

Introduction to Atmospheric Dynamics
ATOC 5050
Fall 2009

Time: Tuesday/Thursday, 9:30-10:45am
Location: Duane E126

Texts: J. R. Holton, Introduction to Dynamic Meteorology, 4th Ed., Elsevier, 2004
R. R. Rogers and M. K. Yau, A Short Course in Cloud Physics, 3rd Ed.,
Butterworth and Heinemann, 1989.

Web Page: <http://atoc.colorado.edu/~dcn/ATOC5050>

Instructor: David Noone, Ekeley S234, 303-735-6073 (dcn@colorado.edu)
Office hours: Tuesdays 2-5pm, by appointment.

Summary: An amount of energy from the Sun is intercepted by the Earth. While, exactly this amount of energy is ultimately radiated back to space, Earth's, spherical shape and rotation causes local imbalance between incoming and outgoing radiation. This discrepancy gives rise to motions that ensure the radiative balance. Understanding the structure and dynamics of the atmosphere is central to forecasting weather and understanding climate. This course aims to build a fundamental set of physical principles and apply them to understanding large-scale atmospheric motions. Mathematical descriptions of the atmospheric dynamics are constructed and interpreted in terms of their physical significance. By the end of this course we will have investigated phenomena such as mountain waves, planetary waves, mid-latitude cyclones, the planetary boundary layer, and the general circulation of the atmosphere.

Grading: A final grade will be composed of homework (25%), two projects (10 and 15%), weekly exercises (10%), a midterm exam (10%) and a final exam (30%).

Homework: About three homework assignments will be set and graded. Each lecture will have a number of problems (mostly from the textbook) that will be assigned for review each week as an exercise. Will go over this in class, and hand it in.

Research assignments: The two projects will comprise a combination of specific tasks and open-ended "research" tasks. A deadline for handing in assignments will be given. Late submission will be penalized at a rate of 20% per day (i.e., three days late will get a maximum of half marks).

Exams: There will be one mid-term, and a final exam. If you score higher on the final than the mid-term(s), the final exam grade will be used.

Deadlines: A deadline for all assignments will be given on the assignment sheet. Late submissions will be accepted by not graded unless special arrangements have been made more than **24 HOURS BEFOREHAND**. All assignments must be handed in as hard copies. **Late homework will be graded as pass fail.**

Reading: Relevant pages from the textbook and extra reading will be assigned in lectures and via the class web site. Not all of this material can be covered in lecture time, but will be covered in assignments and homework and be on the exam.

Final grades: The final letter grade will be constructed by converting your numerical score using the divisions: A-/B+ (80%), B-/C+ (70%), C-/D+ (60%), D-/F (50%).

Absence from class

It is expected that you attend all classes. All lecture slides, reading assignments, and homework assignments will be placed on the class web site after class. However, in the case of research related absences please make arrangements with David.

Religious observance

Campus policy regarding religious observances requires that faculty make every effort to reasonably and fairly deal with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. See me if special consideration is required. See full details at http://www.colorado.edu/policies/fac_relig.html. Please make David aware of any expected absence beforehand.

Disability considerations

If you qualify for accommodations because of a disability, please submit to me a letter from Disability Services in a timely manner so that your needs be addressed. Disability Services determines accommodations based on documented disabilities. Contact: 303-492-8671, Willard 322, and <http://www.Colorado.EDU/disabilityservices>
If you have a temporary medical condition or injury, see guidelines at <http://www.colorado.edu/disabilityservices/go.cgi?select=temporary.html>
Disability Services' letters for students with disabilities indicate legally mandated reasonable accommodations. The syllabus statements and answers to Frequently Asked Questions can be found at <http://www.colorado.edu/disabilityservices>

Classroom behavior

Students and faculty each have responsibility for maintaining an appropriate learning environment. Students who fail to adhere to such behavioral standards may be subject to discipline. Faculty have the professional responsibility to treat all students with understanding, dignity and respect, to guide classroom discussion and to set reasonable limits on the manner in which they and their students express opinions. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with differences of race, culture, religion, politics, sexual orientation, gender variance, and nationalities. Class rosters are provided to the instructor with the student's legal name. I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the semester so that I may make appropriate changes to my records. See policies at <http://www.colorado.edu/policies/classbehavior.html> and at http://www.colorado.edu/studentaffairs/judicialaffairs/code.html#student_code

Honor code

All students of the University of Colorado at Boulder are responsible for knowing and adhering to the academic integrity policy of this institution. Violations of this policy may include: cheating, plagiarism, aid of academic dishonesty, fabrication, lying, bribery, and threatening behavior. All incidents of academic misconduct shall be reported to the Honor Code Council (honor@colorado.edu; 303-725-2273). Students who are found to be in violation of the academic integrity policy will be subject to both academic sanctions from the faculty member and non-academic sanctions (including but not limited to university probation, suspension, or expulsion). Other information on the Honor Code can be found at <http://www.colorado.edu/policies/honor.html> and at <http://www.colorado.edu/academics/honorcode/>

Discrimination and Sexual Harassment

The University of Colorado at Boulder policy on Discrimination and Harassment (<http://www.colorado.edu/policies/discrimination.html>), the University of Colorado policy on Sexual Harassment and the University of Colorado policy on Amorous Relationships applies to all students, staff and faculty. Any student, staff or faculty member who believes s/he has been the subject of discrimination or harassment based upon race, color, national origin, sex, age, disability, religion, sexual orientation, or veteran status should contact the Office of Discrimination and Harassment (ODH) at 303-492-2127 or the Office of Judicial Affairs at 303-492-5550. Information about the ODH and the campus resources available to assist individuals regarding discrimination or harassment can be obtained at <http://www.colorado.edu/odh>

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Lecture outline

Basic concepts (3 weeks) Holton 1, RY 1-3

Composition of the atmosphere, fundamental forces, rotating reference frames
Thermodynamics of dry air, entropy and potential temperature
Dry adiabatic lapse rate and static stability
Thermodynamics of moist air, equivalent potential temperature
(HW 1)

Project 1

Basic equations and applications (3 weeks) Holton 2-3, RY 3

Mass continuity equation, thermodynamic equation, momentum equation
Buoyancy and static stability, topographic waves, baroclinic instability criterion
Spherical coordinates, primitive equations in pressure coordinates
Balanced flow, thermal wind, vertical motion and surface pressure tendency
(HW 2)

Midterm exam

Circulation and vorticity (3 weeks) Holton 4

Circulation theorem, vorticity and the vorticity equation
Potential vorticity, and potential vorticity conservation
Shallow water equations, primitive equations in isentropic coordinates
(HW 3)

Project 2

Boundary layers (2 weeks) Holton 5

Reynolds averaging, surface stress
Flux gradient approximation, mixing length hypothesis
Ekman layer, pumping, and drift, circulation spin-down
(HW4)

Optional: Quasi-geostrophic analysis (1 week) Holton 6, supplements

Quasi-geostrophic assumption, quasi-geostrophic vorticity equation
Geopotential tendency and prediction
Quasi-geostrophic potential vorticity, potential vorticity inversion