Ocean Observatories Initiative

Pioneer Array Micro-Siting Process Meeting

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Pioneer Array

- Multi-platform, multi-scale
- Fixed and mobile assets
- Integrated with regional observing assets

Plueddemann, Trowbridge and Sosik (WHOI)
Middle Atlantic Bight

- Persistent advection of cold, fresh water from the north
- Fresh water input from a series of rivers along the coast
- Influence of Gulf Stream rings and meanders from the south
- Complex frontal zone at the shelf-break

Plueddemann, Trowbridge, and Sosik (WHOI)
Ecosystem Dynamics

- The shelfbreak front is a biological as well as a physical property boundary.
Marine Habitats

• The shelfbreak and coastal zone are the most important marine habitats in the MAB

• The shelfbreak has highest diversity of marine mammals in the U.S. Mid-Atlantic EEZ

Natural Resources Defense Council (2001)
Frontal Dynamics

- The front is distinguished by the transition from cold, fresh shelf water to warmer, saltier slope water
- Surface-intensified jet, near the 150 m isobath
- Mechanisms of cross-front exchange are largely unknown

Linder and Gawarkiewicz (1998)
Shelfbreak processes

Weather & climate forcing

- Mesoscale & submesoscale physical response

- Ecosystem response
Climate Connections

NAO affects atmospheric and oceanic circulation

Greene and Pershing (2007)
High-latitude shifts influence mid-latitude ecosystems

Greene and Pershing (2007)
Pioneer Array

- Full water column
- Cross-front resolution
- Power-generating buoys
- Multi-function nodes
- AUV docks

Plueddemann and Cook (WHOI)
Surface Mooring

• Buoy (with telemetry to shore)
  – Surface meteorology
  – Waves
  – pCO2 (air and sea)

• Subsurface
  – Temperature and salinity
  – Dissolved oxygen
  – pH
  – Water velocity
  – Turbidity
  – Optical properties
  – Chlorophyll, organic matter
  – Nitrate
Benthic Platform

• Multi-Function Node
  – Temperature and salinity
  – Water velocity
  – Dissolved oxygen
  – Turbidity
  – Acoustic zooplankton sensor
  – Connection for additional sensors

• AUV dock
  – Inshore and Offshore sites
  – Offload data and recharge AUV
Wire-Following Profiler

- Buoy
  - Telemetry to shore
- Subsurface profiling body
  - Temperature and salinity
  - Dissolved oxygen
  - Water velocity
  - Turbidity
  - Optical properties
  - Chlorophyll, organic matter
- Lower instrument cage
  - Water velocity profile
Surface-Piercing Profiler

- Profiling Body
  - Telemetry to shore
  - Temperature and salinity
  - Dissolved oxygen
  - pCO2 (water)
  - Water velocity
  - Turbidity
  - Optical properties
  - Chlorophyll, organic matter
  - Nitrate

- Bottom frame
  - Water velocity profile
Gliders and AUVs

- **Gliders**
  - Temperature, salinity and pressure
  - Dissolved oxygen
  - Water velocity
  - Turbidity
  - Optical properties
  - Chlorophyll, organic matter

- **AUVs**
  - Temperature, salinity and pressure
  - Dissolved oxygen
  - Water velocity
  - Turbidity
  - Optical properties
  - Chlorophyll, organic matter
  - Nutrients
Pioneer Infrastructure*

Moored Array
30 x 10 km
Site spacing
6-8 km cross
10 km along

AUV Region
110 x 80 km

Glider Region
150 x 130 km

* Crosses indicate representative locations only – precise locations are not yet determined

Plueddemann (WHOI)
Pioneer Mobile Assets: Gliders

Typical glider missions
6 gliders running simultaneous transects
150 km cross-shelf in 1 week
2000 km total track length
3 mo endurance
Pioneer Mobile Assets: Autonomous Underwater Vehicles (AUVs)

Typical AUV missions
2 AUVs running simultaneous transects
80 km cross-shelf in 12 hr
150 km total track length
24 hr mission
7 day repeat

Plueddemann (WHOI)
Pioneer
Fixed Assets: Moored Array

North/South extent 15 nm
East/West extent 5 nm

Distance between moorings
3.5 nm to 6 nm

Buffer Zone Radius 0.5 nm

Distance between Buffer Zones
2.5 nm to 5 nm – see chart

* Crosses indicate representative locations only; precise locations are not yet determined

The gray contours are spaced at 10 m (5 fathoms) intervals, the red contours at 50 m (27 fathoms), and the blue contours at 100 m (54 fathoms). Contours at 150, 500, and 1,000 m (82, 273, and 547 fathoms) are black. Crosses mark proposed mooring sites. The circles around each mooring site represent a proposed buffer zone of 0.5 nautical mile.
Moored Array Micro-siting

Requirements

• Span the shelfbreak front
• Resolve characteristic frontal features
• Avoid features not associated with the frontal system
• Use AUVs to identify features surrounding the moored array
• Maintain a buffer zone around each mooring site
• Avoid submarine cables

Plueddemann (WHOI)
Moored Array Micro-siting

Requirements

• Span the shelf break front
  – Occupy multiple locations across the shelf from 55 fm to 275 fm
    • The frontal system is seldom found further inshore than 55 fm
    • The equipment is limited to 330 fm maximum depth
  – Occupy a site within the relatively cold, fresh water characteristic of the continental shelf – inshore of the shelf break front
  – Occupy a site within the relatively warm, salty water characteristic of the continental slope – offshore of the shelf break front
  – Occupy a site within the shelf break jet (at the 110 fm line +/- 2.5 nm inshore or offshore)

Plueddemann (WHOI)
Moored Array Micro-siting

Requirements

• Resolve characteristic frontal features
  – Maintain mooring spacing less than or equal to the feature scale in the frontal zone (5 nm)
  – Maintain moorings within +/- 1 nm of a straight line across the shelf
  – Occupy a site eastward (upstream) of, and at the same depth as, the inshore site
  – Occupy a site eastward (upstream) of, and at the same depth as, the offshore site

Plueddemann (WHOI)
Moored Array Micro-siting

Requirements

• Avoid features not associated with the frontal system
  – Locate the array at least 8 nm (1.5 times the feature scale) downstream of canyon
  – Locate the array in a region with similar cross-shelf bathymetry for +/- 10 nm east and west of the center of the array

• Use AUVs to identify features surrounding the moored array
  – Locate moorings at least 8 nm from the edge of the AUV box

• Maintain a buffer zone around each mooring site
  – Buffer zone radius of 0.5 nm recommended

• Avoid submarine cables
  – Buffer zones should not overlap known cable routes

Plueddemann (WHOI)
Moored Array Micro-siting

Plueddemann (WHOI)