

Atmospheric Sciences 336
Introduction to Atmospheric Dynamics
Fall 2007

Lecture: 9:10–10:00 MWF, 110 O&M

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Office Hours: 1:10–2:10 TR

Lab Sections: 4:10–5:00 MW (Lab Sec A) or 11:10–12:00 TR (Lab Sec B), 1107 O&M

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Office Hours: 11:00–12:00 W

Description: ATMO 336 is the first of a two-course sequence presenting an introduction to fluid dynamics in the atmosphere. The course is divided roughly into three parts. The first part of the course reviews the basic principles governing fluids at rest and provides a descriptive introduction to fluid motions in terms of kinematics. The second part considers the forces at work in the atmosphere and develops some simple approximate diagnostic relations for application to large-scale flows. The remainder of the course then develops the full mathematical description of fluid mechanics in preparation for ATMO 435.

Prerequisites: ATMO 335, MATH 311 (or co-enrollment therein)

Homework: Problem sets will be assigned roughly weekly. You are encouraged to work together in groups to solve the problems. However, please make sure that your presentation of the problem reflects *your* understanding of the solution. Plagiarism—mindlessly adopting another’s words or ideas as if they were your own—will be penalized.

Grading: Roughly weekly problem assignments (15%), roughly bi-weekly lab writeups (15%), two in-class exams (22% each), and a final exam (26%).

Texts: The recommended text for the course is:

An Introduction to Dynamic Meteorology, by James R. Holton.

The lab section of the course will involve problems and examples developed in the MATLAB computing environment. A recommended reference text for those unfamiliar with MATLAB is

A MATLAB Companion for Multivariable Calculus, by Jeffery Cooper.

Course Outline: (Section numbers from Holton are given in brackets)

I. Fluid Statics and Kinematics

A. Fluids at rest

1. The continuum hypothesis [1.1]
2. Equations of state, the first law of thermodynamics, and potential temperature
3. Gravity and hydrostatics [1.6]
4. Static stability and the buoyancy frequency [2.7.2,2.7.3]

B. Descriptors of fluid motions: Intro to kinematics

1. Velocity gradients, stretching and shearing
2. Divergence, vorticity and deformation
3. Flux and circulation
4. Streamlines and path lines

II. Diagnostic Relations for Large-scale Flows

- A. The fundamental forces
 - 1. The pressure gradient force [1.4.1]
 - 2. Gravity revisited [1.4.2,1.5.1,1.5.2]
 - 3. The Coriolis force [1.5.3,2.1.1,2.2]
- B. Large-scale balance relations
 - 1. The notion of scale: Idealized circular motion [3.2]
 - The Rossby number
 - 2. Geostrophic balance
 - Cyclones and anti-cyclones, troughs and ridges
 - 3. The balance equations in pressure coordinates [3.1]
 - The temperature-thickness relation
 - The vorticity-curvature relation
 - 4. The thermal windshear [3.4]

III. The Laws of Fluid Mechanics

- A. The governing equations
 - 1. From kinematics to dynamics: the material derivative [2.1]
 - 2. Conservation of mass and related scalars [2.5]
 - 3. The momentum equation in rotating coordinates [1.4,1.5,2.1.1,2.2]
 - 4. The thermal energy equation [2.6,2.7.1]
 - 5. The vorticity equation [4.4]
- B. Scales of motion revisited
 - 1. Formal scaling arguments: the Rossby number redux
 - 2. Turbulent eddies, waves and large-scale balance flows
 - 3. Geostrophic degeneracy and what comes next

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