Physical & Coastal Oceanography Overview

Tutorial Review, Trends & Applications

Summary

This course will provide an overview of contemporary ocean physics, emphasizing issues of current interest particularly interdisciplinary processes in the coastal environment. Areas highlighted will include: the effects of the ocean environment on acoustic propagation and reverberation; shallow water effects, coastal oceanography; global warming and climate effects; environmental degradation and pollution; and a review of current and future programs in the Navy and civil sectors.

Ocean processes play a key role in understanding the world's climate, weather, and local events in our nearby coast. Physical oceanography encompasses scales from global circulation to the sub-millimeter scales of turbulence and mixing - a range encompassing 12 orders-of-magnitude! Important phenomena affected by physical processes in the ocean include: global warming and climate change; Gulf Stream dynamics that affect seasonal weather patterns; and small-scale mixing processes that govern bio-geo-chemical evolution. Further diversity results from geographic differences: from the ice covered polar regions that play an important role in the global warming issue to the equatorial regimes where the El Nino phenomena affects annual climate and ultimately fisheries, as well as the unique problems in the coastal ocean which affect the daily lives of a large fraction of earth's inhabitants.

Scientists and engineers using ocean environmental data will find this course an invaluable overview to the broad scope of ocean physics. The course provides both the theory and applications needed to understand contemporary issues. A complete set of notes will be supplied to all participants.

Instructor

Dr. Alan Brandt is presently Principal Scientist for Oceanography at the Johns Hopkins University, Applied Physics Laboratory (JHU/APL). From 1987 until 1993 he was Program Manager for Physical Oceanography at the Office of Naval Research, responsible for the Navy's basic research program in this area. Dr. Brandt received his graduate degrees in Civil Engineering at Carnegie Mellon University. Dr. Brandt has worked at JHU/APL on a wide variety of programs in fluid dynamics and oceanography, including studies on ocean internal waves, turbulence, interdisciplinary biophysical processes and stratified flow hydrodynamics. He is generally recognized for his expertise in small-scale ocean physics and coastal oceanography, particularly as applied to Navy issues and to the dynamics of Chesapeake Bay.

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Course Outline

1. **Essentials of Ocean and Geophysical Fluid Dynamics.** Basic equations of incompressible fluids. Turbulence. Geostrophic flow. Instabilities. Stratified flows. Rotating flows. Basic dimensionless parameters governing physical oceanography.
2. **Basic Physics of the Ocean.** Ocean structure. Stratification. The thermocline and mixed layer. Air-sea processes. Surface waves. Energy transport and balance. The ocean abyss.
3. **Global and Basin Scale Oceanography.** Ocean circulation. Water mass transport. Arctic and Antarctic Oceans. The Ekman layer. Rossby waves. The El Nino phenomena. The greenhouse effect.
4. **Meso-Scale Processes.** The Gulf Stream. Warm and cold rings. Eddies. Ocean fronts. Mixed layer dynamics.
5. **Small-Scale Oceanography.** Fine and microstructure. Mixing. K-H and double diffusive instabilities. Internal waves. Surface stress and air sea fluxes.
6. **Coastal and Shallow Water Oceanography.** Shelf circulation. Tides. Upwelling. Shelf break fronts. Semi-enclosed seas. Straits. Near shore and beach processes. Estuaries. Example SVPs and bottom characteristics for shallow water environments.
7. **Interdisciplinary Coastal Processes.** Biophysical interactions. Coastal types and ecosystems. Sea level changes near shore-beach dynamics. Coastal hazards. Coastal management.
8. **Methods of Modern Physical Oceanography.** Ships. In water instrumentation. Ocean databases. Satellite/remote sensing. Numerical simulations. Laboratory models.
9. **Acoustical Oceanography.** Processes that affect acoustic propagation. Scattering and reverberation. Basic theory of acoustic/flow interaction. Ocean sound channel. Surface effects - waves and bubbles. Water column (volume) reverberation. Wave propagation in a fluctuating medium.
10. **Environmental Issues.** Global climate change. Pollution monitoring. Oil spill transport. Sediment transport and the lutocline. Biophysical interactions.
11. **Contemporary Issues and Programs.** Navy interests in the changing political climate. Emerging civil issues. Energy from the sea. Major ocean programs: WOCE, TOGA, GLOBEC, LOICZ, JGOFS.