Atmospheric Sciences 5300
Atmospheric Thermodynamics & Boundary Layer Processes
Fall 2023

Instructor: Steve Krueger
Office: WBB 725 , **Phone:** 801-581-3903
e-mail: steve.krueger@utah.edu
`http://www.inscc.utah.edu/~krueger/5300`

Teaching Assistant: Corey Bois
Office: WBB 727
e-mail: corey.bois@utah.edu

Description: Thermodynamics of dry and moist air, including adiabatic processes, parcel theory, and thermodynamic diagrams; boundary layer structure and processes, including turbulence, surface fluxes, vertical structure, and diurnal cycle.

Prerequisite: ATMOS 5000

Classroom: WBB 820

Class hours: M W F 1:25 to 2:15

T.A. office hours Tu 2:00 to 3:00, W 12:00 to 1:15, or by appointment.

Format: Lecture, in-class problem solving, and assigned problem sets. The student will become familiar with the skew-$T \log p$ diagram and learn to use it to solve problems in atmospheric thermodynamics. The students will also use MATLAB programming skills to solve problems and to present results in graphical form.

Grading: The course grade will be determined from problem sets (65%), a mid-term exam (15%), a final exam (15%), and attendance (5%).

The grading scale will be A: ≥ 90, B: 80-89, C: 70-79, D: 60-69, F: < 60.

Class policies: Students must take every exam with exceptions governed by University Policy. You are expected to primarily work independently to solve the problems; however, discussions about physical concepts and using the skew-$T \log p$ diagram among classmates are allowed. Plagiarizing, copying, cheating, or otherwise misrepresenting one's work will not be tolerated.

Missing class will not be penalized directly, but usually results in poor problem set and exam performance. Some course material that you are responsible for will only be presented during lectures (i.e., will not be found in the text or online notes).

Homework is due at the start of class on the due date, unless otherwise arranged at least 24 hours before the deadline. *Late homework will be accepted for 24 hours after the deadline, but the score will be reduced by a factor of 50%.*

Topics Addressed

Thermodynamics:

- Moisture variables; dry adiabatic processes
- Skew T-log p diagram: dry adiabatic processes
- Skew T-log p diagram: saturated adiabatic processes
- Skew T-log p diagram: liquid water and total water
- Precipitation rate; snow versus rain
- Saturation adiabatic lapse rate
- Stability; buoyancy oscillations
- CAPE, LCL, LFC, NBL; maximum updraft speed
- Skew T-log p diagram: microburst downdrafts

Boundary Layer Processes:

- Boundary layer characteristics.
- Introduction to turbulence. Convective and shear instabilities.
- Turbulence, Reynolds averaging, turbulent fluxes, equations for turbulent flow.
- Measurement and analysis of boundary layer turbulence.
- Boundary layer wind and thermodynamic profiles. Convective and stably stratified boundary layers.
- The surface layer. Monin-Obukhov similarity theory, surface roughness.
- Surface fluxes over ocean and land. Land surface models. Diurnal cycle.

Required Notes:

- *Thermodynamics Notes* by S. K. Krueger, (`http://www.inscc.utah.edu/~krueger/5300/Thermo2020.pdf`)

Required Textbook: Wallace, J. M., and P. V. Hobbs, 2006: *Atmospheric Science: An Introductory Survey,* Second Edition, Academic Press, 483 pp.

Optional Textbooks:

- *Practical Meteorology: An Algebra-based Survey of Atmospheric Science* by Roland Stull. (`https://www.eoas.ubc.ca/books/Practical_Meteorology/`)
- *A First Course in Atmospheric Thermodynamics* by Grant W. Petty. List price when purchased through bookstores: $48. Discounted price when ordered directly from Sundog Publishing: $36, including free shipping to U.S. addresses. (`https://sundogpublishingstore.myshopify.com/products/a-first-course-in-atmospheric-thermodynamics-g-w-petty`)

Holidays: Mon., Sep. 4, and Fri., Nov. 24

Fall break: Oct. 9, 11, 13

Classes that may be rescheduled: TBD

Last day of class: Wed., Dec. 6

Midterm exam: Mon., Oct. 16

Final exam: Wednesday, December 13, 1:00–3:00 pm.

Drop and Withdrawal dates:

- Last day to add or drop (delete) classes: Fri., Sep. 1. (Students can drop classes by phone or web through this date, and the classes will not appear on their transcripts.)
- Last day to withdraw from classes: Fri., Oct. 20. (Students can withdraw from classes by phone or web, but "W" will appear on their transcript for these courses.)