U.S. Integrated Ocean Observing System (IOOS): Autonomous Environmental Monitoring and Applications to Offshore Wind (OSW) Energy Development

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Agenda

- OSW and Lessons Learned
- **Autonomous Environmental Monitoring and the U.S. Integrated Ocean Observing System (IOOS)**
- **Applications to OSW**

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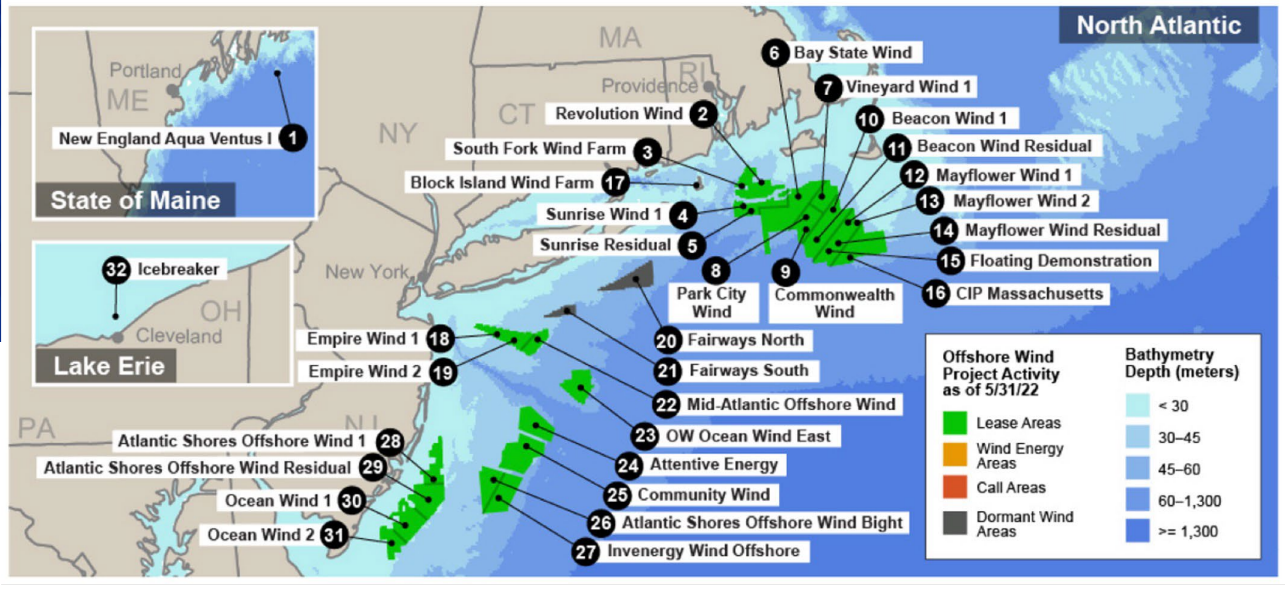
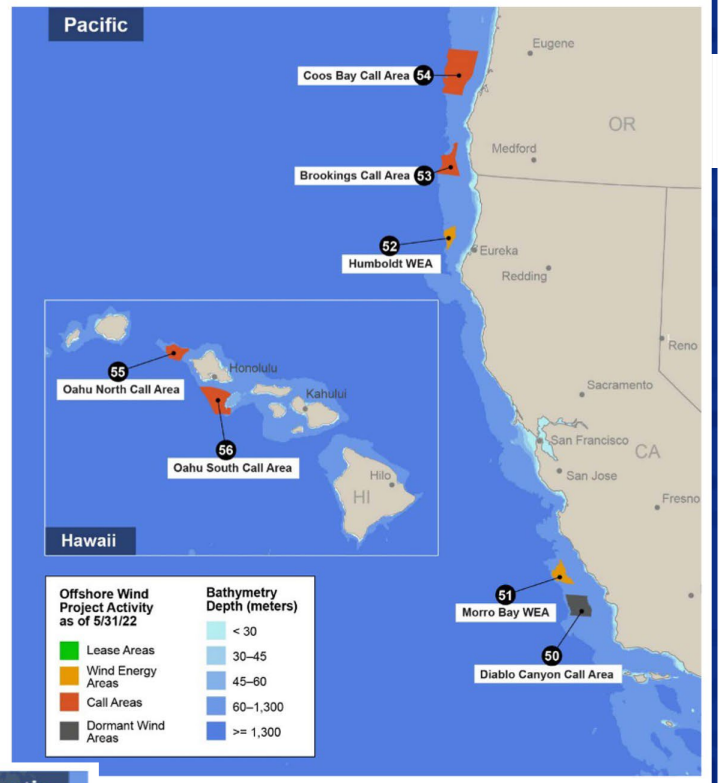
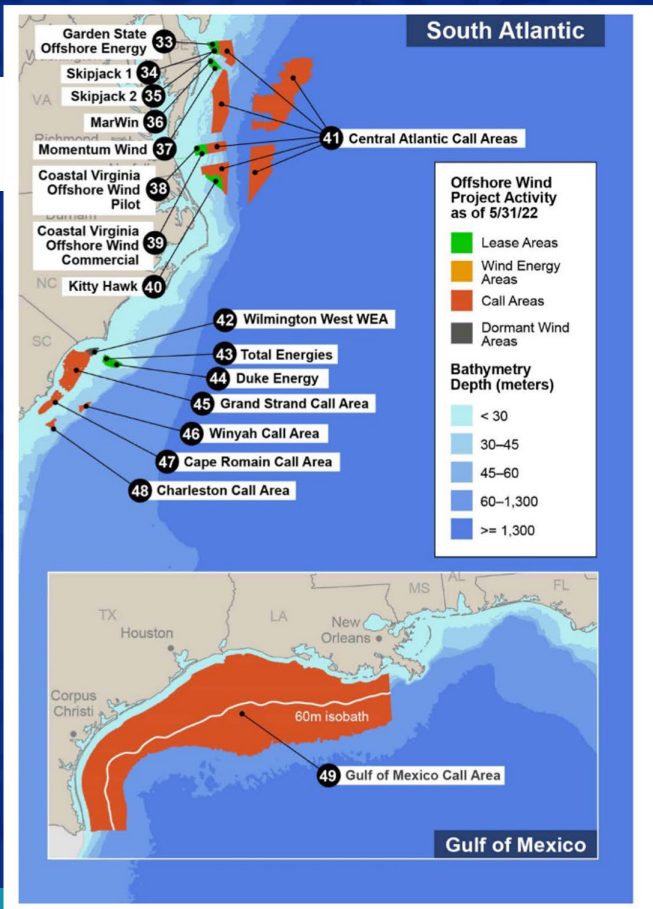
OSW in Context

OSW lease and call areas (BOEM, 2022)

- **OSW is a nationwide issue.**
- **Administration Goal: 30 GW by 2030; 300 GW by 2050.**
- **Per Dept. of Energy: 30 GW of OSW will require at least 2,100 turbines and foundations and 6,800 miles (11,000 km) of electrical transmission cable.**
- **An OSW turbine can be erected in less than a week.**







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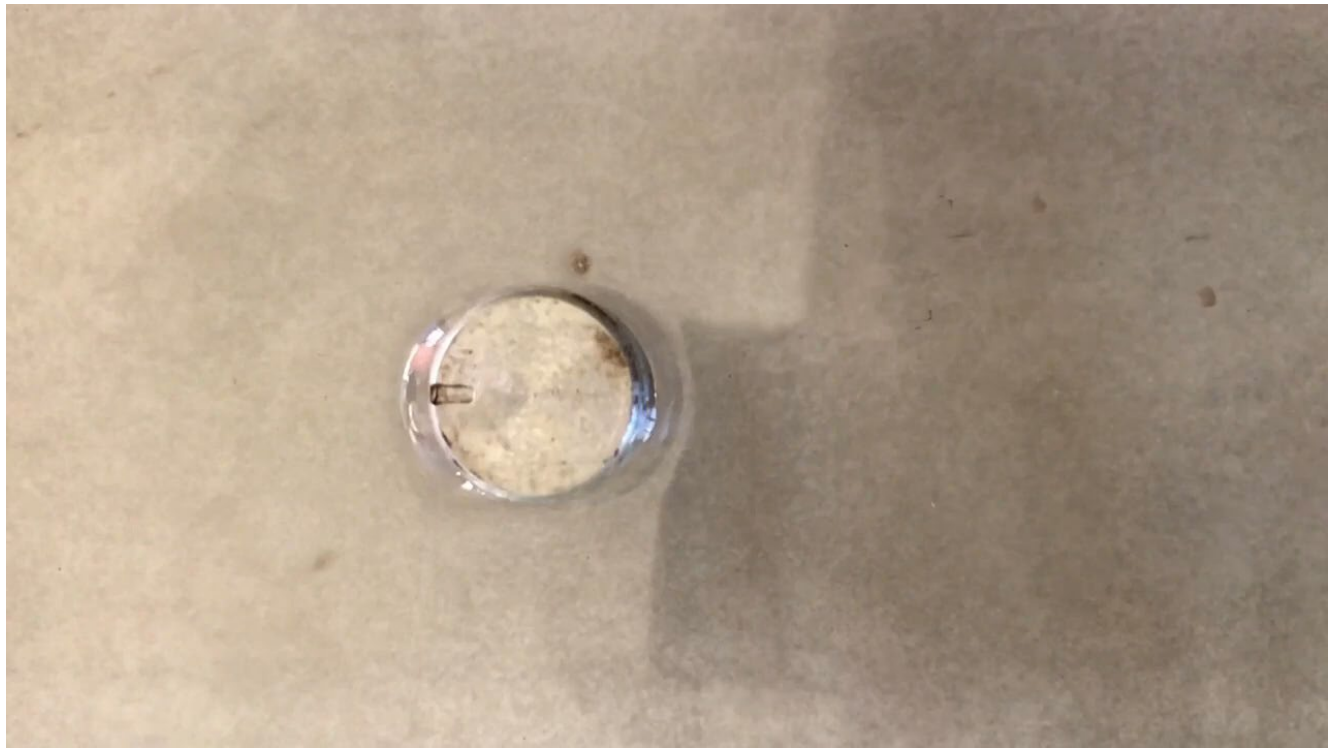
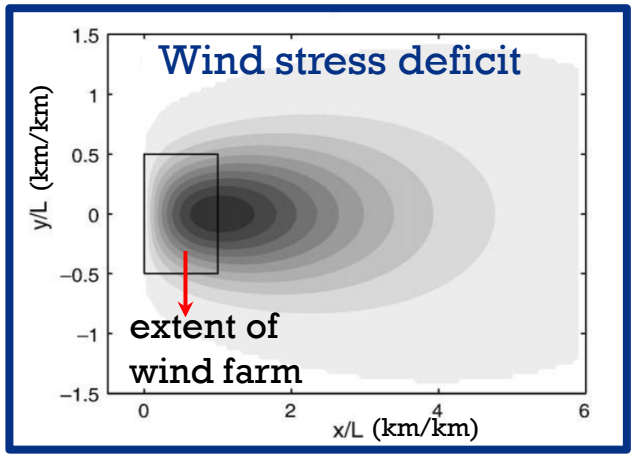
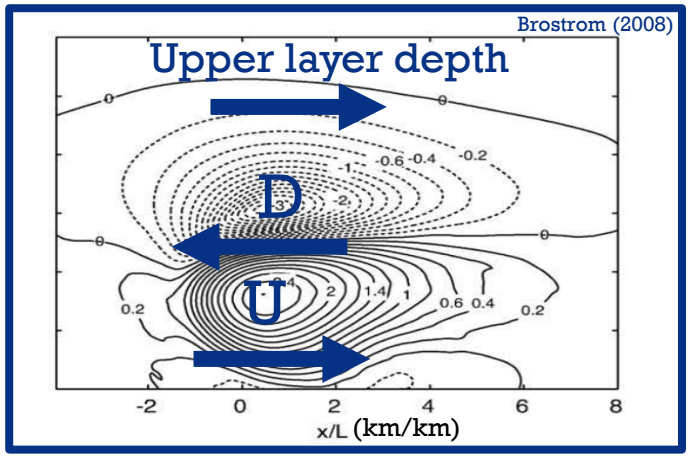
- **The turbines used in the Block Island Wind Farm were 600 ft. (183 m) tall.**
  - **The Washington Monument is 555 ft. [169 m] tall.**
  - **A "skyscraper", of which there are 853 in the U.S., is commonly defined as a high-rise building taller than 492 ft. [150 m]).**

OSW Environmental Alteration



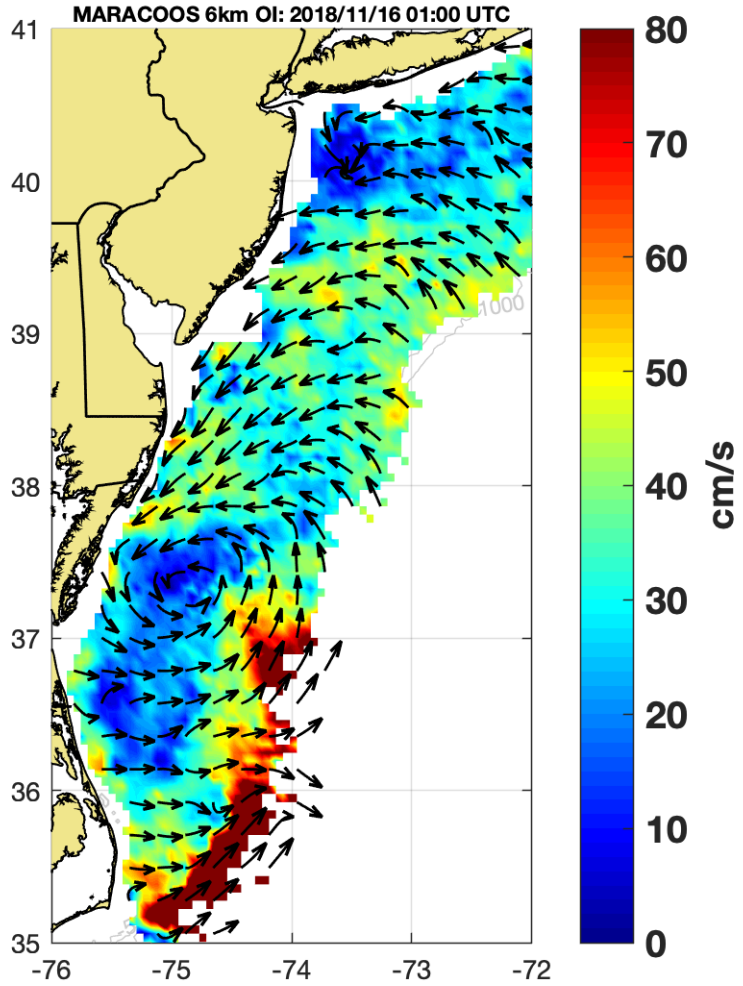




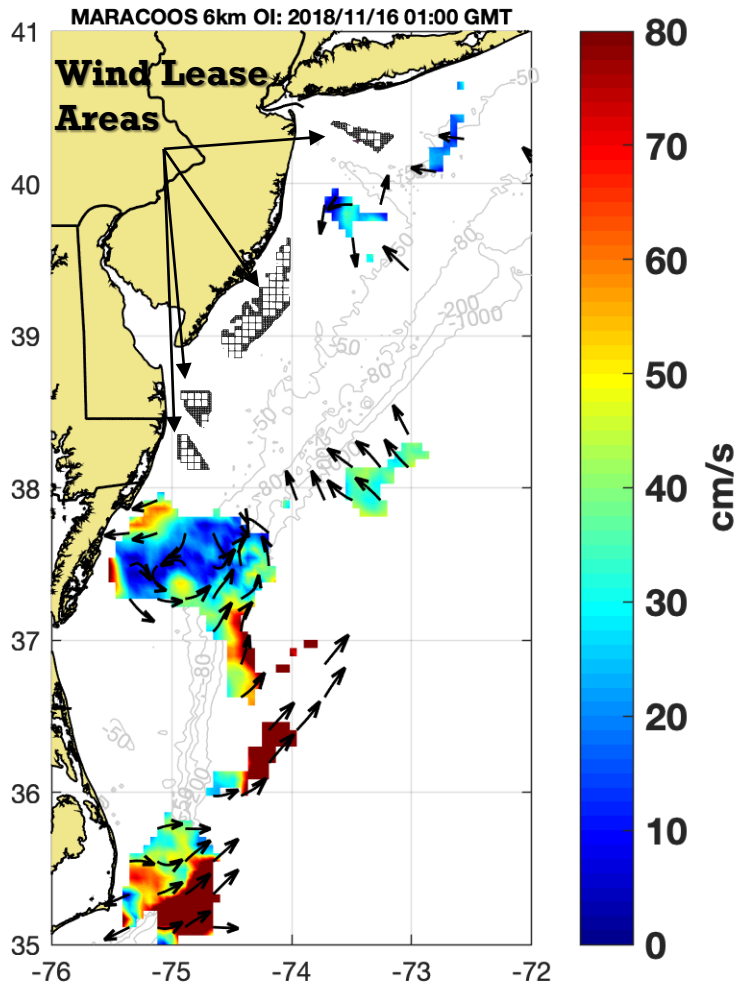
- OSW alters wind and ocean current flow fields—not only within the developments, but also by creating shadowing effects extending 10 km or more downstream.
  - Forecast models and search-and-rescue drift simulators need to be updated to account for this.
- Their presence induces upwelling and/or downwelling.
  - Modifies survival times due to sea surface temperature changes.
- OSW changing the physical ocean environment impacts marine life.

Example: OSW Interference with HF-Radar

Total Map **With No** Interference



Total Map **With** Interference



Both maps filtered by 0.6 normalized uncertainty

- OSW not only alters the environment itself, but also impacts environmental monitoring capabilities.
- OSW turbine interference may be mitigated, in partnerships which include OSW developers and other Federal agencies.

Lessons Learned

- OSW will affect oceanography, ecology, and the operational environment of other ocean users. Some impacts will be modest, others more significant, and many uncertain.
- These uncertainties are driving conflict and delays, and risk inequities and unintended consequences, outcomes that could disadvantage OSW developers and other ocean users alike. *E.g.*:
  - Impacts of OSW on fisheries that are undetected could lead to insufficient compensation to fishing fleets and communities, whereas impacts on fisheries due to climate change or other stressors that are misattributed to OSW could lead to undue compensation required from OSW developers.
  - Redistribution of marine mammals and adverse effects on their population viability could be driven by OSW facilities, or these changes could be caused by other environmental drivers but incorrectly linked to OSW.
- In many cases, there are likely to be multiple drivers of change, and the relative impacts will need to be partitioned among them.

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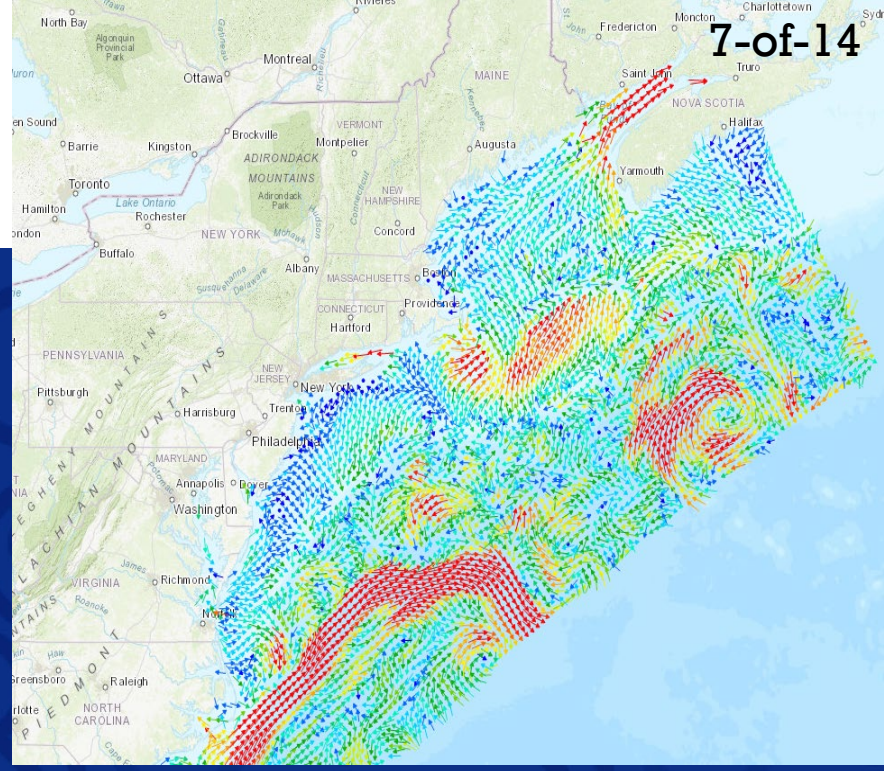

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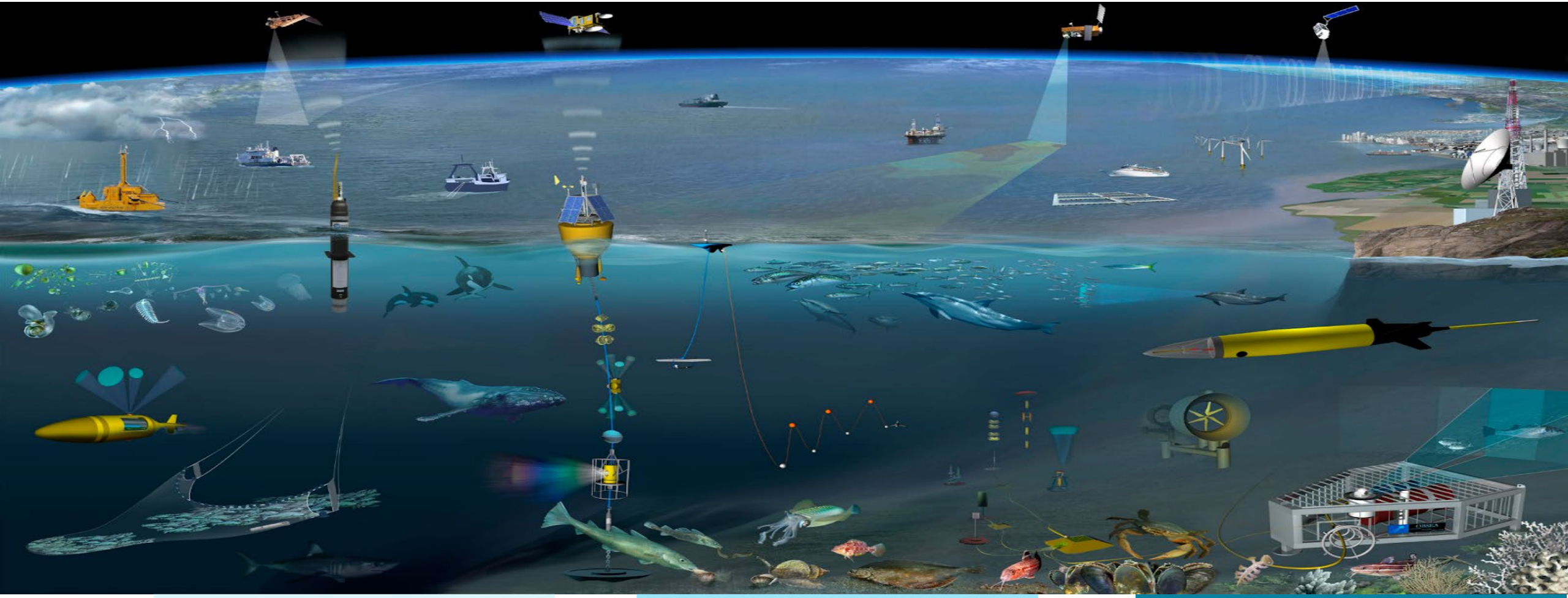
What is U.S. IOOS?

U.S. IOOS is a cooperative, coordinated network of Federal and non-Federal observing networks since 2009.



Thousands of observing data sets gathered every day by public and private programs

Integrated, made accessible, & supported by U.S. IOOS

Supporting weather forecasting, maritime safety, ocean and public health… and now OSW development.

Organizational Overview

Authorizing legislation

Integrated Coastal Ocean Observing System (ICOOS) Act (P.L. No 111-11, March 2009)
Coordinated Ocean Observations and Research Act (P.L. No 116-271, December 2020)

Global Component

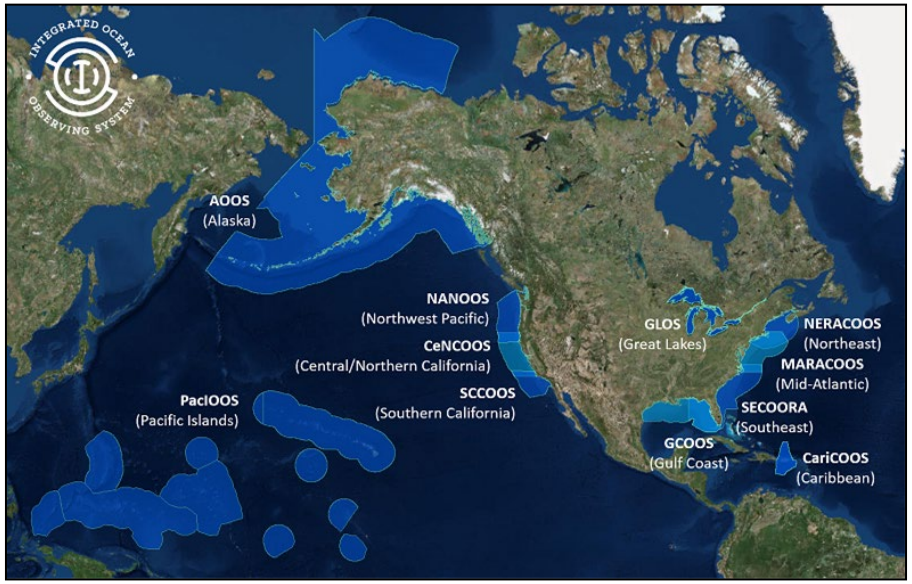
- U.S. contribution to the Global Ocean Observing System (GOOS)
- 1 of 15 Regional Alliances of GOOS

National Component

- 17 Federal agencies

Regional Component

- 11 Regional Associations
  - Academia, state/local/tribal government, private industry



What U.S. IOOS Measures

34 Core Variables

Biology and Ecosystems

- Hard coral cover and composition
- Macroalgal canopy cover and composition
- Mangrove cover and composition
- Seagrass cover and composition
- Microbe biomass and diversity
- Phytoplankton biomass and diversity
- Zooplankton biomass and diversity
- Invertebrate abundance and distribution
- Fish abundance and diversity
- Sea bird abundance and distribution
- Sea Turtle abundance and distribution
- Marine mammal abundance and distribution
- Ocean sound
- Ocean color

Biogeochemistry

- Acidity
- Colored dissolved organic matter
- Contaminants
- Dissolved nutrients
- Dissolved oxygen
- Ocean color
- Optical properties
- Pathogens
- Partial pressures of CO_2
- Total suspended matter

Physics

- Bathymetry
- Bottom character
- Currents
- Heat flux
- Ice distribution
- Salinity
- Sea level
- Surface waves
- Stream flow
- Temperature
- Wind speed and direction

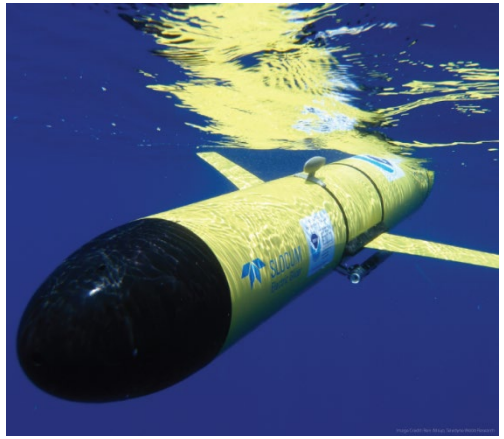
U.S. IOOS Autonomous Environmental Monitoring Assets

IOOS supports a national high-frequency (HF) radar network that is unique to the system, as well as providing for operation and maintenance of observing assets in U.S. coastal & territorial waters.

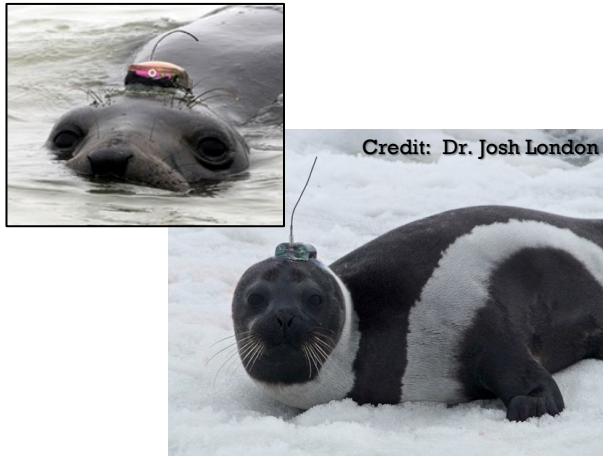
Fixed Moorings & Buoys

HF-Radar

Shore Stations



Sub-surface gliders



Animal Telemetry,
Marine Biodiversity

Water Levels

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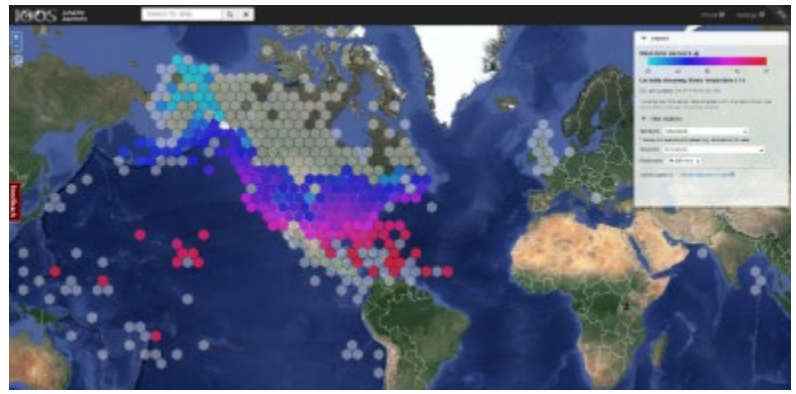
Data Access

Regional Portals: *11 Regional Association portals integrate data at a local level and provide tailored products for stakeholders*

Program portals & data assembly centers: *gliders, animal telemetry, HF-radar, and more!*

https://ioos.us/

a central portal of portals



Sensor Map: *a 2 week cache of real-time observations from 108 providers*

IOOS Model Viewer: *Visualize and access model hindcast/forecast information and compare to observations*

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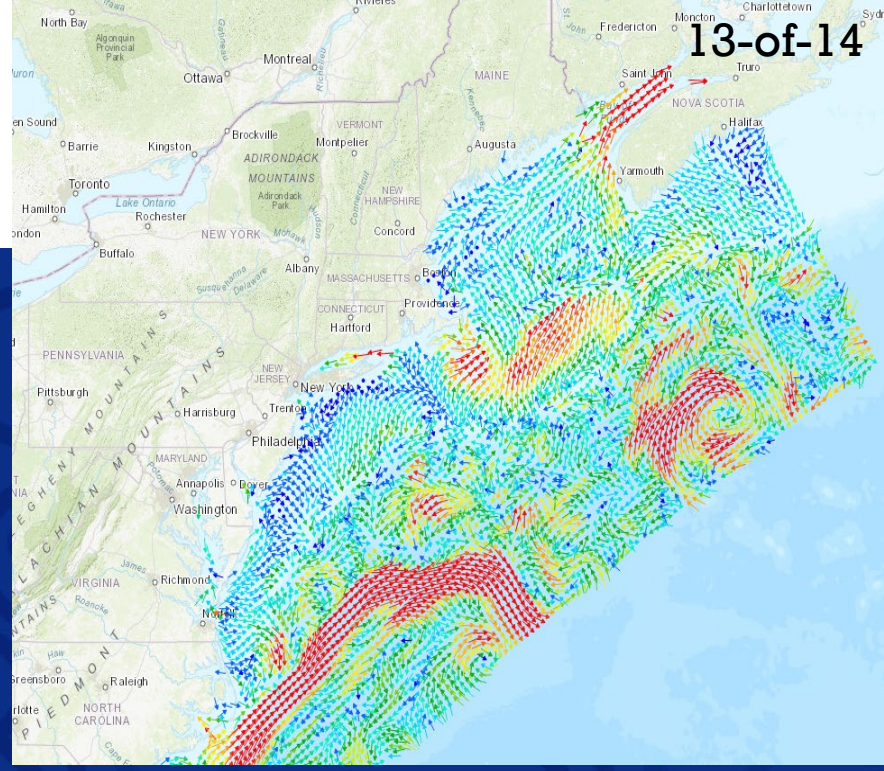

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IOOS Applications for OSW Development

- **The United States enjoys some of the most developed ocean observing systems in its waters, built over the past few decades by a diverse array of Federal, state, non-profit, academic, and private sector partners.**

- **Robust data and analytical systems are essential to developing OSW in ways that reduce uncertainties and improve decision making at all levels, including national policy, agency regulations, industry planning, and on-the-water operations.**

- **As a partnership among 17 Federal agencies, many with responsibilities related to OSW, along with numerous Tribal, state, municipal, private sector, non-profit, academic, and community partners, IOOS collectively is in a unique position to develop a unified data system at the larger scale required for ready access to OSW-relevant ocean observations by agencies, industries, researchers, and other users.**