OCN640: Observational Physical Oceanography

Course Description

This course is intended to accomplish two objectives. The first objective is to develop an appreciation for the challenges and methods of observing the ocean in order to understand its physics. The second objective is to gain knowledge and perspective about the issues at the forefront of experimental physical oceanography. The latter will be of particular value to students searching for thesis topics in physical oceanography.

The course combines lectures and student-led discussions of relevant papers.

This course concentrates on the observation of oceanic motions (including turbulence) and water mass properties, variations of the sea surface topography, and the fluxes of moisture, heat, and momentum across the air-sea interface. Such observations are essential to the understanding of the physical processes that drive the ocean circulation, generate internal and surface waves, and dissipate energy.

The Scientific Method is discussed in relation to its application to geophysics in general, and physical oceanography in particular. The diverse physical processes in the ocean, and its various physical regimes are described.

Modern oceanographic instrumentation is presented briefly, including some discussion of remote sensing techniques (e.g., satellite observations of sea level, sea surface temperature, and wind stress). (A separate course on physical oceanographic instrumentation is offered.) The emphasis here is on in situ observations.

Observational strategies are explored, and issues such as sampling density and array design are highlighted. Examples from actual field programs are used to illustrate the concepts.

Recent major field programs are reviewed in order to give the student a comprehensive overview of the state-of-the-art in observational physical oceanography, particularly with respect to the scientific objectives.

Grading is determined by assigned problems (25%), classroom participation (25%), and a final term paper (50%).

This course is appropriate for second year (or more advanced) graduate students in physical oceanography or meteorology. It is suggested that students interested in this course consult the instructor prior to registering.

Syllabus

The Scientific Method in Geophysics

- Description (monitoring)
- Hypothesis Development (empirical studies)
- Experiment Design (process studies)
- Hypothesis Testing (model experimentation)
- Hypothesis Revision (iteration)

Physical Processes

- Ocean currents
- Ocean waves
- Turbulence

Physical Regimes

- Air-Sea Interface
- Benthic
- Coastal: Nearshore, Western Boundary Currents, and Eastern Boundary Currents
- Open Ocean (eddy dominated)
- Equatorial waveguide
- High latitudes (sea ice)

Observing Techniques

- In situ: currents, water mass properties, sea level, turbulence
- Remote sensing: SST, surface wind, sea level, ocean color

Observational Strategies

- Sampling and Resolution

- Spatial Surveys
- Time Series
- Closing Budgets
- Nesting and Multiple Scales
- The Role of Data Assimilation

Major Observational Programs
(the following are some examples, but actual cases will depend on student interests)

- TOGA (ocean-atmosphere coupling, variability)
- WOCE (global mean circulation)
- CLIVAR (ocean and climate variability -- models and observations)

Applications

- Ocean observing systems
- Operational oceanography
- Climate prediction