

Syllabus

METR 3213: PHYSICAL METEOROLOGY I

MWF, 1100-11:50, NWC 1350
Fall 2009

Instructor: Prof. Phillip Chilson (chilson@ou.edu)
Office: NWC 4618, 325-5095, Office Hours: M 2:00-3:00 PM & W 12:00-1:00 PM
Feel free to come outside of office hours if my door is open

Text: *A First Course in Atmospheric Thermodynamics*,
Grant W. Petty, Sundog Publishing, 2008

Pre-requisites: Grade of C or better in MATH 2443, PHYS 2524, and METR 2023/2021

Course Overview: This course introduces the physical processes associated with atmospheric composition, basic radiation and energy concepts, the equation of state, the zeroth, first, and second law of thermodynamics, the thermodynamics of dry and moist atmospheres, thermodynamic diagrams, statics, and atmospheric stability.

Planned Course Content

- I. Atmospheric Composition and Structure** Pressure and density; Hydrostatic balance; Atmospheric density; Composition; Temperature; Zeroth law of thermodynamics; and Atmospheric temperature profiles.
- II. Thermodynamic Systems and Variables** Air parcels; System variables; State and process variables; Conserved variables; and Extensive and intensive variables.
- III. Physical Properties of Air** Equation of state; Experimental properties of gases; The gas laws; Dry air gas constant; Equation of state for moist air; Mixing ratio and specific humidity; Virtual temperature; and Buoyancy calculations.
- IV. Atmospheric Pressure** Hydrostatic balance; Hydrostatic equation; Geopotential height; Hypsometric equation; Pressure profiles of idealized atmospheres; and The U.S. standard atmosphere.
- V. The First Law of Thermodynamics** The first law of thermodynamics; Internal energy; Heat capacity; Poisson's equations; Potential temperature; Dry adiabats; The dry adiabatic lapse rate; Heat engines; The carnot cycle; Reversible and irreversible processes; Enthalpy; and Diabatic processes.
- VI. The Second Law and Its Consequences** Entropy; and Thermodynamic equilibrium.
- VII. Moist Processes** Water vapor saturation; saturation vapor pressure; relative humidity; Dewpoint; Latent heat of condensation / vaporization; The Clausius-Clapeyron equation; Saturation mixing ratio; Moisture variables on the skew-T diagram; Lifting condensation level (LCL); Moist adiabatic lapse rate; Equivalent potential temperature; and Wet-bulb temperature.
- VIII. Atmospheric Stability** The parcel method; Stable and unstable systems; Local (static) atmospheric stability; dry static stability; Brunt-Vaisala frequency; Potential instability; Parcel stability and atmospheric convection; and Stability indices.

Supplemental Material (Strongly Encouraged and Recommended)*:**Strongly Encouraged**

Sometimes it is helpful to consult materials outside the required textbook in order to better understand and appreciate some of the concepts being presented during the course. To that end, I will be providing supplemental reading and study material for this course, which will be provided through the class home page (<https://learn.ou.edu/>). These materials are considered part of the assigned reading material.

It is the responsibility of the student to regularly access the class home page and check for the availability of new material.

Recommended

In addition to the materials that will be provided via the class home page, you may find the following books useful. These readings are considered as voluntary. They are listed in order of increasing difficulty.

- *Atmospheric Science: An Introductory Survey, 2nd Ed*, J. M. Wallace & P. V. Hobbs, Academic Press, 2006 (Chapter 3): This material is highly relevant to the material being presented in class and provides many examples. Some of the supplemental material is inspired from this book.
- *An Introduction to Atmospheric Thermodynamics, 2nd Ed*, A. A. Tsonis, Cambridge University Press, 2007: This book is very relevant to the material being presented in class but is slightly more theoretical in nature. Again, some of the supplemental material is inspired from this book.
- *Atmospheric Thermodynamics*, C. F. Boren & B. A. Albrecht, Oxford University Press, 1998: This book is clearly intended for the more serious student. It goes deeper into the subtleties of thermodynamics. It is a good reference if you really want to know what is going on (thermodynamically) in the atmosphere. The mathematics is not more advanced, but the treatment of thermodynamics goes deeper.
- *Thermodynamics*, E. Fermi, Dover Press, 1936: I have included this book because it is an excellent text on general thermodynamics from a Nobel Prize winning physicist. Enrico Fermi was a brilliant theoretician and experimentalist. His treatment of thermodynamics is both illuminating and comprehensive. Again, the mathematics is not overly complex.

(*): Please note that I have intentionally refrained from using such words as “required” or “mandatory” in connection with the supplemental material. This could equally apply to other aspects of the course. You are not “required” to read the book, attend the lectures, or do the homeworks. You are invited and encouraged to do these things in order to advance in your studies of meteorology. I pledge to do my best to provide opportunities for you to expand your knowledge of atmospheric thermodynamics; but, I want you to know that you are an active part of the class (not just a bystander). Therefore, I encourage you to take an active role in your investigation and discovery of meteorology.

Examinations and Quizzes:

In our society, testing is a necessary part of assessing how well a student has mastered various components of any subject area. To that end, there will be 11 quizzes, 3 exams, and 1 comprehensive final exam given during the course of the semester. The dates of the quizzes and exams are given in the “Tentative Schedule of Exams, Quizzes, and Breaks” provided with this syllabus. The quizzes will be given during the last 10 minutes of class on the designated days. The exams will occupy one complete class period. Two hours have been allocated for the comprehensive final exam. It is your responsibility to notify me well in advance of any conflicts that you may have with the schedule. Quizzes will be based on the homework sets that will be assigned. Often the quiz question will be taken verbatim from the homework (only the numbers used in the calculations will be different).

Grading:

You are allowed to drop the two lowest quiz grades. The remaining 9 will be averaged and the result will contribute 25% towards your final grade. The exams will be averaged such that your lowest exam grade will only count half as much as the two highest scores and the average will contribute 50% towards your final grade. The comprehensive final exam will contribute 25% towards your final grade. That is:

Quizzes (11)	25%
Examinations (3)	50%
Comprehensive Final Examination (1)	25%

$$\text{Final Grade} = 0.25 \cdot \text{Quiz Average} + 0.50 \cdot \text{Exam Average} + 0.25 \cdot \text{Final Exam Grade}$$

$$\text{Quiz Average} = \frac{1}{9} \sum 9 \text{ Highest Quiz Grades}$$

$$\text{Exam Average} = \frac{2}{5} \cdot \sum 2 \text{ Highest Exam Grades} + \frac{1}{5} \cdot \text{Lowest Exam Grade}$$

Grade distribution:

The following table provides the “target” grade distribution

Final Numeric Grade	Final Letter Grade
90 – 100%	A
80 – < 90%	B
70 – < 80%	C
60 – < 70%	D
< 60%	F

I do reserve the right to lower numerical thresholds for a given letter grade.

Make-up Policy:

No unexcused make-ups for the quizzes or exams will be given. If you cannot be present for an examination, it is YOUR responsibility to make other arrangements before the examination. Otherwise, the missed test cannot be retaken.

Class Homepage:

The class home page will be available through Desire2Learn (<https://learn.ou.edu/>)

Tentative Schedule of Exams, Quizzes, and Breaks

September	04 (Friday)	Quiz 1 & Quiz 2
	07 (Monday)	Labor Day ... no class
	11 (Friday)	Quiz 3
	18 (Friday)	Quiz 4
	25 (Friday)	Exam 1
October	02 (Friday)	Quiz 5
	09 (Friday)	Quiz 6
	14 (Wednesday)	Quiz 7
	16 (Friday)	"Fall Holiday" ... no class
	23 (Friday)	Exam 2
	30 (Friday)	Quiz 8
November	06 (Friday)	Quiz 9
	13 (Friday)	Quiz 10
	20 (Friday)	Exam 3
	25 (Wednesday)	Thanksgiving Break ... no class
	27 (Friday)	Thanksgiving Break ... no class
December	04 (Friday)	Quiz 11
	17 (Thursday)	Final Exam, 1:30 - 3:30 PM

Academic Honesty: Homework assignments are important for your understanding of the material. Occasional help from a classmate is fine but be sure that you actually understand the material. It will help tremendously for you to come visit me in my office hours. Realize that simply copying a homework assignment from any source is considered cheating and will definitely not help your understanding. If caught, such activity could result in a failing grade in the course and possible disciplinary action. All students are expected to be familiar with and abide by the OU Academic Misconduct Code. Information on this code and other student policies is located at <http://studentconduct.ou.edu>.

Religious Holidays: It is the policy of the University to excuse absences of students that result from religious observances and to provide without penalty for the rescheduling of examinations and additional required class work that may fall on religious holidays.

Reasonable Accommodation Policy: The University of Oklahoma is committed to providing reasonable accommodation for all students with disabilities. Students with disabilities who require accommodations in this course are requested to speak with the professor as early in the semester as possible. Students with disabilities must be registered with the Office of Disability Services prior to receiving accommodations in this course. The Office of Disability Services is located in Goddard Health Center, Suite 166, phone 405/325-3852 or fax only 405/325-4173.