Atmospheric Sciences 6220: Boundary Layer Meteorology
Fall 2013

Instructor: Professor Steve Krueger
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Classroom: 820 WBB
Class Hours: M W 1:25 to 2:45
Office Hours: M 3:00 to 4:00 or by appointment

Web page: http://www.inscc.utah.edu/~krueger/6220/

Prerequisites: Meteo 6010 and 6020 (may be concurrent) or instructor’s consent

Background: The atmospheric boundary layer is the interface between the free atmosphere and the surface. It plays a central role in the exchange of heat, moisture, momentum, trace gases, and aerosols between land, ocean, and ice surfaces, in cloud formation, and in the general circulation of the atmosphere. We are immersed in the boundary layer. Forecasts of daily high and low temperatures are boundary layer forecasts. The winds that affect buildings, bridges, trucks, boats, ships, and aircraft during take-offs and landings are boundary layer winds. Boundary layer winds create waves on lakes and oceans, resulting in swells and surf. Wildfires are strongly affected by boundary layer winds, including their interaction with complex terrain. Air pollution is generated and chemically modified in the boundary layer. Boundary layer winds vary on the mesoscale due to interactions with surface characteristics and orography. Boundary layer clouds play an important role in climate change, and are poorly represented in global climate models. Boundary layer clouds may respond to increases in carbon dioxide and aerosol concentrations due to anthropogenic sources.

Course Description: The goals of this course are to provide you with a basic understanding of boundary layer structure and physics and expose you to current approaches used to observe and model the boundary layer. You will analyze measurements of turbulence made from aircraft or from over the salt flats in western Utah, and will become familiar with three basic modeling approaches: mixed layer modeling, in which only the bulk (vertically averaged) properties are predicted; Reynolds-averaged modeling, in which profiles of statistics (mean, variance, etc) are predicted; and LES (large-eddy simulation), in which the 3D turbulent flow is simulated, but just for the large eddies. You will have an opportunity to analyze LES results.
Topics Addressed:

- 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.
- Parameterizations and models of turbulent transport in clear boundary layers.
- Cloud-topped boundary layers and their parameterization.
- Nonhomogenous boundary layers. Terrain effects.
- Student projects.

Grading:

- Homework (70 percent). You may collaborate on the homework assignments. They will require some Matlab programming.
- Term project (30 percent). The term project will be on a topic of your choice related to the course. A 5-10 page written report on his or her term project will be due on the last day of classes. Each student will do a 15-20 minute oral presentation on his or her term project during the final exam period.
- Final exam: There will be no final exam.


Some other relevant textbooks:


**Holidays:** Sep 2, Oct 14 & 16

**Classes that may be rescheduled:** Sep 4, Oct 9, Nov 4 & 6, Dec 9 & 11

**Last day of class:** Dec 11

**Term project written report due:** Dec 13

**Term project oral presentation:** Monday, Dec. 16, 1:00–3:00 pm

**Final exam:** (There will be no final exam.)

**Drop and Withdrawal dates:**

- Last day to drop (delete) classes: Wed., Sep. 4 (Students can drop classes by phone or web through this date, and the classes will not appear on their transcripts.)
- Last day to add classes: Mon., Sep. 9
- Last day to withdraw from classes: Fri., Oct. 25. (Students can withdraw from classes by phone or web, but will “W” will appear on their transcript for these courses.)