DEEP OCEAN OBSERVING STRATEGY

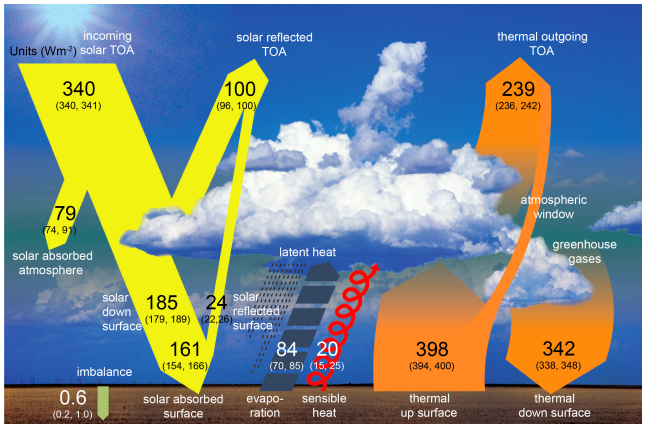
An international, community-based group focused on developing a roadmap that will lead to an improved understanding of the state of the deep ocean with respect to baseline conditions, response to climate variability and response to human disturbance.

The Global Ocean Observing System

DOSI
DEEP-OCEAN STEWARDSHIP INITIATIVE

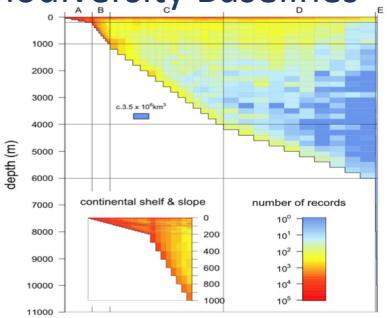
DOOS Motivators

Energy imbalance and overturning circulation, ventilation and turbulence



Climate Change

Biodiversity Baselines

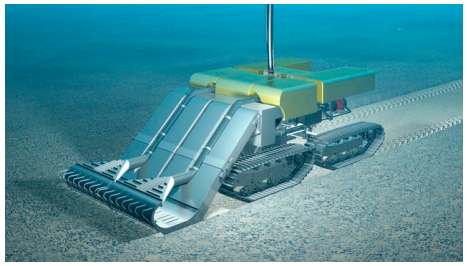


Sustainability

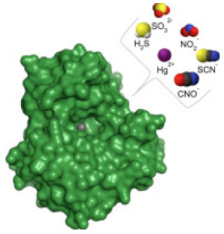
Expanded resource extraction

Fishing

Energy



Minerals Mining



Genetic Resources

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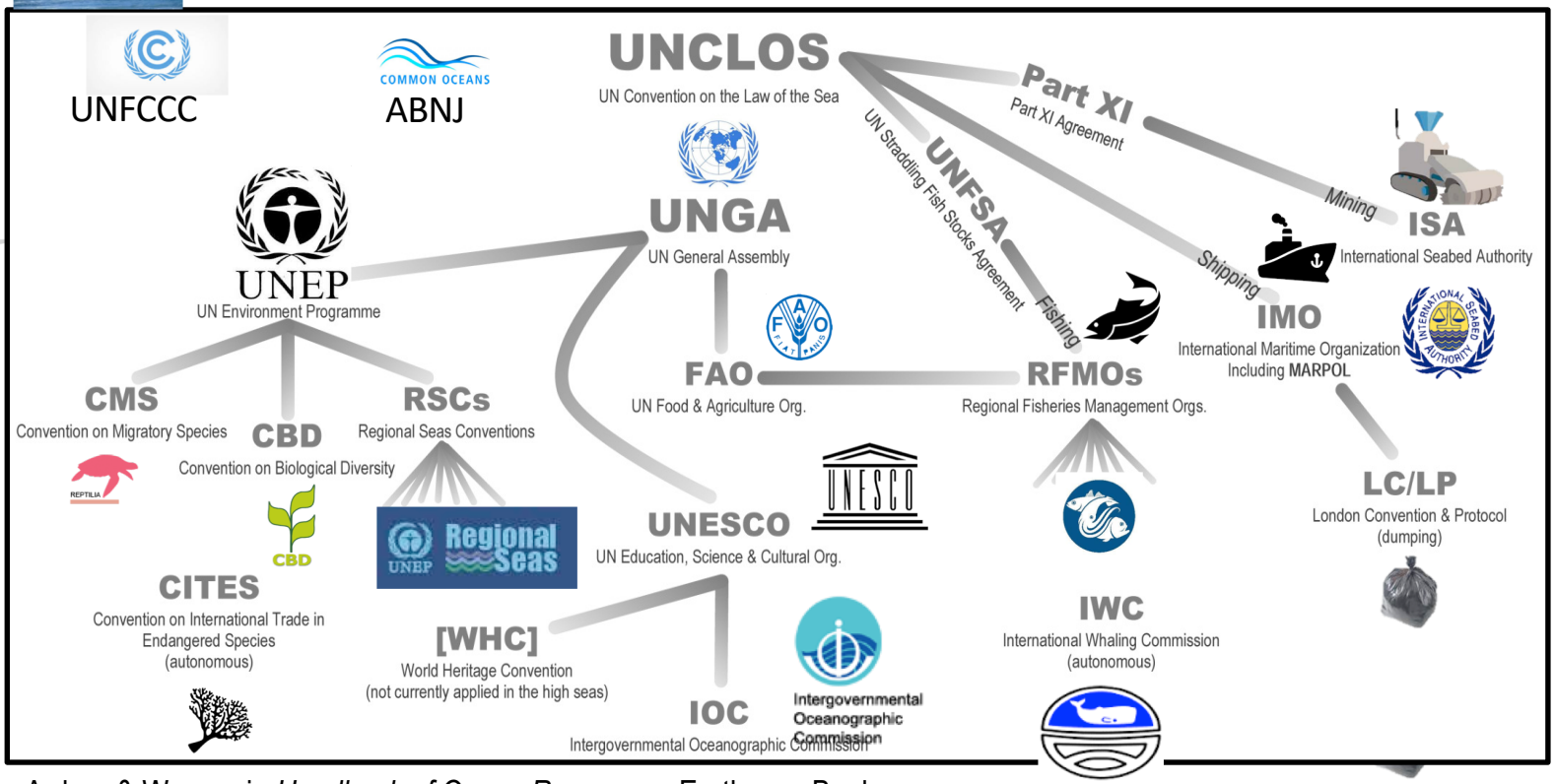
Motivators: Societal Conventions



Ardron & Warner, in *Handbook of Ocean Resources,* Earthscan Books

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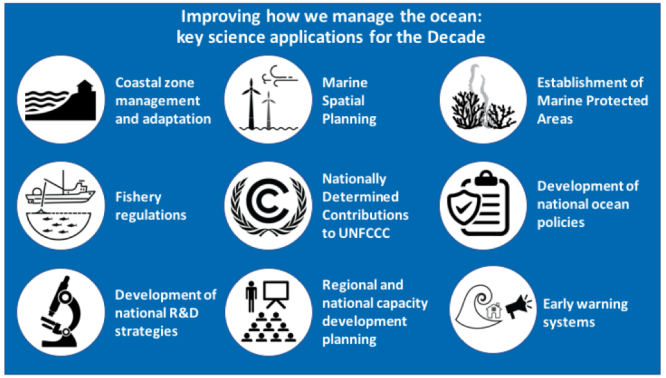
United Nations Decade of Ocean Science for Sustainable Development (2021-2030)

The United Nations has proclaimed a Decade of Ocean Science for Sustainable Development (2021-2030) to gather ocean stakeholders worldwide behind a common framework that will ensure ocean science can fully support countries in the achievement of the Sustainable Development Goal 14 on the ocean.



Decade Roadmap R & D Priorities

- **Area 1:** Comprehensive map (digital atlas) of the ocean
- **Area 2:** A comprehensive ocean observing system
- **Area 3:** A quantitative understanding of ocean ecosystems and their functioning as the basis for their management and adaptation
- **Area 4:** Data and information portal
- **Area 5:** Ocean dimension in an integrated multihazard warning system
- **Area 6:** Ocean in earth-system observation, research and prediction, with engagement of social and human sciences and economic valuation
- **Area 7:** Capacity building and accelerated technology transfer, training and education, ocean literacy

Deep Ocean Observing Strategy History and Status

- **2013-16 Consultative Draft – Precursor to Implementation Plan:**

  Boetius, Fischer, Johnson, Levin, Sloyan, Sibuet,Tanhua, Wanninkhof, (+ Ruhl, Heimbach, Song)
- **2014 Workshop, Adopted as a GOOS Project**
- **2016 Deep-Ocean Observing Inventory -** 70 Responses
- **2016 DOOS Scoping Workshop:** Representatives from GOOS, GO-SHIP, Argo, Deep Argo, Bio Argo, OceanSITES, TPOS 2020, OOI, ONC, GCOS, DOSI (51 Attendees 9 countries)
- **2017 Steering Committee -1**
- **2017 AGU Townhall**
- **2018 OSM Townhall**
- **2018 Science Implementation Guide**

DEEP OCEAN OBSERVING STRATEGY

Website:
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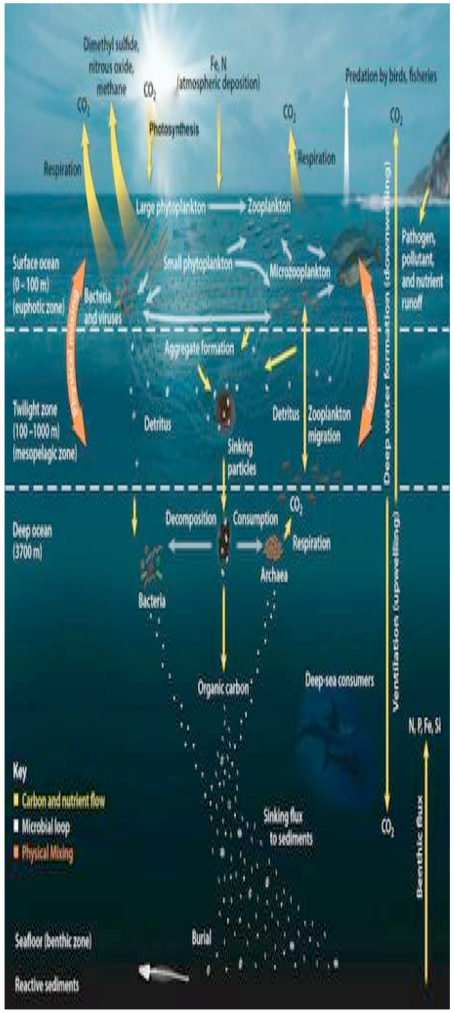
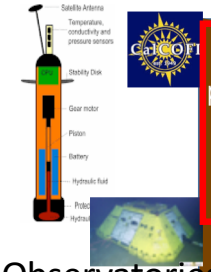
What Depths?

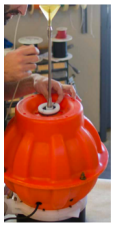


ARGO

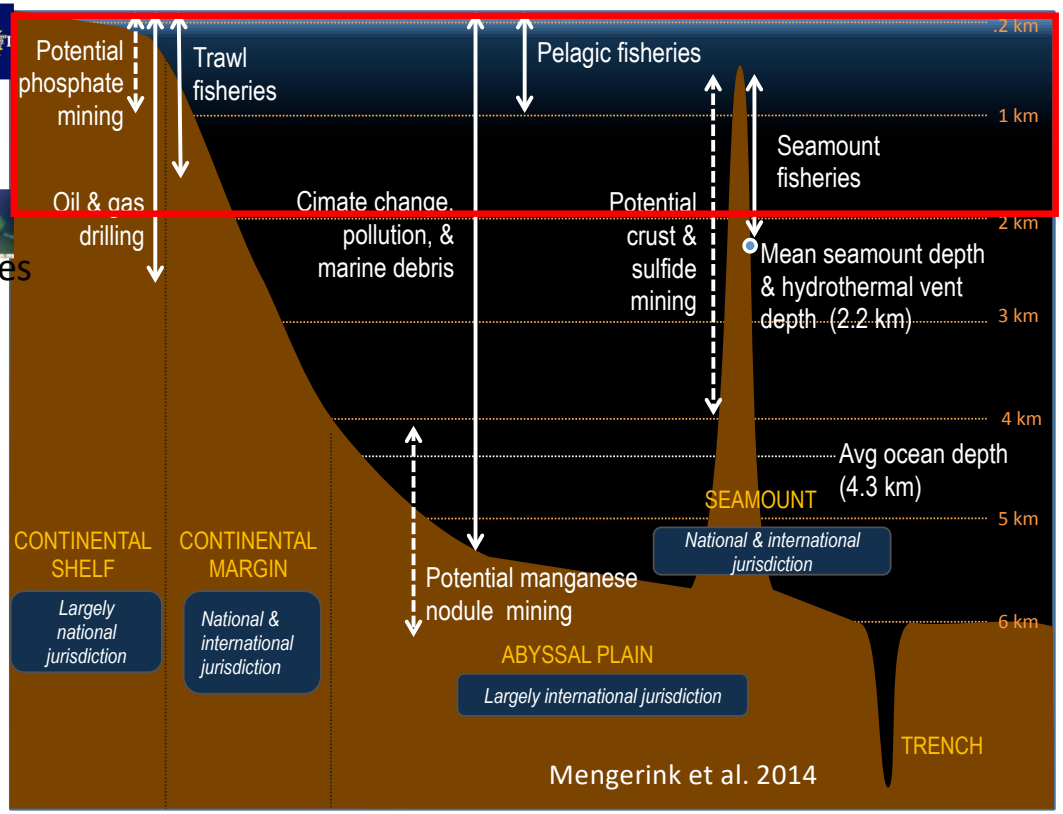


Observatories

DEEP ARGO



A focus > 2000 m, but with necessary observations below 200 m



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Project Leadership

Steering Committee
- 17 Members
- 8 Countries
- 13 Institutions

TASK TEAMS:
- Physics EOVs
- Biogeochemistry EOVs
- Biology & Ecosystem EOVs
- Data & Cyberinfrastructure

SUBCOMMITTEES:
- Capacity Building
- Demonstration projects
- UN Engagement
- Solid Earth Liaison
- Large –Project Liaison

DEEP OCEAN OBSERVING STRATEGY

- Lisa Levin, Scripps Institution of Oceanography, USA
- Henry Ruhl, National Oceanography Centre, UK
- Patrick Heimbach, Univ. Texas at Austin, USA
- Andrea McCurdy, Project Manger, UCAR

Simone Baumann-Pickering	USA	Scripps Institution of Oceanography
Kristina Gjerde	Poland	International Union for Conservation of Nature
Bruce Howe	USA	University of Hawaii at Manoa
Felix Janssen	Germany	Alfred-Wegner Institute
Katsuro Katsumata	Japan	Japan Agency for Marine-Earth Science and Technology
Deb Kelley	USA	University of Washington
Nadine LeBris	France	Universite Pierre et Marie Currie
Craig Smith	USA	University of Hawaii at Manoa
Sun Song	China	Institute of Oceanology, Chinese Academy of Sciences
Adam Soule	USA	Woods Hole Oceanographic Institution
Karen Stocks	USA	Scripps Institution of Oceanography
R. Venkatesan	India	National Institute of Ocean Technology Ministry of Earth Science
Bob Weller	USA	Woods Hole Oceanographic Institution
Paul Snelgrove	Canada	Memorial University

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DOOS Terms of Reference

1. *Build understanding* of what is most important to observe.
2. *Provide a hub* for integration opportunities.
3. *Coordinate* observations.
4. *Develop* deep observing *requirements.*
5. *Build readiness* in observing technology and techniques.
6. *Foster availability*, discoverability and usability of deep-ocean data
7. Create a *common community science implementation plan* for deep-ocean observing that advocates for deep observations

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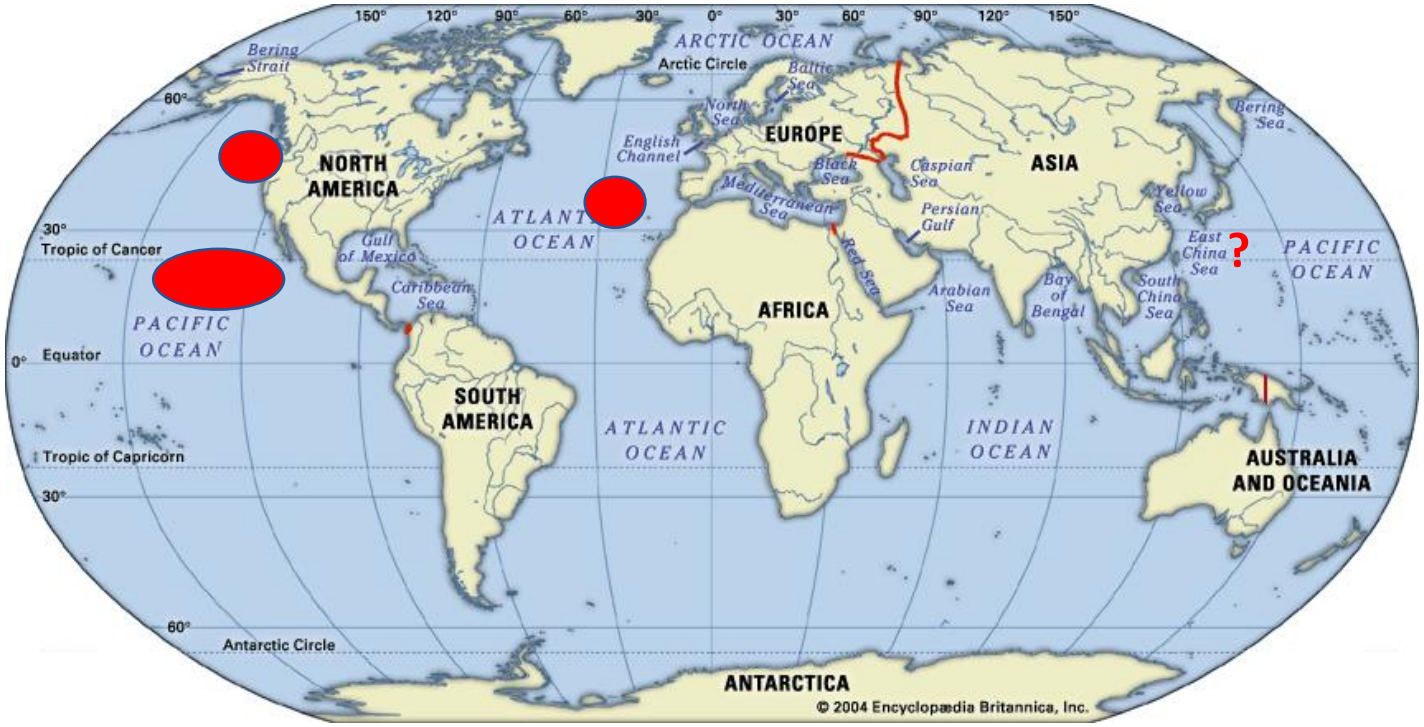
DOOS Demonstration Projects

- Region-specific, interdisciplinary projects
- Demonstrate the feasibility of sustained deep-ocean observing
- Demonstrate the technologies to be employed in deep-ocean observing
- Demonstrate impact and utilization of deep-ocean observations

- Azores
- NE Pacific
- Clarion Clipperton Fracture Zone

Take advantage of existing infrastructure, where possible, and maintain a focus on the scientific and societal motivations for DOOS



Demonstration projects & sites: concepts & philosophy

Projects may make use of existing infrastructure, or may be based on new platforms, but it is key that they:

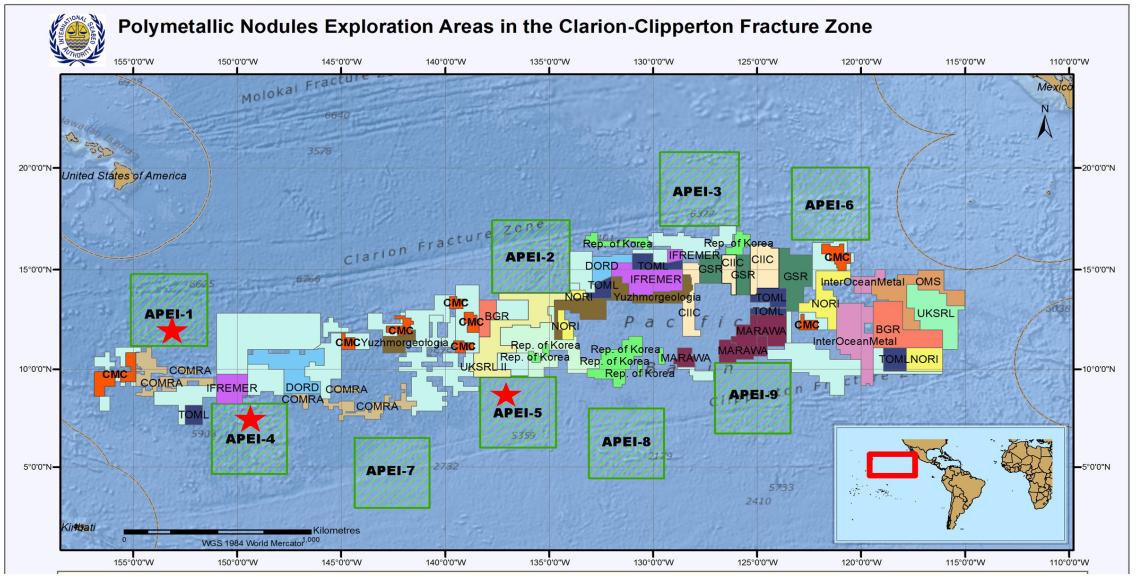
- illuminate the end-to-end process of deep ocean observing, of data processing and quality control;
- make the data readily available to users with appropriate documentation;
- advance the state of the art on key EOVs and technological capacities for deep ocean obs.;
- facilitate the evolutive and modular dimensions of these platforms;
- are scalable to global-scale observing networks

Advantages of DOOS engagement:

- Novel approaches to integrating disciplines
- New platforms, sensors, questions
- Extended connection to other systems, broadened applications
- New engagement, funders, stakeholders
- New end users – knowledge action , policy applications
- New capacity building and outreach opportunities

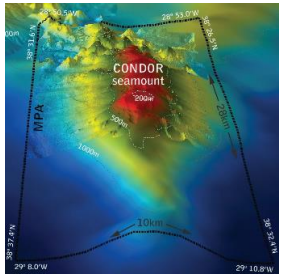
Clarion-Clipperton Zone (CCZ) – Rationale

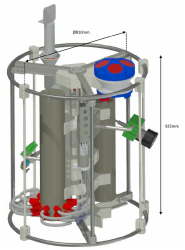
- Strong geographical synergy with TPOS-2020
- Falls within the core region of nodule-mining claims registered with the International Seabed Authority (ISA)
- Span the intense, expanding OMZ of the eastern tropical Pac.
- Contain key fisheries populations
- Representative of some of the largest, least-studied benthic and mid-water biogeographic provinces

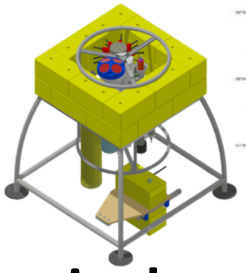


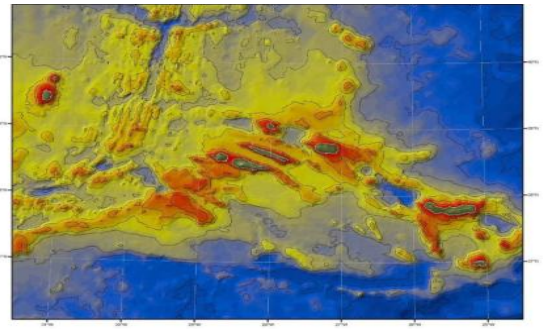
The Azores – Rapid access to diverse deep-sea ecosystems

- European Multidisciplinary Seafloor Observatory (EMSO) at Lucky Strike hydrothermal vent field (MPA)
- EMSO in near future at CONDOR seamount (MPA)
- European Aquatic Animal Tracking Network
- DeepSeaLab @ IMAR/MARE







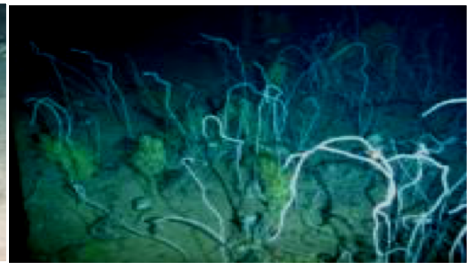


Biodiversity hotspots & environments

Deep-sea hydro-thermal vents

Island slopes

Mid-depth seamount summits



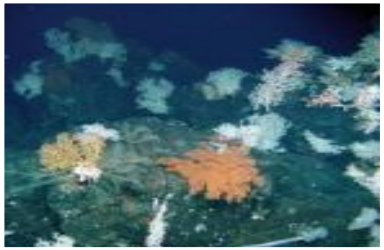
Proposal for an ASPIRE mission to the FAMOUS segment and Sarda seamount on the Mid-Atlantic Ridge

Contact Information
Primary Contact: Ana Colaço; (Marina Carreiro e Silva, Telmo Morato)

Abyssal plains

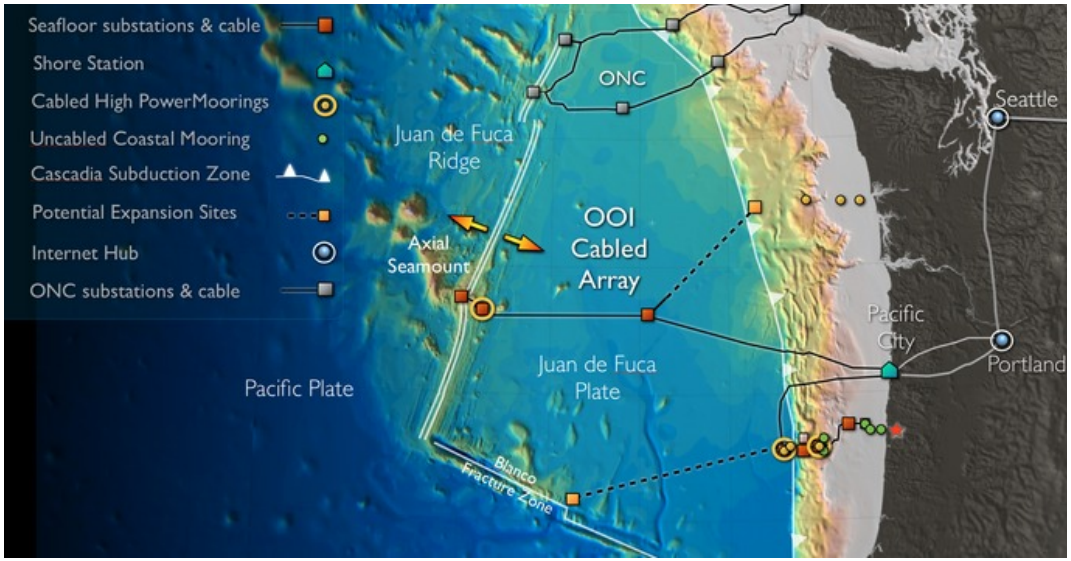
Seamount slopes

Deep seamount summits



OOI Northeast Pacific Cabled Array

- spans the Cascadia Margin and Subduction Zone,
- crosses the Juan de Fuca Plate with instrumented sites at the base and summit of Axial Seamount.
- hosts the largest, most concentrated and advanced network of infrastructure
  - cabled and uncabled instrumented moorings
  - profiling capabilities and surface expressions
  - an extensive seafloor array
  - gliders,
- monitors margin environments coincident with an active subduction zone,
  from 25 m to 2900 m depth,
  and the most active volcano
  on the Juan de Fuca Ridge.

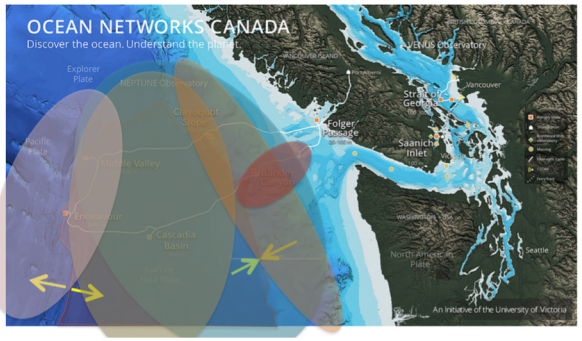


Ocean Networks Canada (ONC)

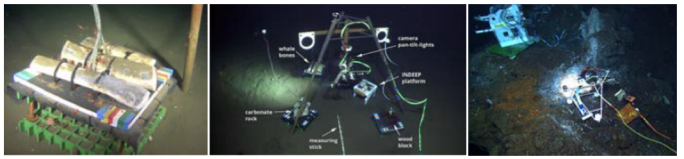
NEPTUNE Observatory
NE Pacific

Cover a wide-range of deep-sea ecosystems

- Hydrothermal Vents
- Abyssal Plain
- Oxygen Minimum Zone
- Submarine Canyon and Open Slope
- Cold/Methane Seeps



NEPTUNE Observatory
NE Pacific



What processes/phenomena are being monitored:

CLIMATE
- Earthquakes, tsunamis
- Ocean currents, waves
- Primary productivity
- Carbon flux
- Ocean Acidification/Deoxygenation
- Zooplankton biomass/migration

- Marine mammal occurrence/behavior
- Benthic ecology and dynamics
  - Community structure change over time
  - Larval colonization/connectivity studies
  - Colonization and community succession experiments

Core Instrumentation & (EOV's) ?

- CTDs (temp, pressure, conduct.)
- ADCPs (u, v, speed, backscatter)
- ZAPs (backscatter/biomass)
- Oxygen sensors (O_2)
- Nitrate sensors (nutrients)
- pH and pCO_2 sensors (acidity)
- Fluorometer (chlorophyll)
- Sediment traps (POC)
- Hydrophones (soundscape)
- Fixed video cameras (abund./diversity)
- ROV video transects (abund./diversity)
- Seismometers (p, s waves)
- Bottom pressure recorders (Δp (mm))
- Vertical Profilers (various: pelagic)