OOI Science Themes

To understand processes at all oceanographic scales, from ocean basin to tidal basin, seafloor to surface, and within the thin sections of wave fronts and stratified nutrient layers, requires the complete set of observing and computational assets envisioned for the OOI. Many assets must be capable of finding and following transient and localized phenomena, wherever they occur, while other platforms must provide stable reference points over time and space. The short-term nature of many processes demands reactive control of high-speed measurements, while large-scale phenomena must be measured consistently over months, years, or decades.

Ocean-Atmosphere Exchange

Quantifying the air-sea exchange of energy and mass, especially during high winds (greater than 20 ms-1), is critical to providing estimates of energy and gas exchange between the surface and deep ocean and to improving the predictive capability of storm forecasting and climate-change models.

Climate Variability, Ocean Circulation, and Ecosystems

Understanding how climate variability will affect ocean circulation, weather patterns, the ocean's biochemical environment, and marine ecosystems is a compelling driver for multidisciplinary observations.

Turbulent Mixing and Biophysical Interactions

Turbulent mixing plays a critical role in the transfer of materials within the ocean and in the exchange of energy and gases between the ocean and atmosphere. Horizontal and vertical mixing within the ocean can have a profound effect on a wide variety of biological processes.

Coastal Ocean Dynamics and Ecosystems

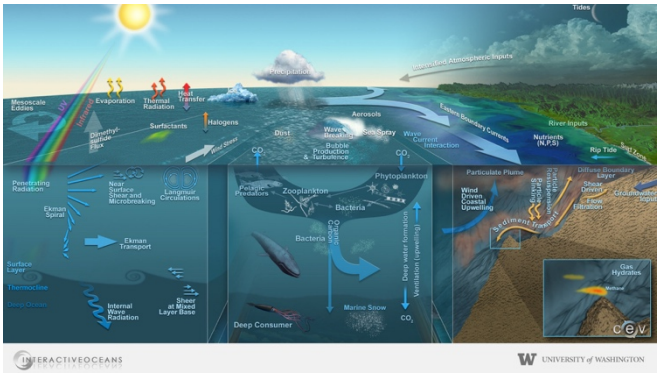
The coastal ocean is host to a variety of dynamic and heterogeneous processes, including human influences, which often strongly interact. This results in unique challenges for improved understanding and management of coastal resources in a changing climate.

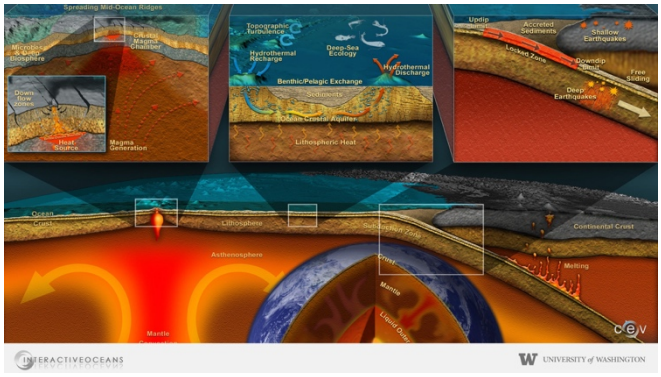
Fluid-Rock Interactions and the Sub-seafloor Biosphere

Many seafloor and all sub-seafloor ecosystems are inextricably linked to, and perhaps inevitable consequences of, the flow of energy and material between the earth's crust and the deepest portions of the overlying ocean.

Plate-scale Geodynamics

Lithospheric movements and interactions at plate boundaries at or beneath the seafloor are responsible for short-term events such as earthquakes, tsunamis, and volcanic eruptions.





OOI Related Science Questions

Ocean-Atmosphere Exchange

- How important are extremes of surface forcing in the exchange of momentum, heat, water, and gases between the ocean and atmosphere?
- What is the effect of extreme surface forcing on air-sea fluxes of mass and energy?
- What is the effect of extreme wind on the structure of the upper mixed-layer?
- How does variability in surface forcing affect primary productivity (and carbon fixation)?

Climate Variability and Ecosystems

- How do climate signals due to forcing at ENSO, NAO, and interdecadal time scales (e.g., PDO) lead to changes in water column structure and chemical and biological properties?
- What are the effects of climate signals on variability in water column structure, nutrient injection in the photic zone, primary productivity, and vertical distribution and size structure of particulate material?

Ocean Circulation, Mixing, and Ecosystems

- How do severe storms and other episodic surface mixing events affect physical, chemical, and biological water column processes?
- What are the effects of variable strength storms on surface boundary layer structure and nutrient injection in the photic zone, primary productivity, and vertical distribution and size structure of particulate material?

Global Biogeochemistry and Carbon Cycling

- What is the ocean's role in the global carbon cycle?
- What are the dominant physical and biological processes that control the exchange of carbon and other dissolved and particulate material (e.g., nutrients, organic matter, dissolved gases, and other materials) across the air-sea interface, through the water column, and to the seafloor?
- What is the spatial (coastal versus open ocean) and temporal variability of the ocean as a source or sink for atmospheric CO2?
- What is the seasonal to inter-annual variability in particulate (organic) flux?
- What is the impact of decreasing pH to the chemistry and biology of the ocean?

Ocean Mixing and Rough Topography

- How does topography-driven mixing maintain the observed abyssal stratification?
- What processes are responsible for enhanced near-boundary mixing?
- What are the spatial and temporal variability, and steady state dynamics of these processes?
- How are these processes engendered and/or modulated by the general circulation, mesoscale eddies, mesoscale waves, inertial wave energy levels, barotropic tides, higher frequency internal wave energy levels, and ambient stratification?

Shelf/Slope Exchange

- How do shelf/slope exchange processes structure the physics, chemistry, and biology of continental shelves?
- What processes lead to heat, salt, nutrient, and carbon fluxes across the mid-Atlantic Bight shelf-break front?
- What is the relationship between the variability in shelf-break frontal jets and along-front structure in phytoplankton distributions?
- What aspects of interannual variability (in stratification, offshore circulation patterns, jet velocities, and wind forcing) are most important for modulating shelf/slope exchange of dissolved and particulate materials?

Hypoxia on Continental Shelves

- What are the dynamics of hypoxia on continental shelves?
- What are the relative contributions of low-oxygen, nutrient-rich source water, phytoplankton production from local upwelling events and along-shore advection, and local respiration in driving shelf water hypoxia in the Northern California Current?

- What are the impacts of shelf hypoxic conditions on living marine resources?
- How are wind-driven upwelling, circulation, and biological responses in the coastal zone affected by the El Niño Southern Oscillation, water mass intrusions, and inter-decadal variability?

Fluid-Rock Interactions and the Sub-seafloor Biosphere

- How does plate scale deformation mediate fluid flow, chemical and heat fluxes, and microbial productivity?
- What are the temporal and spatial scales over which seismic activity impacts crustal hydrology?
- How do the temperature, chemistry, and velocity of hydrothermal flow change temporally and spatially in subsurface, black smoker, diffuse, cold seep, and plume environments? How are these systems impacted by tectonic and magmatic events?
- What is the composition and concentration of microbial material in subsurface, black smoker, diffuse, cold seep, and plume environments in time and space? How are these systems impacted by tectonic and magmatic events?

Gas Hydrates

- How do tectonic, oceanographic and biologic processes modulate the flux of carbon into and out of submarine gas hydrate “capacitor”, and are there dynamic feedbacks between the gas hydrate methane reservoir and other benthic, oceanic and atmospheric processes?
- What is the role of tectonic, tidal, and other forces in driving the flux of carbon into and out of the gas hydrate stability zone out of the sediment? How is this response influenced by geologic parameter (stratigraphy and structure)?
- What is the significance of pressure change on hydrate stability and methane fluxes due to winter storms and pressure pulses, and bottom currents interacting with topography?
- Can natural temperature fluctuations help us understand the effects of long-term temperature change on hydrate stability, or are perturbation experiments requirements to artificially raise the temperature?
- What is the fate of hydrate/seep methane in the ocean and atmosphere? Does significant methane arrive to the atmosphere from hydrate sources?
- Are there temporal variations in animal/microbial activity and composition that are affected by temporal variation in fluid flow, chemistry and flux?

Plate-scale Geodynamics

- What are the forces acting on plates and plate boundaries that give rise to local and regional deformation and what is the relation between the localization of deformation and the physical structure of the coupled asthenosphere-lithosphere system?
- What is the style of deformation along plate boundaries?
- What are the boundary forces on the Juan de Fuca Plate and how do the plate boundaries interact?
- What are the causes and styles of intra-plate deformation?
- What is the return flow from the ridge to the trench?
- How much oceanic mantle moves with and is coupled to the surface plate?
- How and why do stresses vary with time across a plate system?