Introductory Fluid Dynamics and Synoptic Meteorology

EAS - 6502
Fall 2005
Theory Lectures: Monday and Wednesday; 10:05-10:55
Synoptic Lectures: Friday, 9:05-9:55
Location: ES&T L1116

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Textbook

Required:	An Introduction to Dynamic Meteorology (Academic Press; Holton; 2004)
On reserve:	Synoptic-Dynamic Meteorology in Midlatitudes (I & II) (Oxford University Press; Bluestein; 1992)

Office Hours

By appointment (e-mail recommended)

Course Overview

The course is designed to provide an introduction to the fundamental concepts underlying our current understanding of atmospheric fluid dynamics and its relation to midlatitude weather processes. The course includes both a theoretical component and a synoptic meteorology component focusing on meteorological data, observational analyses, large-scale weather systems, midlatitude cyclone development, and numerical weather prediction.

Fluid Dynamics Outline

Week:

1. Fundamentals
   -> Fluid properties and fluid forces, equation of state

2. Statics
   -> Hydrostatic balance, geopotential height, hypsometric equation, pressure as a vertical coordinate

3-4. Kinematics
   -> Flow characterization, natural coordinates, vorticity and circulation, divergence and deformation, nondivergent and irrotational flow, streamfunction, velocity potential

5-6 Dynamics in an inertial reference frame (H: 1.4.3, 2.5-2.7; B: 4.2.1, 4.3.1)
   -> Conservation of mass, momentum and energy; reference frames; momentum, thermodynamic, and continuity equations

7-8. Dynamics in an rotating reference frame (H: 1.5, 2.1-2.3)
   -> Spherical coordinates, Centrifugal and Coriolis forces, effective gravity, equations of motion

9-11. Balanced flows (H: 1.3, 2.4, 3.1, 3.2, 3.4)
   -> Scale analysis; geostrophic approximation; inertial, gradient, and cyclostrophic flow; thermal wind; planetary boundary layer; barotropic and baroclinic atmospheres

12-14. Quasi-geostrophic theory (H: 3.5, 4.2-4.5, 6.2-6.4)
   -> quasi-geostrophic approximation; vorticity, height tendency, and omega equations; forcing of vertical motions; potential vorticity equation

15-16. Introduction to atmospheric waves (H: 7.1-7.4, 7.7)
   -> Linear theory and perturbation methods, wave properties, Rossby waves

Synoptic Meteorology Outline

Week:

1. Introduction: Atmospheric composition & structure, weather, and climate
2. Meteorological data: Observation types, METAR codes, station model plotting
3-4. Objective analysis methods: Plotting and analysis of upper air and surface charts
5. Overview of large-scale weather systems
6. Upper tropospheric waves
7. Structure and evolution of midlatitude cyclones and anticyclones
8. Introduction to numerical weather prediction
9. Midterm Quiz
10-11. Plotting and analysis of atmospheric soundings; buoyancy and vertical stability analysis
12-13. Overview and application of diagnostic tools for synoptic meteorology
14. No Lecture (Thanksgiving Holiday)
15. Case study: Diagnosis and numerical prediction
16. Review Session

Course Evaluation

Problem Sets (6):	20%
Lab Exercises (6):	20%
Midterm Quiz:	20%
Final:	40%

Problem sets/laboratory exercises are expected to be turned in at the beginning of class on the day that they are due. Students within the class may work together on solving problem sets and lab exercises, but must turn in separate individual writeups. Tentative quiz date is October 21. There is no class on September 5 (Holiday), October 17 (Midterm Break), and November 25 (Holiday).