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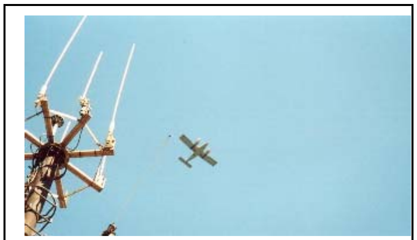
Coastal Ocean Advances in Shelf Transport

Introduction: The coastal ocean is a region of special societal importance. As more of the world's population shifts toward coastal areas, human impact on the coastal ocean in terms of pollution, waste disposal and recreation continue to increase. Key issues range from coastal navigation and coastal hazards such as flooding and erosion, to the utilization of renewable resources (e.g. fisheries) and nonrenewable resources (e.g. minerals, sand, and petroleum) while minimizing environmental damage. Sensible management decisions require greater fundamental comprehension of how the coastal ocean system functions.

Mission/Problem to be Addressed: Ocean currents, temperature and biological productivity change with the seasons off the Oregon coast. The strong summertime southward wind drives a swift ocean flow to the south. These same winds cause cold, nutrient-rich subsurface water to upwell near the coast. This nutrient-rich water combined with sunlight creates phytoplankton blooms in Oregon's coastal waters, resulting in an abundant ocean food chain. Much is known about the north-south currents that carry material along the coast, but far less is known about the transport of waters east-west across the continental shelf. Off the Oregon coast, wind and the topography of the ocean floor influence these east-west currents. Understanding and being able to predict wind-driven ocean currents and their influence on the chemistry and biology of the coastal ocean has major implications for assessing influences on ocean ecosystem health, pollutant transport, shipping and navigation.

Program Description: The Coastal Ocean Advances in Shelf Transport (COAST) program is an intensive five-year study combining a unique set of observational tools and ocean and atmosphere models to investigate the circulation, biology, and chemistry of the Oregon coastal ocean. The goal is to develop a comprehensive picture of the coastal ocean and provide a better understanding of the complex processes regulating the movement of water, organisms, nutrients, and pollutants that influence ecosystem health. This interdisciplinary research project sponsored by the National Science Foundation and led by Oregon State University (OSU) involves nearly 60 experts in ocean biology, chemistry and physics from OSU, the University of North Carolina, Lamont-Doherty Earth Observatory and the Woods Hole Oceanographic Institution.



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COAST researchers flew a SENECA III aircraft over coastal waters, dropping probes to capture an instant picture of temperature variations and collect data to profile the atmosphere and its boundary with the ocean below.

COAST investigators employed research vessels equipped with towed underwater vehicles, twin-engine aircraft, a land-based coastal radar system, and an array of state-of-the-art instruments to measure water temperature, salinity, velocity, and turbulence, along with phytoplankton and zooplankton content and wind velocity. These measurements bring together a unique set of observational tools not previously applied simultaneously to the study of coastal processes. Coordinated with ocean ecosystem and atmospheric modeling, the results of this research are significantly advancing our understanding of coastal processes, with implications for fisheries management, pollution control, coastal tourism, shipping, invasive species, and other issues. A better understanding of the currents and wind off the Oregon coast can help elucidate influences on fish productivity, more accurately predict the direction of oil spills and inform decisions for preventing invasive species and pollutants from entering productive coastal areas.

Accomplishments: Through intensive measurements of the coastal ocean and significant advances in techniques for ocean modeling, the COAST program has provided new understanding of coastal upwelling and the physics of the ocean. Coordinated use of observations and models show how currents interact with the seafloor to create areas of concentrated phytoplankton production off the coast of Oregon. While this production fuels a successful fishery in the region, the eventual decay of phytoplankton leads to hypoxia – low levels of oxygen – in bottom waters that may impact nearshore fish and invertebrate communities. COAST has also shown that absorption of carbon dioxide by phytoplankton makes the central Oregon shelf a net sink for atmospheric carbon dioxide. If this result can be extrapolated to large portions of the continental shelf off the west coast of the U.S., it will represent a major fraction of the carbon sink for the entire North Pacific and provide additional insight on the global carbon cycle as a whole.

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Dye experiments reveal how ocean waters move at different depths, an important consideration in management options to control invasive species and pollution.

Measurements of interactions between the ocean and atmosphere in the Oregon coastal region also revealed two previously unknown phenomena. The first is the presence of a layer within the boundary between the ocean and the atmosphere that affects the exchange of heat, moisture, and energy between the ocean and atmosphere and may influence fog formation over the cool, upwelled water off Oregon. The second discovery was the very strong influence of the intraseasonal – on the time scale of 20 days – variability of the jet stream on coastal ecosystems. Measurements made during the COAST program show good correlation between these changes in the position of the jet stream and changes in ocean temperature, chlorophyll (an indicator of phytoplankton abundance) and zooplankton.

Next Step/Future Actions: Researchers currently are analyzing data sets and modeling output (e.g., high-resolution spatial mapping, circulation and ecosystem modeling), including finalizing results on wintertime ocean circulation. This will be a significant result from COAST because little research has been done on wintertime circulation and the resulting ecosystem response off the U.S. west coast. The remainder of the project will also include circulation and ecosystem modeling to incorporate and compare model results to in situ data sets and test existing and new research hypotheses for coastal ocean processes, including the influence of physical processes versus biological processes in the formation and impact of hypoxic waters.