Atmospheric Physics I

PHYS 621, Fall 2019

Dates and Location: Tuesday & Thursday, 2:30PM- 3:45AM; Sherman Hall 108

INSTRUCTOR: Dr. Pengwang Zhai
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Ph.: 410-455-3682 (office)

OFFICE HOURS: Anytime Through Email appointment

TEXTS:

Wallace, J.M. and P. V. Hobbs, *Atmospheric Science: An Introductory Survey*, 2nd ed., Elsevier, 2006

Holton, James R., An Introduction to Dynamics Meteorology, Fifth edition, Academic Press. Elsevier 2013.

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

GRADING:

Homework (15%), Two Midterms (25% each), Final (30%), Participation/Discussion(5%)

- A: 90% and above
- B: 80%-89%
- C: 70%-79%
- D: 60%-69%
- F: below 60%.

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. No late homework submission is accepted.

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.]

Disclosures of Sexual Misconduct and Child Abuse or Neglect

As an instructor, I am considered a Responsible Employee, per UMBC's Policy on Prohibited Sexual Misconduct, Interpersonal Violence, and Other Related Misconduct (located at http://humanrelations.umbc.edu/sexual-misconduct/umbc-resource-page-for-sexual-misconduct-and-other-related-misconduct/). While my goal is for you to be able to share information related to your life experiences through discussion and written work, I want to be transparent that as a Responsible Employee I am required to report disclosures of sexual assault, domestic violence, relationship violence, stalking, and/or gender-based harassment to the University's Title IX Coordinator.

As an instructor, I also have a mandatory obligation to report disclosures of or suspected instances of child abuse or neglect (www.usmh.usmd.edu/regents/bylaws/SectionVI/VI150.pdf).

The purpose of these reporting requirements is for the University to inform you of options, supports and resources; you will not be forced to file a report with the police. Further, you are able to receive supports and resources, even if you choose to not want any action taken. Please note that in certain situations, based on the nature of the disclosure, the University may need to take action.

If you need to speak with someone in confidence about an incident, the following Confidential Resources are available to support you:

The Counseling Center: 410-455-2472

University Health Services: 410-455-2542

(After-hours counseling and care available by calling campus police at 410-455-5555)

Other on-campus supports and resources:

The Women's Center, 410-455-2714

Title IX Coordinator, 410-455-1606
Additional on and off campus supports and resources can be found at:
http://humanrelations.umbc.edu/sexual-misconduct/gender-equitytitle-ix/.