OCEAN OBSERVATORIES INITIATIVE

OOI Science Themes

The OOI cutting-edge technology and instrumentation enables novel and exciting research on a wide range of topics in the Earth and ocean sciences. The data can be used to investigate science questions directly or through the use of different models, or data can be used in support of additional process-based research projects. The high-level science themes upon which the OOI was developed include:

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 Food Webs, and Biogeochemical Cycles

Understanding how climate variability will affect ocean food webs, 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

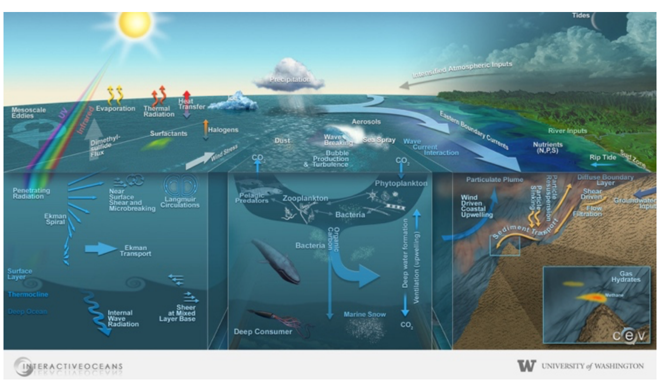
The coastal ocean is host to a variety of dynamic and heterogeneous processes, including human influences, which often strongly interact. This results in unique challenges for improved understanding and management of coastal resources in a changing climate.

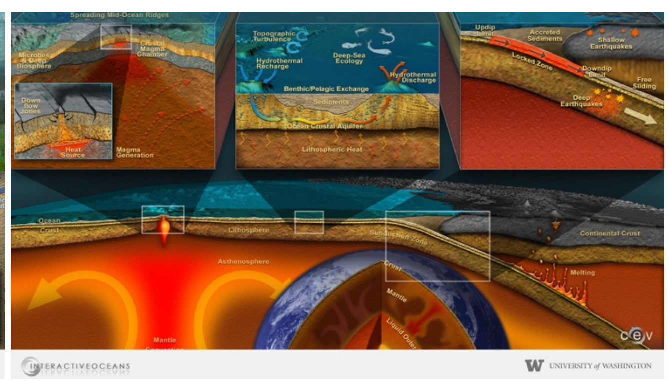
Fluid-Rock Interactions and the Sub-seafloor Biosphere

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.

Global and 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

How is climate change influencing ocean ecosystems?

- What is the ocean's role in the global carbon and other biogeochemical cycles?
- How have ocean biogeochemical and physical processes and their interactions contributed to today's climate and its variability, and how will ocean systems change over the coming decades?
- What are the dominant physical, chemical, and biological processes that control the exchange of carbon and other dissolved and particulate material 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 interannual variability in the biological carbon pump and particulate flux?
- What factors control the distributions of marine organisms?
- How are the oceans changing and what are the consequences for our living resources and food webs?
- How productive are our ocean ecosystems and how does primary productivity vary over space and time?
- How will the effects of climate change in the ocean, superimposed on other natural and anthropogenic stressors, alter the carrying capacity and recovery potential of marine ecosystems?

How does ocean circulation and the distribution of heat in the ocean and atmosphere respond to natural and anthropogenic drivers?

- How are marine heat waves influencing ocean ecosystems?
- What processes dominate mixing in the ocean and on what space and time scales?
- How does topography-driven mixing maintain the observed abyssal stratification?
- What processes are responsible for enhanced near-boundary mixing?
- How is heat transported into the ocean interior? What is the role of mean seasonal versus episodic processes?
- What is the importance of the abyssal stratification and how is it maintained?
- How do changes in mixing and circulation affect nutrient availability and ocean productivity?
- What is the spatial and temporal distribution of ocean mixing, turbulence, and stirring, and how might these processes be represented in climate-scale ocean models?

How important are extremes of surface forcing (high wind and waves) in the exchange of momentum, heat, gases, and water between the ocean and atmosphere?

- What is the effect of extreme wind, buoyancy forcing, and turbulent mixing on the structure of the upper mixed-layer?
- What are the effects of ocean-atmosphere interactions on ocean properties and large-scale thermohaline circulation?
- What are the air-sea fluxes of aerosols and particulates?
- In what ways do severe storms and other episodic mixing processes affect the physical, chemical, and biological water column processes?
- What are the effects of variable strength storms on surface boundary layer structure and nutrient injection into the photic zone?
- How do storm-induced nutrient injections influence primary productivity, and the vertical distribution and size structure of particulate material?
- At what depth does primary productivity occur and how does this vary over space and time

How do cyclical climate signals at the El Niño Southern Oscillation, North Atlantic Oscillation, and Pacific Decadal Oscillation time scales structure the water column, and what are the corresponding impacts on ocean chemistry and biology?

- 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?
- Are secular climate change trends detectable in the oceans?
- 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?

How do coastal ecosystems and communities respond to multiple stressors? What is the impact of decreasing pH (ocean acidification) on ocean chemistry and biology?

- What is the impact of decreasing pH (ocean acidification) on ocean chemistry and biology?
- What are the dynamics of hypoxia (low oxygen) 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?
- What are the impacts of shelf hypoxic conditions on living marine resources?
- How do harmful algal blooms affect marine ecosystems and how are these blooms related to environmental forces?
- How do anthropogenic and natural stressors affect the productivity, resilience, and connectivity of marine communities?

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 shelf-break fronts?
- What is the relationship between the variability in shelf-break frontal jets and along-front structure and how does this impact marine communities?
- What aspects of interannual variability in stratification, upwelling, offshore circulation patterns, jet velocities, and wind forcing are most important for modulating shelf/slope exchange of dissolved and particulate materials?
- How do warm core rings influence cross-shelf exchange?
- How do sub-mesoscale physical processes influence marine biogeochemical properties?

What processes govern the formation and evolution of ocean basins? What information is needed to improve the ability to forecast geohazards like mega-earthquakes, tsunamis, undersea landslides, and volcanic eruptions?

- How can risk of these major events be better characterized?
- Where does magma form and what are its pathways to the surface to form the oceanic crust?
- 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 are the boundary forces on the Juan de Fuca Plate and how do the plate boundaries interact?
- What are the causes and styles of intraplate deformation?
- 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?

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 formation, deformation, and hydrology?
- How does seafloor heat flow and crustal circulation vary over time?
- 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, and on what time scale, and how long do resultant perturbations last? What is the permeability of the oceanic crust and overlying sediments?
- How do the chemical and physical characteristics of the oceanic crust vary over time and affect crustal permeability?

How do tectonic, oceanographic, and biological processes modulate the flux of carbon into and out of the submarine gas hydrate "capacitor," and are there dynamic feedbacks between the gas hydrate 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?
- 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?
- What is the fate of hydrate/seep methane in the ocean and atmosphere and how is climate change impacting the release of methane from the seafloor?