MPO 721: Waves and Tides

Spring 2017,
Tu/Th 3:00-4:20,
MSC 329

Lynn K. (Nick) Shay
Department of Ocean Sciences

Description:

The focus of this course is on the kinematics, dynamics and energetics of wave motions in the ocean from both theoretical and observational perspectives. We examine the internal wave spectrum ranging from the buoyancy frequency to the inertial frequency including the WKBJ scaling of the momentum by the buoyancy frequency. The IW spectrum often contains both the semidiurnal and diurnal tidal frequencies where the former is often referred to as internal tide that are excited along continental margins by barotropic tides. Within the context of normal modes, Kelvin and topographically Rossby waves are also present in this regime known as coastally trapped (also known as continental shelf waves). The course then goes into the equatorial wave guide that supports these motions (except for near-inertial motions). This is followed by the forced wave motions by atmospheric fronts and cyclones where Green's functions are introduced to derive analytical expressions for the 3-D current structure.

1. Introduction: Basic Processes (Weeks 1-2)
A. Definitions
B. Governing Equations/Laws
C. Plane Wave Assumption
D. Acoustic Waves

2. Surface Boundary Layer (Weeks 3-4)
A. Friction velocity and surface layer
B. Log layer
C. Methods of determining wind stress
D. Nondimensional Scaling/Buckingham Pi Theorem

3. Sea Level Variations and Barotropic Tides (Weeks 5-6)
A. Tidal Constituents
B. Harmonic Analysis of Tides
C. Tidal Currents
D. Internal Tides

4. Density Stratification Effects (Week 7)
A. Pycnocline as a Wave Guide
B. WKBJ Approximation
C. Normal Modes (Barotropic and Baroclinic)
D. Projection of Wind Stress onto Modes

5. Internal Waves (Weeks 8-10)
A. Garrett-Munk IW Spectrum
B. Internal Gravity Waves
C. Near-Inertial Waves
D. Phase and Energy Propagation

E. Impact of Background Vorticity

6. Coastally Trapped Waves (Weeks 10-11)
A. Kelvin Wave
B. Topographical Rossby Waves

7. Equatorially Trapped Waves (Weeks 12-14)
A. Wave Guide and Hermite Polyomials
B. Kelvin
C. Rossby
D. Internal Gravity
E. Yani Mode

8. Forced Ocean Waves (Week 15)
A. Green's Functions
B. Near-Inertial Motions
C. Equatorial Kelvin Waves

Books:On Reserve

Csanady, G., 1982: Circulation in the Coastal Ocean. D. Reidel, London, England, 279 pp. (Reference)

Garratt, J. R., 1992: The Atmospheric Boundary Layer, Cambridge University Press (Reference)

Gill, A. E., 1982: Atmospheric-Ocean Dynamics, Academic Press, Inc., London, 662 pp. (Reference)

Leblond, P. H. and L. Mysak, 1980: Waves in the Ocean, Elsevier Scientific Publishing Company, New York, New York, 602pp (Reference)

Morse, P. M. and H. Feshbach, 1953: Methods of Theoretical Physics, Parts 1 and 2, McGraw Hill Book Company, New York, New York, 1939pp (Reference)

Phillips, O. M., 1977: The Dynamics of the Upper Ocean, 2nd edition, Cambridge University Press, 336 pp. (Reference)

Phillips, O. M. and K. Hasselman, 1986: Wave Dynamics and Radio Probing of the Ocean Surface, Plenum Press, 681 pp. (Reference)

Whitham, G. B., 1973: Linear and Nonlinear Waves, Pure and Applied Mathematics Series, John Wiley and Sons, New York, New York, 636pp. (Reference)

Selected manuscripts as assigned.

Grading:

1. Homework assignments: 50%
2. Mid Term Exam: 25%
3. Final Exam: 25%