes
Data Management Efforts

- **NetCDF file format:**
  - based on Trajectory CF Discrete Sampling Geometry
  - IOOS optimized for web services distribution via THREDDS Data Server

- **Proposal:** GROOM/EGO; IMOS; IOOS agreed to international standardization of NetCDF – GROOM Assembly meeting June 4-5, 2013

- **GTS Distribution**
  - IOOS funding National Data Buoy center to write encoding software to deliver glider data in both TESAC and BUFR
  - Need to work through JCOMM Task Team on Table Driven Codes to get this approved through WMO

- **Proposal:** GROOM/EGO; IMOS, IOOS agreed to work together on this effort and with corresponding meteorological agencies – GROOM assembly meeting June 4-5, 2013
Automated notification when thresholds exceeded

3 day wave forecast

CDIP provides waves

SCCOOS provides currents

Maritime Transportation-San Pedro Channel
Safe and Efficient Navigation

- Coastal Data Information Program (CDIP) providing wave observations, nowcasts, and forecasts.
- SCCOOS providing HF Radar surface currents.
- NOAA Physical Oceanographic Real-Time System (PORTS)
Inspection of Hyperion Outfall Pipe (never internally inspected for 50 years). Serves City of Los Angeles. One of the world's largest coastal populations.

Close to a billion gallons of sewage to be diverted to an in-shore/shallow outfall.

Concern of extent of impact and public health risk in the Santa Monica Bay.