Atmospheric Physics and Thermodynamics

(3 credits, meeting 11:15–12:05 MWF, Colburn Lab 109)

Brian Hanson	209 Pearson Hall
Office Hours:	2:30–3:30 Wednesday & Friday
	1:30–2:30 Thursday
	and by appointment

The most fundamental atmospheric measurements are temperature, pressure, and humidity. This course explores the meaning of these in great detail, so that students should come out with a strong understanding of the thermodynamics of the particular two-component system – dry air and water – most important to understanding weather.

In GEOG 220 (or a similar course), you learned the following sequence of steps: warming air becomes less dense (expands) and may rise, rising air cools, as the water vapor cools along with the air, it will eventually start to condense. Keep that going and a cloud will form. This course repeats all those points, but tries to provide a deeper understanding, working from a few physical priniciples and getting to quantitative answers.

Approximate Course Outline

1. Composition and structure of the atmosphere (1 week; §1.3, 2.2, 2.5)
2. Thermodynamics of the atmosphere. (6 weeks, Ch. 3)
   a) Gas laws for the atmosphere.
   b) Thermodynamics of the dry atmosphere.
      (*Test 1*)
   c) Multicomponent thermodynamics
   d) Effects of water vapor.
3. Vertical dynamics of the atmosphere. (3 weeks; Ch. 3, parts of Ch. 9)
   a) Gravity and the hydrostatic equation.
   b) Vertical forces and stability.
      (*Test 2*)
4. Cloud formation. (2 weeks, Ch. 6)
   a) Mixed phase thermodynamics
   b) Cloud condensation processes.
      (*Comprehensive Final Exam*)

Primary course text: J. M. Wallace & P. V. Hobbs *Atmospheric Science, An Introductory Survey, 2nd Ed.*, Academic Press, 2006.

Useful backup books:

G. W. Petty, 2008. *A First Course in Atmospheric Thermodynamics.* Sundog Publishing. (Better coverage of the generalized thermodynamics parts of this course than the main text.)

R. G. Fleagle & J. A. Businger, *An Introduction to Atmospheric Physics, 2nd. ed.* Academic Press, 1980. (The graduate version, with detailed mathematical proofs and much more about statistical physics.)

(Any book with "Cloud Physics" or "Atmospheric Thermodynamics" in the title is likely to cover similar material. The library has a number of these.)

Grades for the course will be based on a series of problem sets (approximately 50%, eight problem sets—slightly more often than once every two weeks), two hour-exams (25% total), and a comprehensive final exam (25%). Hour exams and problem set due dates will be announced as we go along. The final exam will use the two-hour slot scheduled for us by the University during Finals Week.

Prerequisites: A calculus sequence through some integral calculus (Math 242) and a previous introductory course in atmospheric science (Geog 220). Students with a good background in physical science and math should be able to pick up the necessary introductory meteorology by reading.

Computer usage: This course relies on traditional pencil, paper, and calculator problems. On some problem sets, repetitious calculations can be done more easily with a spreadsheet program, which is allowed. Use of atmospheric physics for operational forecasting or climate research inevitably requires large computer programs, so issues related to programming and operational implementation are sometimes discussed, but programming is not required of students in this course.