Introductory Fluid Dynamics and Synoptic Meteorology

EAS - 6502

Atmospheric Dynamics

EAS - 4655

Fall 2020
Monday & Wednesday 3:30-4:45pm

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Textbooks

Required: An Introduction to Dynamic Meteorology
(Academic Press; Holton/Hakim; 2013)
Midlatitude Synoptic Meteorology
(American Meteorological Society; Lackmann; 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 theoretical and synoptic meteorology components, with the latter focusing on meteorological data and analysis, large-scale weather systems, and midlatitude cyclones.

Atmospheric Dynamics Topics (Monday & 3:30-4:00pm Wednesday)

Week (**H**olton; **B**luestein; **L**ackmann; **L**ynch & **C**assano; **M**artin)

1. Fundamentals (H: 1.1-1.2; B: 1.2.1; L: 1.1-1.2; 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: 1.4; B: 2.1.5; L: 1.4; LC: 4.3; M: 4.1)

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

3-4. Kinematics (H: 1.5, 2.1, 3.2.1, 3.3, 11.2; B: 1.3.2, 2.1, 4.1.5; L: 6.2; 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

5 Dynamics in an inertial reference frame (H: 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

6-7. Dynamics in an rotating reference frame (H: 1.3, 2.1-2.3; B: 4.1.1, 4.1.2; L: 1.3; LC: 4.4, 4.5; M: 2.2, 3.2.1)

   -> Physical concepts, Spherical coordinates, Centrifugal and Coriolis forces, effective gravity, equations of motion

8-10. Balanced flows (H: 1.6, 2.4, 3.1, 3.2, 3.4, 8.3.1; B: 4.1.3, 4.1.6, 4.4; L: 1.3, 1.4, 1.6; 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

11-14. Quasi-geostrophic theory (H: 3.5-3.6, 4.1-4.5, 6.2-6.5, 6.7; B: 5.1-5.10; L: 1.5, 2.1-2.6, 4.1-4.3; 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: 5.1-5.3, 5.7; L: 1.5.3; LC: 8.1-8.3)

   -> Linear theory and perturbation methods, wave properties, Rossby waves

Synoptic Meteorology Topics (4:00-4:45pm Wednesday)

1. Atmospheric composition & structure, weather, and climate
2. Meteorological data and observations
3. Objective analysis
4. Synoptic weather systems
5. Cyclones
6. Vertical stability
7. Balanced flows
8. Quasi-geostrophic case study
9. Rossby waves

Course Evaluation

6502:	Attendance and Class Participation:	10%
	Problem Sets (~6):	20%
	Laboratory Exercises (~6):	15%
	Midterm Exam:	20%
	Final:	35%
4465:	Attendance and Class Participation:	10%
	Problem Sets (~6):	30%
	Midterm Exam:	25%
	Final:	35%

Problem sets/laboratory exercises (hardcopy or electronic versions) are expected to be turned in **no later than the beginning of class** on the day that they are due. There will be a 10% grade reduction penalty for each 24 hour period thereafter. Students within the class may work together on solving problem sets and lab exercises, but must turn in separate individual writeups.

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.policylibrary.gatech.edu/student-affairs/academic-honor-code.