Introductory Fluid Dynamics and Synoptic Meteorology

EAS - 6502

Atmospheric Dynamics

EAS - 4655

Fall 2012
Monday, Wednesday, & Friday @ 10:05-10:55
Location: ES&T L1116

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Textbook

Required:	An Introduction to Dynamic Meteorology (Academic Press; Holton; 2004) Midlatitude Synoptic Meteorology (American Meteorological Society; 2011)
On reserve:	Synoptic-Dynamic Meteorology in Midlatitudes (I & II) (Oxford University Press; Bluestein; 1992) Applied Atmospheric Dynamics (Wiley; Lynch & Cassano; 2006) Mid-Latitude Atmospheric Dynamics (Wiley; Martin; 2006)

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 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.

Dynamics Outline

Week:

1. Fundamentals
(H: 1.1-1.4; B: 1.2.1; LC: 1.2, 2.1-2.3, 2.5, 3.1-3.3; 4.1-4.2; M: 1.1, 1.2.1-1.2.3, 2.1, 3.1)

   -> Fluid properties and fluid forces, equation of state, mathematical tools

2. Statics
(H: 1.6; B: 2.1.5; LC: 4.3; M: 4.1)

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

3-4. Kinematics
(H: 2.1, 3.2.1, 3.3, 11.2; B: 1.3.2, 2.1, 4.1.5; LC: 2.7-2.8, 6.1, 7.2; M: 1.4, 4.4, 4.5)

   -> Flow characterization, trajectories/streamlines, total derivative, 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; LC: 3.7, 4.5; M: 2.1.3, 3.2.2, 3.3)

   -> 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; B: 4.1.1, 4.1.2; LC: 4.4, 4.5; M: 2.2, 3.2.1)

   -> Physical concepts, 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, 5.3; B: 4.1.3, 4.1.6, 4.4; LC: 5.1-5.5, 6.1-6.5; M: 3.2.1, 4.3, 4.4)

   -> Scale analysis; geostrophic approximation; inertial, gradient, and cyclostrophic flow; thermal wind; planetary boundary layer; barotropic and baroclinic atmospheres

12-14. Quasi-geostrophic theory
(H: 3.5-3.6, 4.1-4.5, 6.2-6.4; B: 5.1-5.10; LC: 6.5, 7.1-7.4; M: 5.1-5.4, 6.3, 8.3-8.4)

   -> quasi-geostrophic approximation; circulation theorem; vorticity, height tendency, and omega equations; ageostrophic circulation; surface pressure tendency; forcing of vertical motions; potential vorticity conservation

15-16. Introduction to atmospheric waves
(H: 7.1-7.4, 7.7; LC: 8.1-8.3)

   -> Linear theory and perturbation methods, wave properties, acoustic waves, shallow water gravity waves, Rossby wave

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. Midterm Exam
8. Structure and evolution of midlatitude cyclones and anticyclones
9-10. Plotting and analysis of atmospheric soundings; buoyancy and vertical stability analysis
11. Cold Air Damming
12. Introduction to numerical weather prediction
13. Overview and application of diagnostic tools for synoptic meteorology. Part I
14. No Lecture (Thanksgiving Holiday)
15. Overview and application of diagnostic tools for synoptic meteorology. Part II
16. Review Session

Course Evaluation

6502:	Problem Sets (~7):	20%
	Lab Exercises (~7):	20%
	Midterm Exam:	20%
	Final:	40%
4465:	Problem Sets (~7):	35%
	Midterm Exam:	25%
	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. The Midterm Exam is tentatively scheduled for October 5. There will be no class on September 3 (Holiday), October 15 (Midterm Recess), and November 23 (Holiday).

Academic Honor Code:

The instructor and students in this class, as members of the Georgia Tech community, are bound by the Georgia Tech Academic Honor Code. The instructor will provide example copies of previous examinations upon request. Unauthorized use of any previous semester course materials, such as tests, quizzes, homework or any other coursework, is strictly prohibited in this course. Using these materials will be considered a direct violation of academic policy and will be dealt with according to the GT Academic Honor Code. Plagiarism of any kind (including the reproduction of materials found on the internet) is also strictly prohibited. The complete text of the Academic Honor Code may be found at: http://www.catalog.gatech.edu/rules/18b.php