Ocean Observatories Initiative

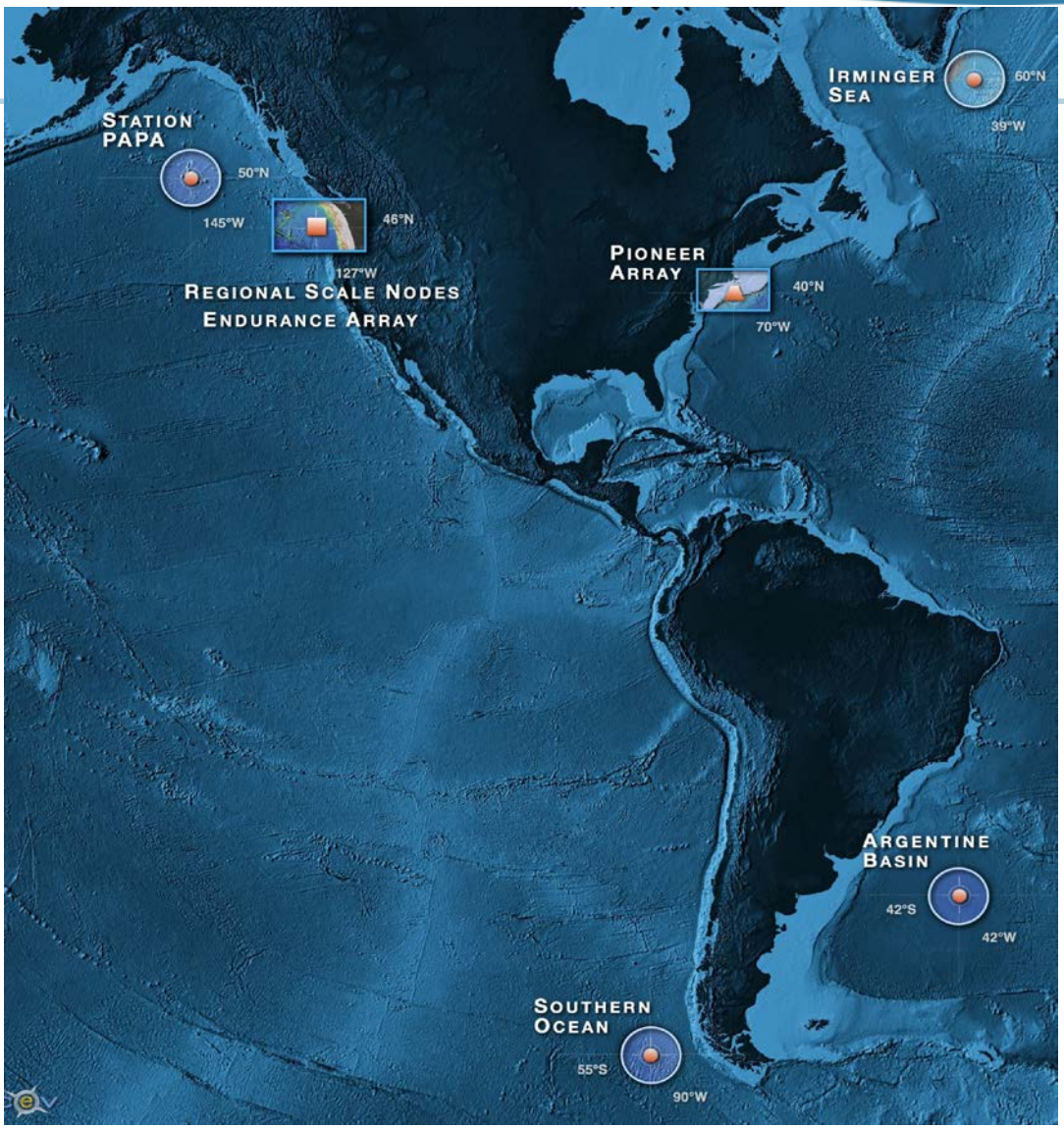
Ocean Observatories Initiative (OOI) Moorings: New Capabilities for Seagoing Science

presented by Ed Dever and Walt Waldorf

November 20, 2014

OOI Science Themes

- Coastal and Global Scale Nodes (Global, Endurance, Pioneer)
  - Ocean-Atmosphere Exchange
  - Climate Variability, Ocean Circulation and Ecosystems
  - Turbulent Mixing and Biophysical Interactions
  - Coastal Ocean Dynamics and Ecosystems
- Regional Scale Nodes
  - Fluid Rock Scale Interactions and the Sub-Seafloor Biosphere
  - Plate-Scale Geodynamics



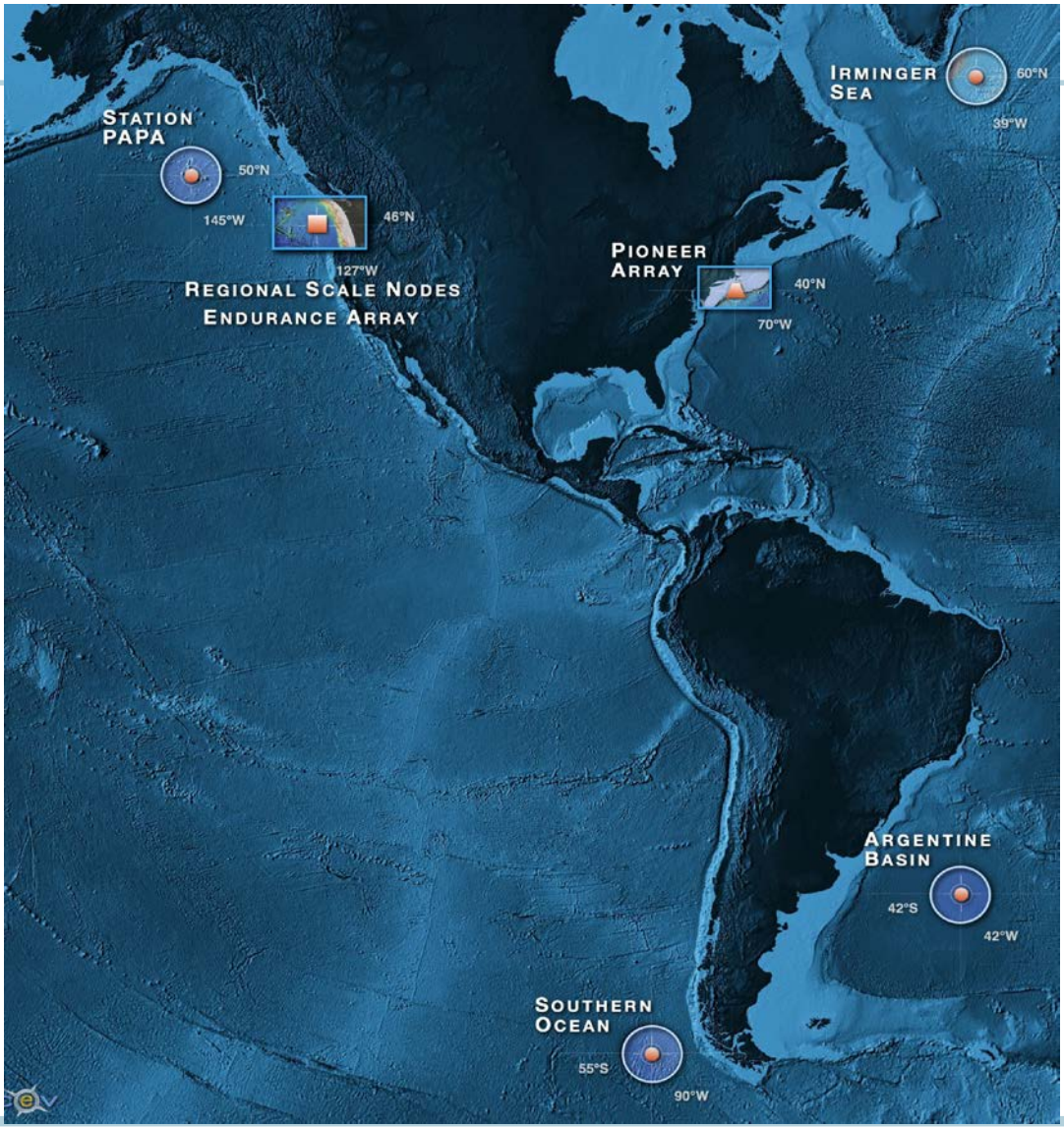
OOI components

- infrastructure (moorings, profilers, AUVs, gliders, and seafloor platforms) to measure physical, chemical, geological and biological variables at the air-sea interface, in the ocean, and seafloor.

- integrated by a cyberinfrastructure to manage resources and bring data to scientists, educators and the public.

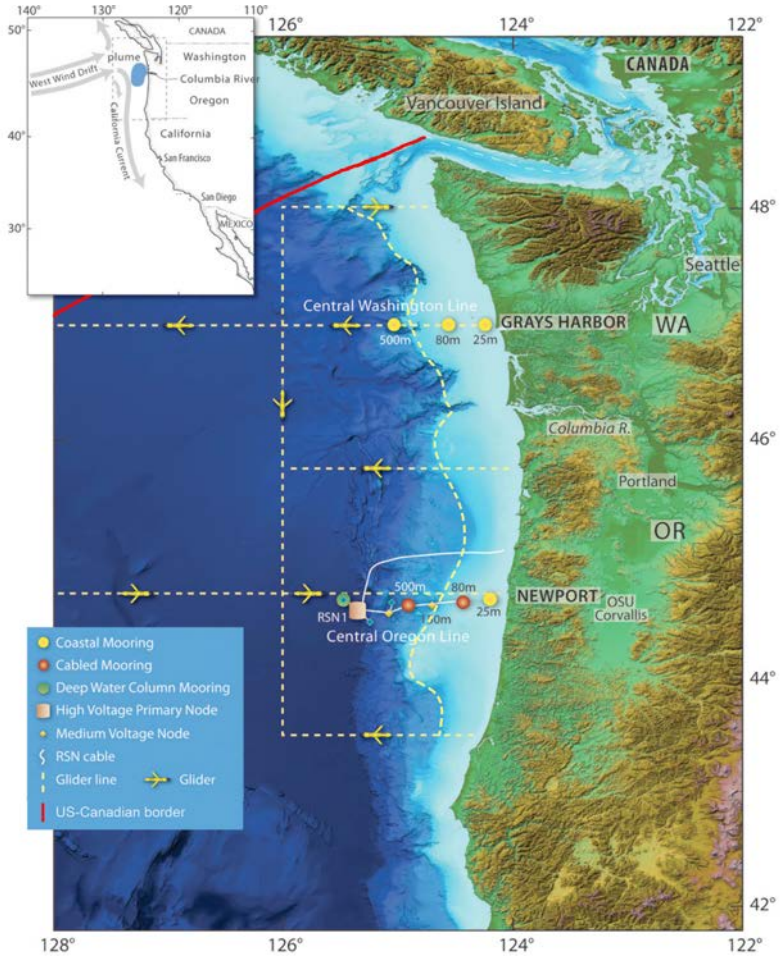
- Education and Public Engagement component.

- Funded by the ***National Science Foundation*** through the Consortium for Ocean Leadership (OL). OL funds the implementing organizations



Endurance Array

- The Endurance Array has two lines of cross-shelf moorings (inner-shelf, mid-shelf, and slope) off Newport and Grays Harbor.
- At the Newport line, the shelf and slope sites have cabled as well as uncabled platforms.
- At any time, up to 6 gliders will support the Endurance array by resolving mesoscale spatial variability.

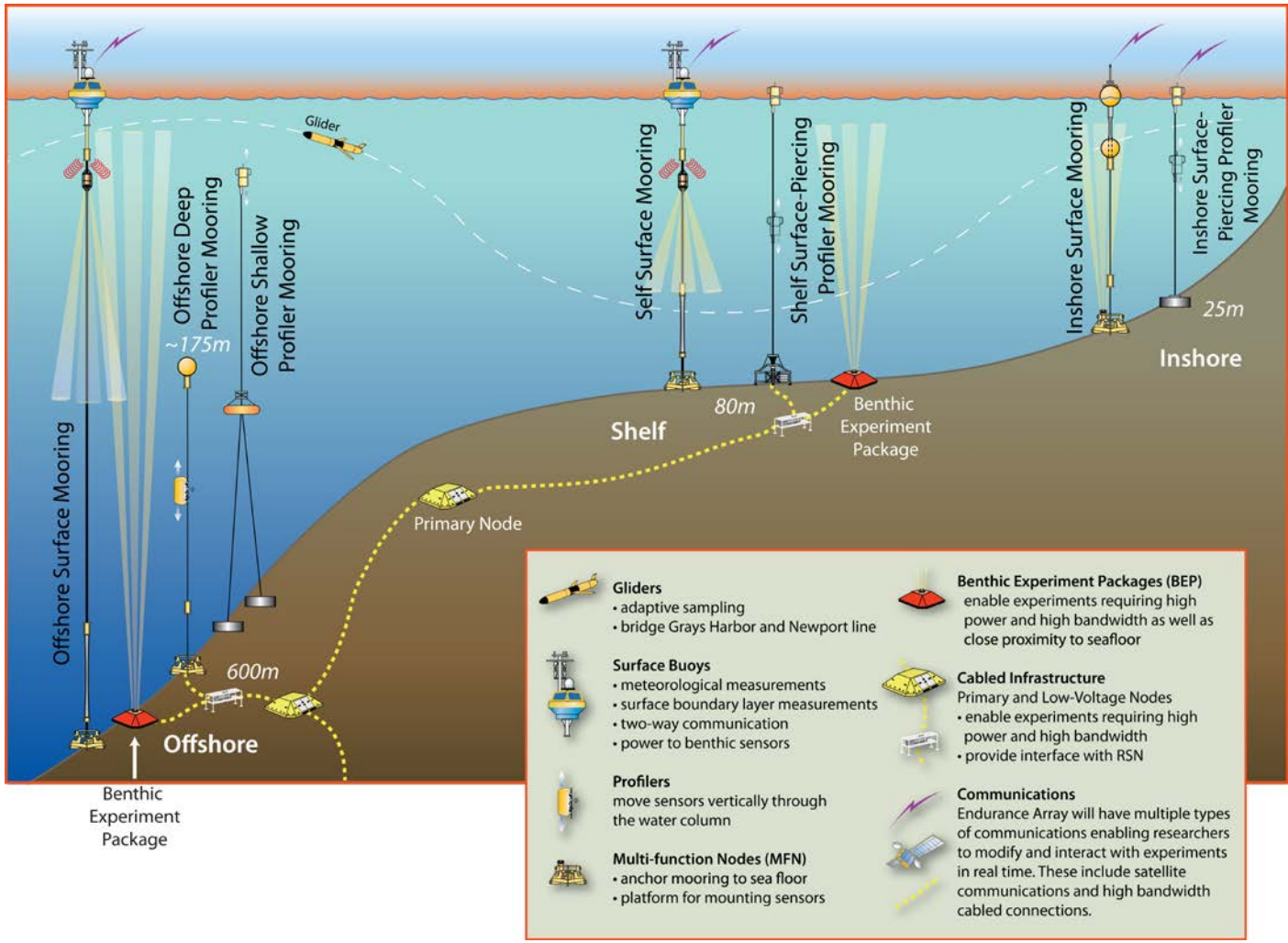


Endurance Array

- uses fixed and mobile assets to observe cross-shelf and along-shelf variability in the coastal upwelling region off Oregon and Washington

- provides an extended spatial footprint that encompasses a prototypical eastern boundary current regime

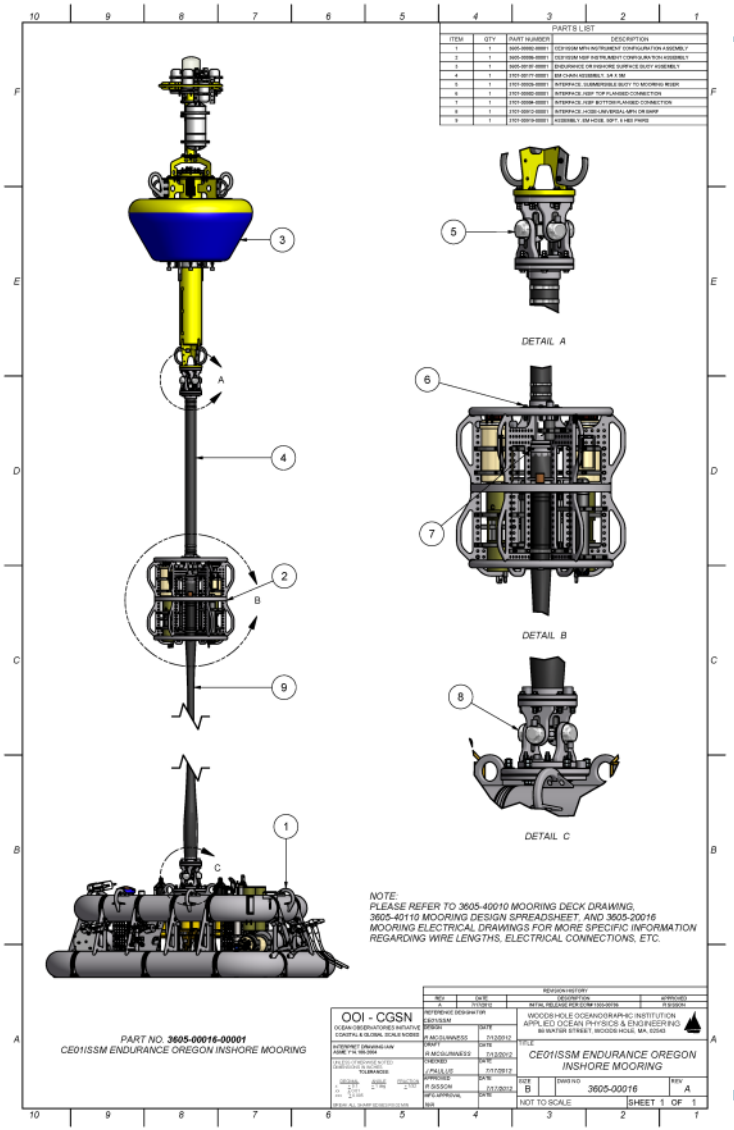
- joins with the RSN cabled infrastructure.



Focus on OOI coastal surface moorings

- Up to 24 instruments on one mooring with instruments on the buoy, near-surface, at the bottom
- WiFi, Iridium, Fleet Broadband two-way communications
- Wind and solar charging of AGM batteries
- Compliant (scope of 1) moorings using stretch hose technology with electrical connectivity to bottom
- Mooring recovered in two separable pieces (buoy and mooring riser; anchor and line pack)

Example – Inshore Surface Mooring



Inshore Surface Mooring

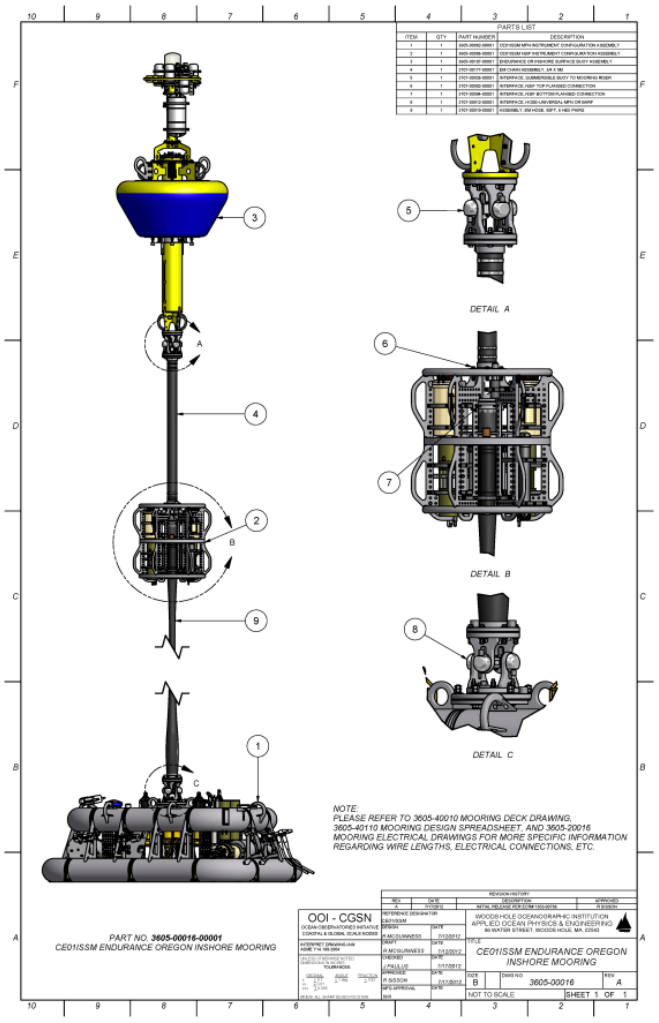
Mooring Components deployed and recovered at the inshore (25m depth) sites:

- Surface Buoy Air Weight: estimated 454 kg (1000 lbs), net buoyancy estimated 227 kg (500 lbs.)

- Mooring Riser and Near Surface Instrument Frame – estimated 227kg (500 lbs) air weight,
net buoyancy estimated – negative/sinks 68 kg (150lbs.)

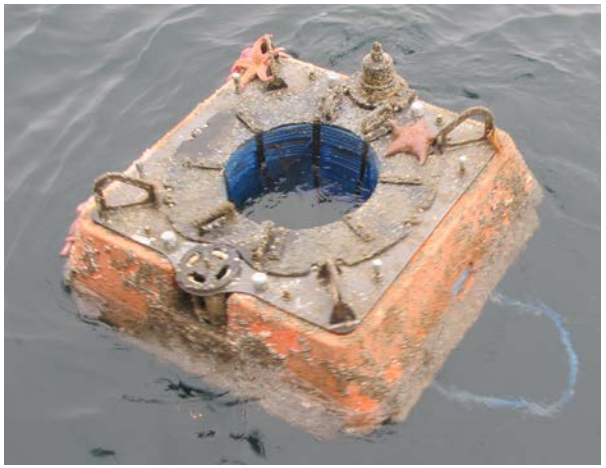
- MFN, Instruments, Line Pack, and Frame - estimated 4652 kg (10,235 lbs) air weight
stainless steel anchor = 2955 kg (6500 lbs) air weight
line pack = 214 kg (470 lbs) air weight
frame only = 1173 kg (2580 lbs) air weight
instruments = 178 kg (393 lbs) air weight

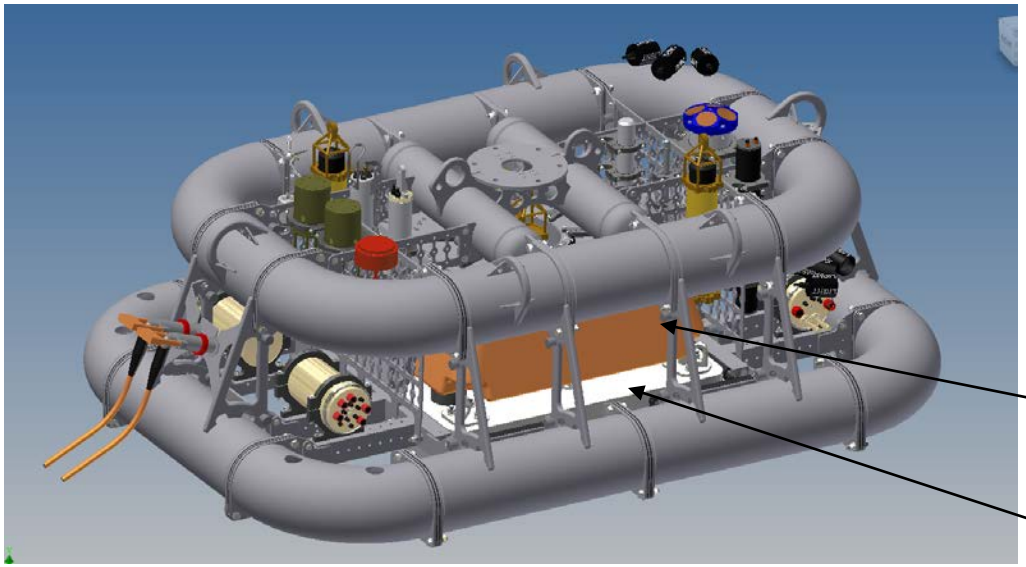
- Molded chain and stretch hose provide electrical connectivity to bottom, allow relatively high data transfer rate



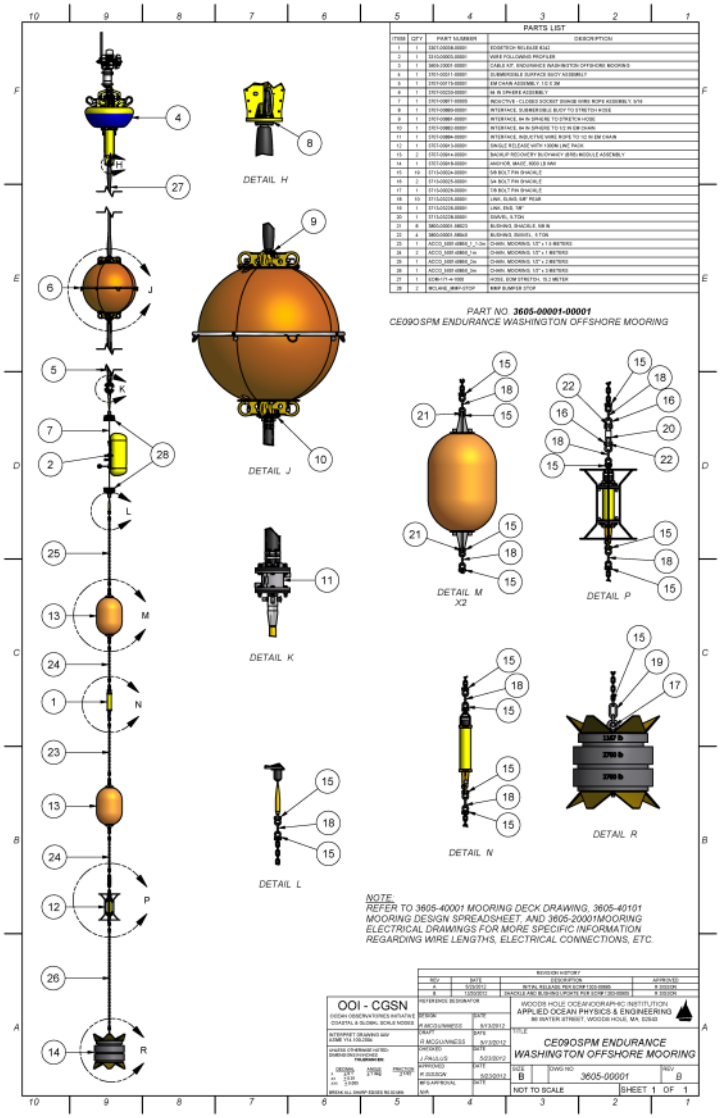
Anchor separation and recovery

- Anchor and Line pack = 6970 lbs (air weight)
- Anchor only = 6500 lbs (air weight)
- frame only = 2500 + 1000 lbs of instruments = 3500 lbs (air weight)
- Instruments & Frame = 10,200 lbs (air weight)





Example – Offshore Wire Following Profiler



Charging system – wind and solar

Pioneer buoy deployed Nov 2013

Height: 5.1m (16.5')

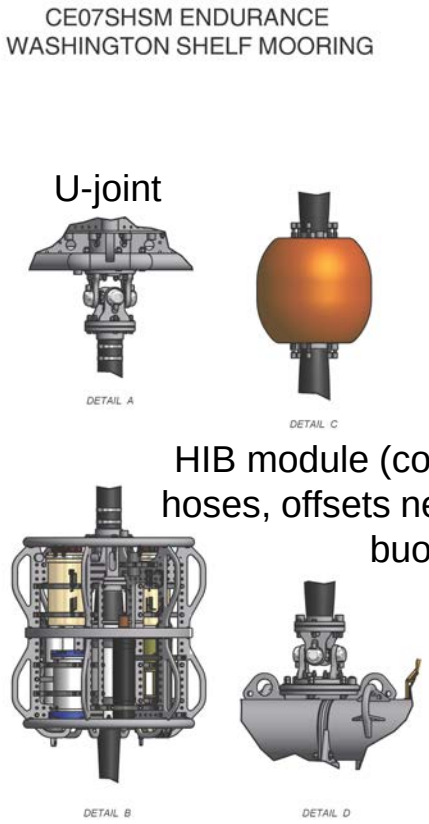
Weights

- Tower: 528kg (1161 lbs)
- Well: 1055 kg (2322 lbs)
- Total: 1591kg (3500 lbs)

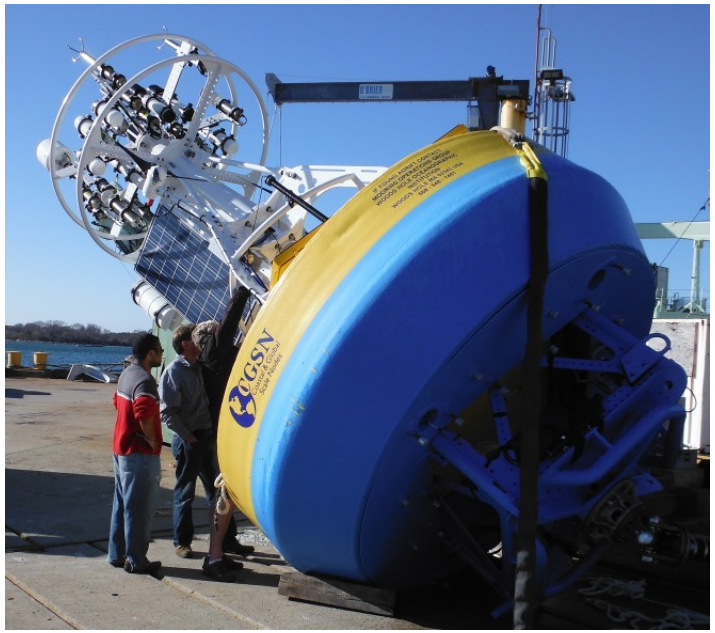
Mitigation of hydrogen buildup

- passive ventilation system used by Coast Guard and NDBC buoys
- Hydrogen sensors in well
- Disconnect charging based on voltage limits
- Shore side monitoring
- operational procedures based on NDBC and industry practice
  - At recovery determine state of system
  - Hydrogen measurement and purging procedures

Coastal surface moorings are large and heavy compared to mooring types often deployed from UNOLS vessels



- Buoy Air Weight: 4125 kg (9100 lbs)
- Height: from bottom of buoy frame to top of instrument halo: approx. 6.15 m (20’)



Pioneer central mooring at WHOI, Fall 2013

Handling gear: heavy lift winch

heavy lift winch on base plate

- Designed and manufactured by Sound Ocean Systems Inc. of Redmond, WA to OOI specifications.
- To be transferred to UNOLS west coast winch pool

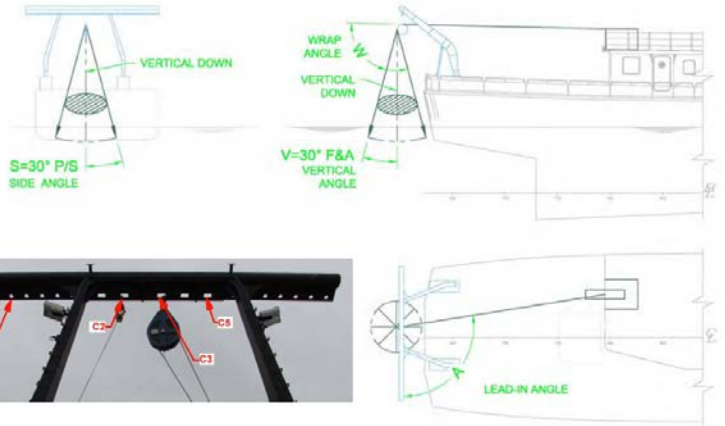
Testing at OSU ship operations pier

UNOLS Appendix B compliance Overboard Handling Data Document (inshore mooring)

- Maximum Package Weight 6,000 lbs in water. Maximum Package Mass 10,660 lbs. in air
- Maximum drag 300 lbs (max winch speed can be adjusted to control tension).
- Maximum deploy depth 30 meters. Deployment depth/water 100% (mooring anchor is lowered to seafloor)
- OHS/Components from Science See System MCD: includes Winch, Foundation, Tension Member, Hanging Block (Sheave)
- Vessel Services Required Beyond deck support, Heavy Lift Winch requires 480V, 3phase, 200Amp line service to wire to winch reactor junction box.
- Tension Member Type Amsteel-Blue (Sampson Rope). Synthetic, torque-free 12-strand single braid line, 0.50 diameter. Tension member weight 0 lbs in water (slightly buoyant) Tension member mass 126 lbs (600 meters). Tension member NBL = 30,600 lbs (Sampson MBS) = ABL
- Load Mitigating Devices Auto-Render supported by LCI-90i. (Line tension, speed and payout length digitally displayed with a 10 Hz update rate on local and remote stations with characters of minimum ½ inch height that are readily visible at night and in direct sunlight.

Hanging Block/Sheave – 34,000 DLT (with Chris Holm – on the left)

Deployment Type: Station Keeping, Deep Water (B.2.1.6) using C3 pad eye on A-Frame



UNOLS App B Compliant Load Rated Pickup Hook – 10,000 lbs. buoy + 1.75 dynamic factor

West Coast Wire Rope & Rigging

This is to certify that we have tested:

Customer: TIMBER SUPPLY CO INC
Customer PO: OSU

Working Load Limit:
Break Test:
Proof Test: 15000

Description of Specimen

1 EA CUSTOMERS 5/8" AMSTEEL BLUE SLING WITH CUSTOMERS FITTINGS EACH END. PROOF LOADED TO 15,000 LS. ON CERT #1390152.

Description of Test

PROOF LOADED TO 15,000 LBS WITHOUT FAILURE OR DEFORMATION.

Sales Order #: 1390152

Tested By:

This test was performed at the customer's request and in accordance with the specifications and directions provided by the customer. As such West Coast Wire Rope makes no warranties, nor assumes any responsibility, whatsoever, for the procedures utilized in the performance of this test or the results derived from this test.

Titanium buoy pick up hook:

Designed by:
Aaron Davis
Winch and Wire Engineer
University of California
Scripps Institution of Oceanography

Summary

- The OOI Endurance Array off Oregon and Washington incorporates state of the art mooring technologies developed by Woods Hole Oceanographic Institution (WHOI). The moorings provide a variety of capabilities including solar and wind charging, two way communication to shore, and electrical connectivity from the surface to the bottom.
- The moorings support a broad set of sensors including meteorological, physical oceanographic, bio-optical, chemical, and acoustic instruments. With these capabilities come significant maintenance challenges. Due to biofouling and physical wear, coastal moorings will be turned twice per year.
- The size and complexity of the moorings make necessary specialized equipment and handling procedures for deployment and recovery. Handling equipment and documentation will be compliant with UNOLS Appendix B.
- Similar care must be taken to ensure safe operation of the electrical charging systems. Hydrogen buildup will be mitigated using equipment and handling and operations procedures based on NDBC and industry experience.