ORION – Sensors

ORION Sensors Committee
Scott Gallager, Chair

ORION Sensors Committee

ISSUES Discussed by Sensor Committee

ORION
- Do we have the sensors necessary to meet transformative science questions?
- Sensor and Interface Standardization
- Interoperability
- Automated Instrument Calibration
- Core vs. Community Sensors
- Enhanced Instrument Development (For Mobile Low Bandwidth, Low Power Platforms)
- New Anti-biofouling Techniques
- New Sensor & Platform Web site at JOI/ORION

Implementing Organization
- QA/QC certification
- Develop instrument pool
- Technical Training

Sensor Standardization

Sensor Physical and Electrical standards

- Standard physical and electrical interface
  (Science Instrument Interface Module) (SIIM)
  - Physical interface
    - Adopting one family of connectors as the dry mate standard is highly desirable (e.g., ODI; SeaCon, SubConn, Impulse, etc.)
  - Electrical interface
    - e.g., 12, 48, and 400 VDC

Sensor Standardization

Communication standards
(based on CI, ENG, Sensors meetings at D&I and 3 May 2006)

- Interoperability standards should be processor- and programming language-independent to the greatest extent reasonable.
- Cabled observatories and HP/HB moorings will have Ethernet and TCP/IP-like communication.
- Every sensor (or instrument suite) will have a separate address.
- Develop SIIMS (Science Instrument Interface Module) to simplify physical, electrical communication interfacing for various instruments. (e.g., RS232, RS485 to Ethernet)
- Metadata could be at the instrument or on land, which ever makes most sense for the platform and application.
  - Note that meta data in NEPTUNE Canada is on the sensor

Core Sensors

Core vs Community and PI Sensors

- "Core" sensors funded by OOI
  - "Core" sensors are not engineering or status instruments (e.g., ground-fault monitoring, voltage monitoring, etc.)
  - Recommendations for "Core" sensors vary among the 3 ORION components, geolocation, and depth.
- "Community" sensors defined as those that are broadly used by a large number of investigators, but not among the core sensors (proposal driven).
- "PI" sensor defined as one-off or specialized sensors that are only used by a small number of investigators (proposal driven).

Core Sensors

Core sensors should have the following characteristics:

- Long lived (capable of long deployments for Global and RCO components; recognizes that biofouling often governs deployment duration in coastal regions)
- Reliable
- Useful for multiple disciplines – many researchers will be served, will address a broad number of science questions
- Addresses research questions for "early success", high probability of major advancement, significant impact
- Addresses research questions needed for long time-series
- Commercially available [this will impact costs]

Core Sensors

Philosophy for Defining Core Sensors

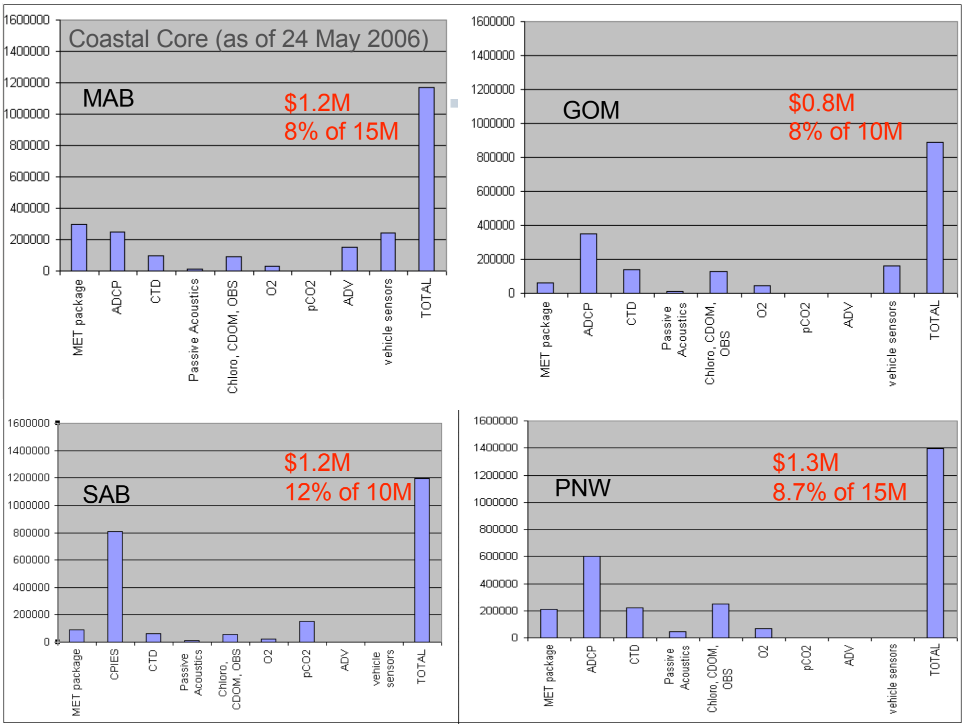
1. Build an Extensive Infrastructure for Long Term Presence in the Ocean and Add Sensors as Science Programs are Funded.
   (Add Minimal Set Of Core Sensors That Are Robust And Of The Shelf)
2. Install Extensive Suite of Sensors at the Expense of some Infrastructure
   – Immediate Data Acquisition
   – Sustained Presence Less Probable
   – "Core" Sensors May Not Be Reliable

Process to define core vs community sensors

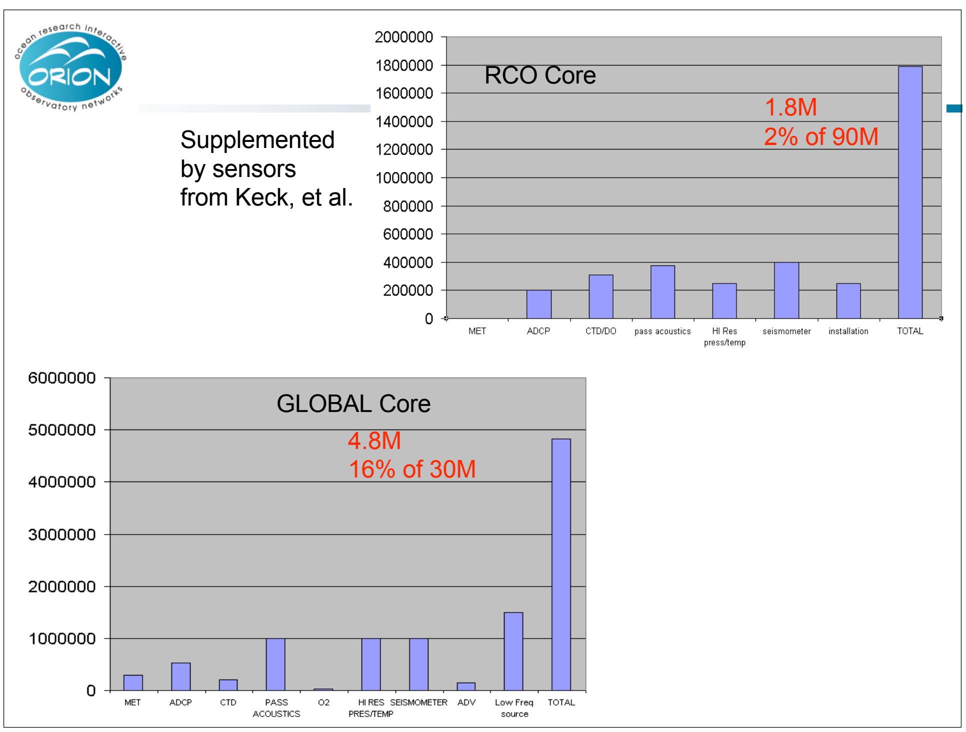
1) Develop sensor spreadsheets for RFA proposals.
2) Determine top 5 sensors for each RFA proposal
3) Evaluate these sensors
   (total number requested; profiling *vs.* fixed depth sensors through the water column *vs.* one/few critical instruments at the air-sea interface or seafloor)
4) Estimate costs of the recommended “core” sensors
5) Work with to STAC subcommittees and ENG to refine list relative to evolving CNDs

Sensors Types

CORE SENSORS specified	COMMUNITY SENSORS examples	PI-SPECIFIC SENSORS examples
MET package	spectral irradiance	flow cytometer
ADCP / CPIES	upwelling irradiance	imaging cytometer
CTD	nitrate	radionuclides
passive acoustics	iron	FRRF
Chloro, CDOM, OBS	phosphate	sector scanning sonar
O_2	spectral a	bubble scanner
pCO_2	spectral beam c	holography/PIV
ADV	pH	methane mass spec
Hi Res Press/Temp		LISST
seismometer		zoocam, VPR
active LF source		CPRISM
		radon towers
		bioacoustics



Coastal Core (as of 24 May 2006)
MAB
$1.2M
8% of 15M
GOM
$0.8M
8% of 10M
SAB
$1.2M
12% of 10M
PNW
$1.3M
8.7% of 15M
MET package
ADCP
CTD
Passive Acoustics
Chloro, CDOM, OBS
O2
pCO2
ADV
vehicle sensors
TOTAL
CPIES



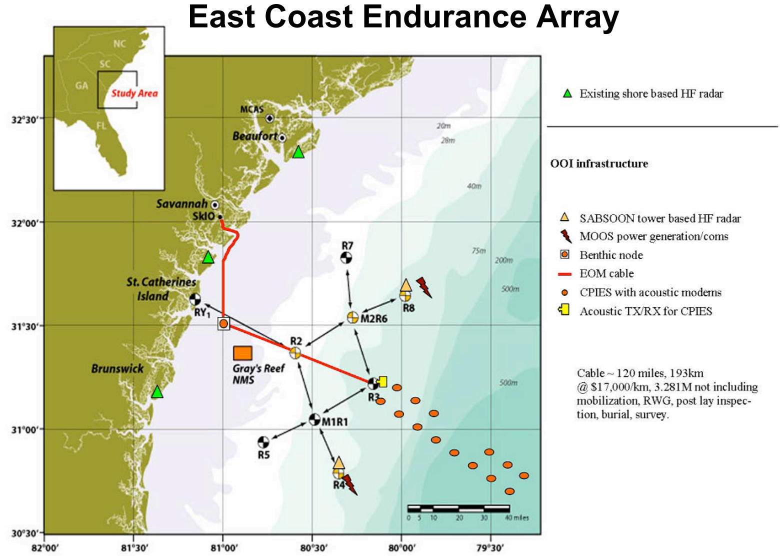
Supplemented by sensors from Keck, et al.
RCO Core
1.8M
2% of 90M
MET
ADCP
CTD/DO
pass acoustics
HI Res press/temp
seismometer
installation
TOTAL
GLOBAL Core
4.8M
16% of 30M
MET
ADCP
CTD
PASS ACOUSTICS
O2
HI RES PRES/TEMP
SEISMOMETER
ADV
Low Freq source
TOTAL

ORION Sensors

- The time is NOW to start thinking about what new sensors we need, and to start development
  - We now know much of the…
    - What: infrastructure (platforms, data rates, power)
    - Where: locations of observatories
    - When: 6 years beginning in FY2007

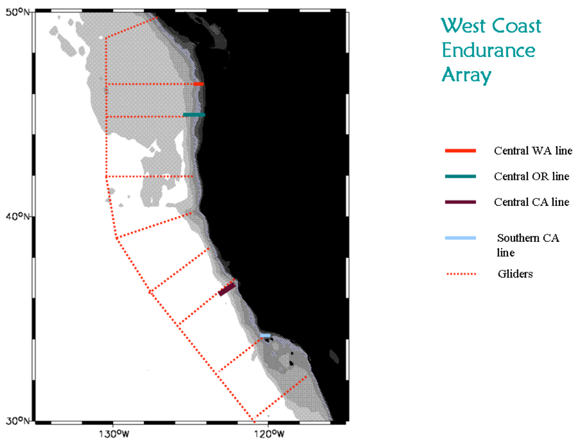
Coastal

East Coast Endurance Array

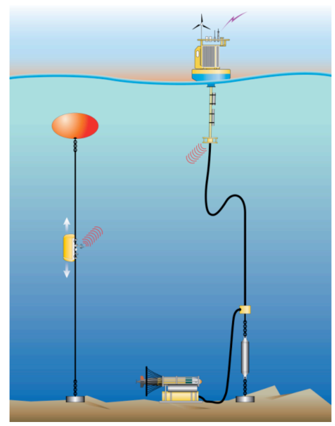


Coastal

West Coast Array

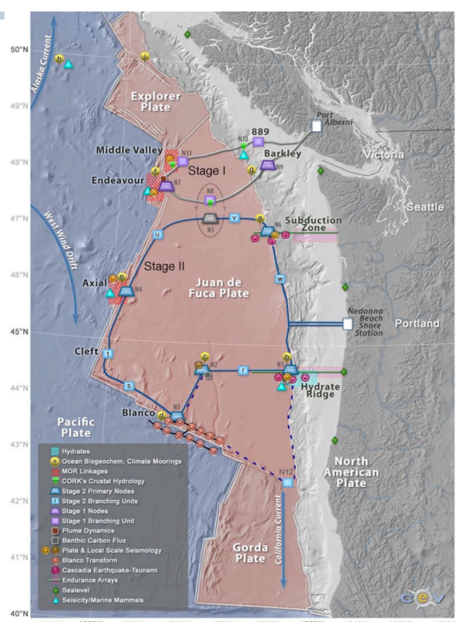


Pioneer Array



Regional

- 5 Instrumented Nodes
  - Subsurface moorings at each node
  - Secondary infrastructure (cables) at some nodes
- 2 Non-cabled Moorings
- Connection to Coastal Arrays

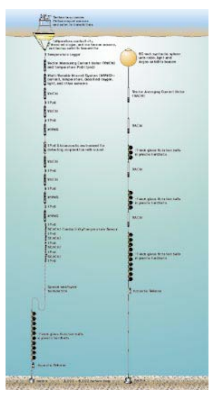


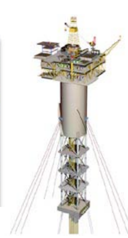
Global

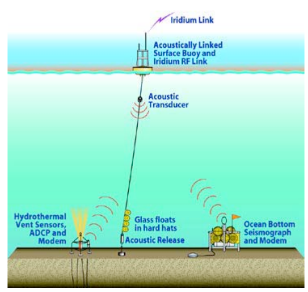
- 9 total sites
  - 4 high latitude sites
  - 2 spar moorings, 2 EOM, 5 acoustic
  - 2 moorings (1 w/ surface expression) at each site
  - All have multidiciplinary support
  - $0.5 Million per site for sensors
  - RIDGE (EPR) is a high priority site
  - PAPA site ties into RCO and West Coast CSO site
  - Hawaii & Bermuda existing time series sites are low priority
- Relocatable “Pioneer” Array

Global

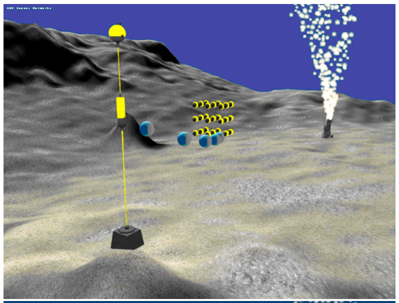
- 3 Types of moorings
  - Spar Buoy
    - High power
      - 10-30 kW @ buoy
      - ~500 W @ seafloor
    - High bandwidth
      - 100s of MB/day
  - Acoustic Buoy
    - No power to seafloor
    - A few MB/day
  - Buoy w/ EOM Cable
    - 100 W @ buoy
    - ~50 W @ seafloor
    - A few MB/day

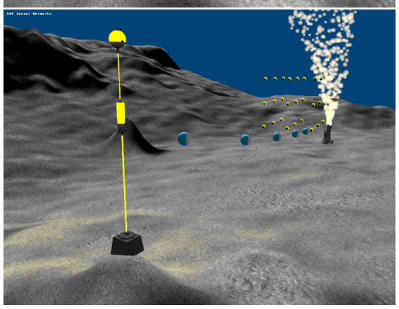






New Sensors/Technology



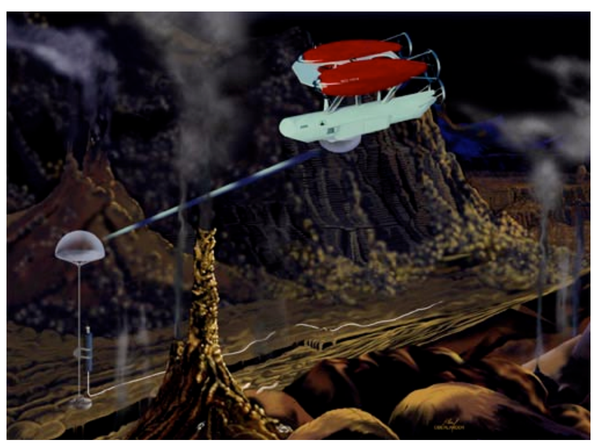


John Delaney's Sensorbots

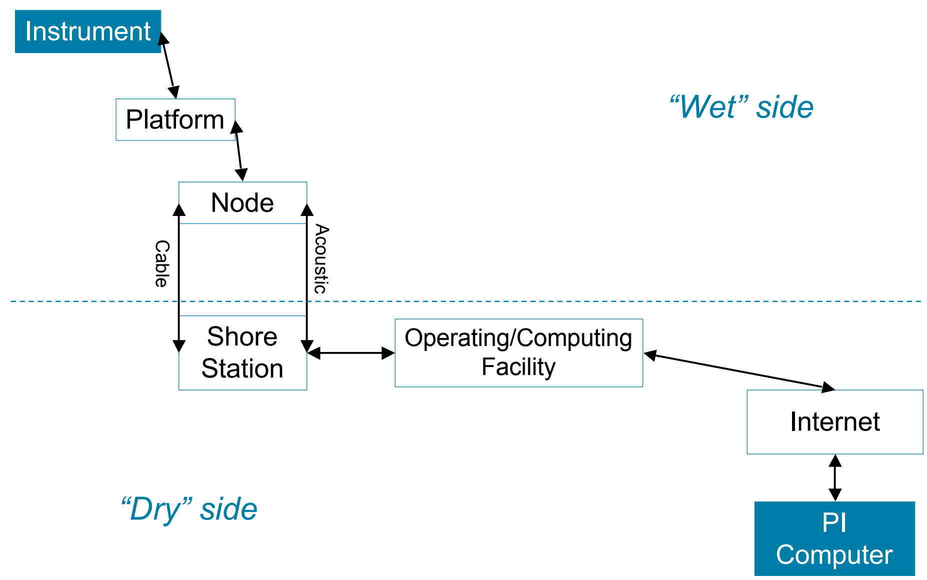
- Mooring delivers power and GB/sec bandwidth connectivity from/to land-based power control system
- Sensorbot power on-board is from rechargeable batteries (initially); serviced at charging stations near moorings
- Communication with sensorbot swarm by optical modem with acoustic backup via comm/nav modules (blue)
- Sensorbots make simultaneous measurements in time and controlled space
- Sensorbots can adjust their buoyancy

New Sensors/Technology

- Optical Modem
  - *Chave, Farr, Freitag, Preisig, Sonnichsen, White, Yoerger*
  - High data rates, short (100 m) range
- Microbial fuel cells
  - *Peter Girguis (Harvard) and others*
  - Low power for extended periods of time (years)



Sensor to Scientist



Oceanographic Sensors, Deployment Platforms, and Associated Technology Searchable Web Site Data Base

Objectives

- provide oceanographic community with up to date, searchable, interactive data base
- sensors
- instrumentation development
- platforms- mobile, fixed
- technology- e.g., biofouling, autocalibration

- on-line forms filled out and maintained by manufacturers/developers
- minimize maintenance by JOI/ORION personnel
- data stored in simple ascii flat files
- searchable by any data field
- organized to provide
  - engineers and system developers with critical information
    - i.e., most common interface for power and communications
  - scientists- experimental design for nested observations
    - i.e., sampling frequency, resolution

Oceanographic Sensors, Deployment Platforms, and Associated Technology Searchable Web Site Data Base

Sensors

measurement	(oxygen, etc)
sensor type	(polarographic, etc)
manufacturer	()
model	()
voltage	(v)
peak power	(w)
nominal power	(w)
bandwidth	(bits/sec)
communication interface	(e.g., serial, TCP/IP)
frequency response	(Hz)
sample rate	(Hz)
resolution	(measurement units)
precision	(measurement units)
accuracy	(measurement units)
size	(cm x cm)
weight, air	(kg)
weight, water	(kg)
intended deployment platforms	(glider, AUV, mooring, ship)
operating environment	(e.g., tropical to polar)
operating depth range	(m)
calibration requirements	(e.g., local, remote configuration file)
ant-biofouling capabilities	(e.g., copper shutter)
maintenance cycle	(d)
readiness	(e.g., COT, in development)
environmental conflicts	(e.g., active acoustics)
source power	(dB)
mechanical mounting	security
permitting required	
special considerations	(e.g., requires power ramp)
price range	
other comments	

Platforms

Platform type
manufacturer
model
mission range
mission resolution
depth capability
propulsion
battery type
battery capacity
hotel load
navigation
communications
operational sea states
deployment/retrieval operations
maintenance frequency
working life
available sensors, typical
docking station capability
emergency locating device

Technology

Biofouling
Auto-calibration
Connectors
Node specifications