ATM 505 INTRODUCTION TO ATMOSPHERIC PHYSICS II

SPRING 2023 CLASS #: 6881 (Lecture)

Instructor: Chris Thorncroft cthorncroft@albany.edu
Office Hours: Email for appointment

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Instructor: Jie Zhang jzhang35@albany.edu
Instructor: Fangqun Yu fyu@albany.edu
Instructor: Sara Lance smlance@albany.edu

Office Hours for instructors will be provided at the beginning of each Module

Lecture Times:	Mon and Wed	3.00pm-4.20pm
Location:	ETEC 482	
Credits:	3	

Prerequisite for Course: ATM504

Grading Scheme: Graded

Aims of Course:

The course aims to expose students to the application of physical laws and principles in the following 4 fundamental areas:

- Planetary boundary layer
- Atmospheric Chemistry
- Aerosols
- Cloud Microphysics

The course is, by definition, introductory with the goal of exposing students to different areas of atmospheric physics.

Course Assessment:

1.	First Exam	Modules (1-2) March 6th	34%
2.	Four problem sets	Given one week to do them (8% each)	32%
3.	Second exam	Modules (3-4) TBD	34%

Homework policy

Each Module has a homework. You have 1 week to complete and hand them in by the end of the class that they are due in.

LATE HOMEWORK will incur a penalty of 15% per day unless there is a documented and legitimate reason such as a health issue or travel to a conference or fieldwork etc. Homework will not be accepted after the answers have been graded and returned to the rest of the class.

Academic integrity

We encourage an atmosphere of open inquiry and mutual respect. While collaborations with fellow students on homework is permissible you must always submit your own work and your own thoughts, and give proper credit to others for previous work and ideas. Every student must be familiar with the standards of academic integrity at UAlbany. Claims of ignorance, of unintentional error, or of academic or personal pressures are not sufficient reasons for violations of academic integrity. Please review these policies in the Graduate Bulletin at http://www.albany.edu/graduatebulletin/requirements_degree.htm

Textbook

There is no recommended textbook for this course. Recommended reading will be made by instructors as appropriate

OVERVIEW OF COURSE

MODULE 1: Boundary Layer (5 Lectures)

Instructor: Jeff Freedman

The atmospheric boundary layer (ABL) is the lowest layer of the atmosphere (order 10^2-10^3 m) that is coupled with the surface via the exchange of momentum, heat, moisture and trace gases. These fluxes are driven by processes occurring at relatively small scales (sub-millimeter to ~10^3 m), yet they play a critical role in driving motions at much larger scales and in determining the composition of the atmosphere. This course module will introduce the basic structure of the ABL and how it responds to shear and buoyancy forcing, atmospheric turbulence, similarity scaling relationships between profiles and surface-atmosphere fluxes, parameterization of surface fluxes in models, and air-sea interaction.

Lecture 1: Atmospheric Boundary Layer
Lecture 2: Atmospheric Turbulence
Lecture 3: Similarity Scaling
Lecture 4: Parameterization of Surface Fluxes
Lecture 5: Air-Sea Interaction

MODULE 2: Atmospheric Chemistry (5 Lectures)

Instructor: Jie Zhang

Atmospheric chemistry is the study of the chemical composition of the atmosphere, and the chemical reactions that occur in the atmosphere. The study encompasses reactive trace gases as well as chemistry in condensed phases that exist in the atmosphere (aerosols, fog and cloud droplets). This brief introduction to the field will introduce students to the following important topics: 1) stratospheric chemistry, including the chemistry of the ozone layer and our understanding of the Antarctic ozone hole; 2) tropospheric gas phase chemistry, concentrating on photochemical oxidation processes including the formation of ground level ozone pollution; 3) aqueous chemistry in the atmosphere, which involves fog and cloud droplets and their interactions with soluble gases and the chemistry occurring in the aqueous phase; 4) the atmospheric chemistry of aerosols, which will present some of the basic chemical understanding of the composition and reactions of micron and submicron sized particles that are suspended in the atmosphere; and 5) Atmospheric Chemistry Measurements.

Lecture 1: Introduction and Stratospheric Chemistry
Lecture 2: Gas Phase Chemistry of the Troposphere
Lecture 3: Aqueous Phase Atmospheric Chemistry
Lecture 4: Atmospheric Chemistry of Aerosols
Lecture 5: Atmospheric Chemistry Measurements

MODULE 3: Aerosols (5 Lectures)

Instructor: Fangqun Yu

The importance of aerosols in the atmosphere arises from their links to aerosol-cloud-radiation-precipitation interactions – and thus climate forcing and the hydrological cycle – as well as role in atmospheric chemistry and air quality – and therefore public health and morbidity. This brief introduction to the field will introduce students to the following important topics: 1) Properties of atmospheric particles and approaches to characterize them; 2) Thermodynamic processes controlling gas to particle conversion and new particle formation (nucleation); 3) Main aerosol microphysical processes determining the transformation of particles in the atmosphere; and 4) Impacts of aerosols on cloud properties, precipitation, and climate.

Lecture 1: Introduction and Aerosol Characterization
Lecture 2: Particle Microphysics Overview and Thermodynamics
Lecture 3: New Particle Formation
Lecture 4: Aerosol Growth, Coagulation, and Deposition
Lecture 5: Environmental and Climatic Impacts of Atmospheric Aerosols

<u>MODULE 4: Cloud Microphysics (5 Lectures)</u>

Instructor: Sara Lance

Clouds are a vital link in the global climate and water cycle and an integral part of weather forecasting and analysis. Emphasis will be on the basic microphysical processes that are involved in the formation and growth of cloud and precipitation particles, focusing on warm cloud processes (where the temperature is everywhere above 0ºC) and cold clouds (in which the temperature drops below 0ºC and both ice and liquid particles may exist). Topics include nucleation, condensation and ice crystal growth (deposition).

Lecture 1: Overview of Cloud Microphysics
Lecture 2: Cloud Droplet Formation (Nucleation) and Condensational Growth
Lecture 3: Cloud Supersaturation and Warm Rain Process (Collision-Coalescence)
Lecture 4: Overview of Cold Cloud Processes & Ice Nucleation Modes
Lecture 5: Vapor Diffusional Growth and Ice Crystal Habit Effects