Atmospheric Physics I

PHYS 621, Fall 2016

Dates and Location: Tuesday & Thursday, 2:30PM- 3:45AM; Public Policy 367

INSTRUCTOR: Dr. Pengwang Zhai
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OFFICE HOURS: Anytime Through Email appointment

TEXTS:
Wallace, J.M. and P. V. Hobbs, *Atmospheric Science: An Introductory Survey*, 2nd ed., Elsevier, 2006
Salby, M. L., Fundamentals of Atmospheric Physics, Academic Press, 1996.

REFERENCE TEXTS (Highly recommend):
Holton, J. R. *Introduction to Dynamic Meteorology*, 4th ed., Academic Press, 2004.

DESCRIPTION: **Composition and structure of the earth's atmosphere, atmospheric radiation and thermodynamics, fundamentals of atmospheric dynamics, overview of climatology.**

GRADING:
Homework (25%), Midterm (30%), Final (40%), Participation/Discussion(5%)

Course Strategy:

There will be no exam make-up except for University-policy accepted absence.

To promote active learning, students are strongly encouraged to read the corresponding textbook chapters before each lecture. Pre-lecture homework and discussion assignments are given routinely before lectures.

Reading the sections of the textbook corresponding to the assigned homework exercises is considered part of the homework assignment; you are responsible for material in the assigned reading *whether or not it is discussed in the lecture.* Homework will be due weekly in Thursday's lecture. There will be a 30% penalty on late homework submissions.

COURSE OUTLINE:

Overview

A. Earth's atmosphere
- System of units
- The Sun and the orbit and size of Earth
- Chemical constituents of Earth's atmosphere
- Vertical structure of temperature and density
- Wind and precipitation
- Ozone layer, hydrological and carbon cycles
- Global Energy Budget

B. Atmospheric Radiation
- Maxwell's Equation & EM wave
- Blackbody radiation: Planck's Law and Stefan-Boltzmann's law
- Spectral characteristics of Solar and Thermal infrared radiation
- Atmospheric absorption & Greenhouse effect
- Atmospheric scattering, clouds and aerosols
- Radiative forcing and climate
- Spatial and Temporal distribution of solar radiation

C. Overview of atmospheric motion and the general circulation
- Atmospheric Forces, Coriolis effect and Coriolis force
- One-cell circulation model and three-cell circulation model
- Effects of season and land mass distribution
- Jet stream and monsoon
- General circulation and climate zones

Atmospheric thermodynamics

A. Thermodynamic Principles
- Ideal gas equation of state; Dry air as a mixture of ideal gases;
- First Law: work, heat, specific heat and energy conservation
- Second Law: entropy, adiabatic processes, potential temperature
- Thermodynamic potentials
- Thermodynamic cycles
- Hydrostatic equation, scale height, geopotential
- Dry adiabatic lapse rate and static stability

B. Thermodynamics of moist air
- Phase changes of water and the phase diagram, latent heat
- Humidity, vapor pressure
- Saturation vapor pressure, Clausius-Clapeyron equation
- The pseudo-adiabatic chart
- Saturated adiabatic lapse rate

C. Static stability
- Lifting condensation level (LCL), level of free convection (LFC)
- Brunt-Vaisala frequency and gravity waves
- Subsidence; heating by compression

D. Thermodynamic aspects of various weather and climate phenomena:
- Cloud formation, hurricanes, rain shadow deserts, monsoons

Atmospheric Dynamics

A. Kinematic and mathematical fundamentals
- Vector differential operators and integral theorems
- Scalar, vector, and tensor fields

Vorticity and divergence
Rotating frames
Curvilinear coordinates

B. Atmospheric forces
Driving versus steering forces
Gravity, pressure gradient, Coriolis, friction, centrifugal force
Pressure gradient force on isobaric surfaces
The sea breeze
Geopotential height contours, surface and 500mb weather maps

C. Atmospheric equations of motion
Eulerian and Lagrangian frames, streamlines and trajectories
Forces and stresses
Conservation of mass: continuity equation
Conservation of energy: thermodynamic equation
Conservation of momentum: momentum equation

D. Applications of the equations of motion: balanced flow
Geostrophic, cyclostrophic and inertial flow
Gradient wind, thermal wind and temperature advection
Frictional effects

E. Applications of the equations of motion: time dependent
Scale analysis
Creation, conservation and modification of vorticity
Barotropic vorticity equation and Rossby waves
Barotropic and baroclinic stratification
Sound waves, shallow water waves and gravity waves
Potential vorticity on isentropic surfaces

Academic Honesty Policy

By enrolling in this course, each student assumes the responsibilities of an active participant in UMBC's scholarly community, in which everyone's academic work and behavior are held to the highest standards of honesty. Cheating, fabrication, plagiarism, and helping others to commit these acts are all forms of academic dishonesty, and they are wrong. Academic misconduct could result in disciplinary action that may include, but is not limited to, suspension or dismissal. To read the full Student Academic Conduct Policy, consult the UMBC Student Handbook, the Faculty Handbook, or the UMBC Policies section of the UMBC Directory. [Statement adopted by UMBC's Undergraduate Council and Provost's Office.]