Fall 2013 METR 3213: Physical Meteorology I ("Thermo")

MWF 11:00-11:50, NWC 1350

Instructor: Dr. Kevin Kloesel (longhorn@ou.edu)
Office: NWC 2900 (Oklahoma Climate Survey suite)
Office Hours: TBD (Feel free to come in if my door is open)
Grader: Andrew Dzambo (Andrew.M.Dzambo-1@ou.edu)
Text: *A First Course in Atmospheric Thermodynamics*, Grant W. Petty, Sundog Publishing.

Facebook: "Reflections on the Motive Power of Fire"
https://www.facebook.com/groups/594350030617397/

Prerequisites: 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

1. Atmospheric Composition and Structure: Pressure and density; Hydrostatic balance; Atmospheric density; Composition; Temperature; Zeroth law of thermodynamics; and Atmospheric temperature profiles.
2. Thermodynamic Systems and Variables: Air parcels; System variables; State and process variables; Conserved variables; and Extensive and intensive variables.
3. 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.
4. Atmospheric Pressure: Hydrostatic balance; Hydrostatic equation; Geopotential height; Hypsometric equation; Pressure profiles of idealized atmospheres; and The U.S. Standard Atmosphere.
5. 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.
6. The Second Law and Its Consequences: Entropy and Thermodynamic equilibrium.
7. 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.
8. 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.

METR 3213 Supplemental Material

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 through the class home page (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/Optional

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 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.

Examinations, Quizzes, Homework and Programming Assignments:

Quizzes (15%): These will be given during the first 10 minutes of class. Quizzes will be based on the homework sets assigned during the semester. Solutions to the homework will be available to you before taking the quiz. I anticipate that there will be between 5-10 of these during the semester.

Programming Assignments (15%): The assignments (probably 5 or 6) will consist of calculations and analysis of thermodynamic quantities and scenarios using MATLAB, which is available on the School of Meteorology computing facilities. Programming assignments will be deposited to the Dropbox on the class web page.

Homework Sets (15%): These assignments (probably 5-6) will focus on everything from derivations and calculations to demonstrating a physical understanding of thermodynamic concepts.

Exams (30%; 2 exams @ 15% each): One complete class period will be allotted for each of the two exams given during the regular semester. Both exams will be comprehensive.

Final Exam (25%): A comprehensive review exam consisting of material from each of the grading categories above.

The standard OU grading policy will apply (90+ = A; 80+ = B, etc.) I reserve the right to lower numerical thresholds for a given letter grade.

Make-up Policy:

No unexcused make-ups for the quizzes or exams. Extensions on the programming assignments and homework might be granted on a case-by-case basis. It is your responsibility to notify me if you cannot take an exam or quiz or turn in an assignment by the given deadline.

Tentative Calendar (including Kevin's perpetual travel issues)

EXAM 1 is tentatively scheduled for Friday 27 September

EXAM 2 is tentatively scheduled for Friday 15 November

FINAL EXAM is Tuesday 10 December 1:30-3:30pm

7 class periods will need to be covered or alternate plans arranged
Aug 28 Stillwater for Oklahoma Mesonet Steering Committee Meeting
Aug 30 Austin for Bat Conservation International Education Meeting
Oct 2/4 Kyoto for International Earth Sciences Challenges Symposium (tentative)
Nov 18/20/22 Seoul South Korea to teach for a week at KMA

Academic Honesty:

Homework and programming 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 make an appointment to visit if you are having trouble understanding the material. 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 me 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.