

METEO 521
DYNAMIC METEOROLOGY
SPRING 2005

The aim of this course is to provide an overview of some of the more important concepts in dynamic meteorology. As much as possible, these ideas will be used to explain observed atmospheric circulations. The course emphasis is on the understanding the concepts and the application of these concepts. The course is not meant to be comprehensive - many important topics, because of time limitations, will not be covered.

Finally, keep in mind that none of the material to be covered is at the cutting edge of dynamic meteorology. In fact, most of the ideas are at least a decade old.

OUTLINE

1. The General Circulation
 - a. the origin of atmospheric motion (Jeffrey's theorem)
 - b. global radiation balance
 - c. atmospheric and oceanic heat transports
 - d. angular momentum balance
 - e. energy (kinetic and potential)
 - f. available potential energy (Lorenz)
 - g. the global energy cycle

2. Circulation, Vorticity and Potential Vorticity
 - a. vortex tubes and filaments
 - b. vorticity dynamics (Helmholtz's theorem)
 - c. circulation (Bjerknes' & Kelvin's theorems)
 - d. Ertl's potential vorticity
 - e. isentropic potential vorticity
 - f. effect of diabatic heating on potential vorticity (Haynes & McIntyre theorem)
 - g. examples of PV thinking

3. Atmospheric Waves
 - a. perturbation technique
 - b. phase and group velocities
 - c. sound waves
 - d. internal gravity waves (mountain waves)
 - e. barotropic Rossby waves

4. Quasi-Geostrophic Theory
 - a. scale analysis of equations of motion
 - b. q.-g. vorticity and thermodynamic equations
 - c. q.-g. potential vorticity (the development equation)
 - d. the omega equation (traditional and Q-vector forms)
 - e. Rossby and planetary waves

5. Zonally-Averaged Circulations
 - a. Held-Hou model of Hadley circulation
 - b. mid-latitude eddies and the zonal mean circulation

6. Atmospheric Instabilities
 - a. inertial instability
 - b. convective instability
 - c. barotropic instability
 - d. two-layer model of baroclinic instability
 - e. the role of boundaries - internal & external baroclinic instability

References:

Green, John, 1999. **Atmospheric Dynamics**, Cambridge University Press

James, Ian N., 1994. **Introduction to Circulating Atmospheres**. Cambridge University Press.

Holton, J.R., 1992. **An Introduction to Dynamic Meteorology**, Academic Press

Lorenz, E.N., 1967: **The Nature and Theory of the General Circulation of the Atmosphere**, World Meteorological Organization

Office Hours: TR 9:00-11:00

Two examinations will be given during the semester. The final will occur as scheduled during finals week. The examinations will be aimed at assessing your understanding of the principles and your ability to apply those principles. Homework assignments will be given about every two weeks. The final grade will be assigned using the following weighting scheme: homework (20%), final (40%), semester examinations (20% each).

Statement on Academic Integrity:

Academic integrity is the pursuit of scholarly activity in an open, honest and responsible manner. Academic integrity is a basic guiding principle for all academic activity in the College, and all members of the College are expected to act in accordance with this principle. Consistent with this expectation, all students should act with personal integrity, respect other students' dignity, rights and property, and help create and maintain an environment in which all can succeed through the fruits of their efforts. Academic integrity includes a commitment not to engage in or tolerate acts of falsification, misrepresentation, or deception. Such acts of dishonesty violate the fundamental ethical principles of the EMS community and compromise the worth of work completed by others. The full college policy on academic integrity can be found at <http://www.ems.psu.edu/students/integrity/statement.html>

Any student in this course who has a disability that may prevent him or her from fully demonstrating his or her abilities should contact me as soon as possible so that

accommodations necessary can be made to ensure full participation and to facilitate your educational opportunities.