Atmospheric Physics I

PHYS 621, Fall 2017

Dates and Location: Tuesday & Thursday, 2:30PM- 3:45AM
Public Policy 203

INSTRUCTOR: Dr. Zhibo Zhang
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OFFICE HOURS: Thursday after class or appointment by Email

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:
Holton, J. R. *Introduction to Dynamic Meteorology*, 4th ed., Academic Press, 2004.
Houghton, J. T., *The Physics of Atmospheres*, 3rd ed., Cambridge University Press, 2001
Petty, G.W. A First Course in Atmospheric Thermodynamics, Sundog Publishing, 2008 (www.sundogpublishing.com) [<- cheapest option]

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

GRADING:
Homework (30%), Midterm (30%), Final (30%), Participation/Discussion(10%)

COURSE OUTLINE:

Overview

A. **Earth's Atmosphere and Climate**
Chemical constituents of Earth's atmosphere
Vertical structure of temperature and density
Wind and precipitation
Ozone layer, hydrological and carbon cycles

B. **Global Energy Budget and Global Warming**
Global radiative energy budget
Overview of Earth's climate system
Greenhouse effect and global warming
Atmospheric scattering, clouds and aerosols
Radiative forcing and climate

Atmospheric thermodynamics

A. Basic Laws of atmospheric thermodynamics
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. **Atmospheric Static stability**
Lifting condensation level (LCL), level of free convection (LFC)
Brunt-Vaisala frequency and gravity waves
Subsidence; heating by compression

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

The planetary boundary layer (as time permits)

A. Overall structure and processes
Vertical transport of mass, energy and momentum
Aspects of turbulence
Modelling rapidly varying and small scale degrees of freedom
Reynolds decomposition, flux gradient, eddy fluxes
Ekman spiral, Ekman pumping
Coupling of the climate subsytems in the PBL

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.]