Atmospheric Physics I

PHYS 621, Fall 2020

Dates and Location: Tuesday & Thursday, 11:30AM- 12:45PM;
INSTRUCTOR: Dr. Pengwang Zhai
Email: pwzhai@umbc.edu
Ph.: 410-455-3682 (office)
OFFICE HOURS: Friday 9:00 am or 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.]

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At a Glance:

UMBC Policies and Resources for Students during COVID-19

UMBC's Vision Statement

Our UMBC community redefines excellence in higher education through an inclusive culture that connects innovative teaching and learning, research across disciplines, and civic engagement. We will advance knowledge, economic prosperity, and social justice by welcoming and inspiring inquisitive minds from all backgrounds.

Technology: Access, Requirements, Resources, Support

To help ensure that UMBC students are equipped for academic success, the Division of Information Technology (DoIT) provides a wealth of resources and support, including tips for getting online and minimum specifications to consider when purchasing a computer. UMBC does require all students to be technologically self-sufficient, which entails having a reliable personal computer (preferably a laptop with webcam) and Internet access. It is important to note that this university requirement has been factored into UMBC's official "cost of attendance," which can be funded by student financial aid. To learn more about the resources and support that DoIT offers to students, visit doit.umbc.edu/students.

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COVID-19: Safety Expectations and Guidelines

Students enrolled in this course are expected to adhere to all UMBC policies, rules, and regulations, including COVID-19 emergency health and safety rules, policies, guidelines, and signage enacted for the UMBC community. For students attending in-person classes, signage, policies, rules, and/or guidelines may include but are not limited to specific requirements for face coverings, physical distancing, and sanitization, in addition to efforts to reduce density efforts that involve reductions in seating and room capacity. Please be aware that UMBC's COVID-19 emergency health and safety rules, regulations, policies, guidelines, and/or signage are subject to change as our public health crisis evolves. Any violation will be subject to disciplinary action and may include but not limited to immediate dismissal from the classroom, removal from the classroom and/or campus, a requirement to work remotely, and/or sanctions and conditions enumerated in the UMBC Code of Student Conduct that may entail suspension or expulsion from UMBC.

Academic integrity in the Online Instruction Environment

Academic integrity is an important value at UMBC. 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. These principles and policies apply in both face-to-face and online classes. Resources for students about academic integrity at UMBC are available at https://academicconduct.umbc.edu/resources-for-students/

Enrollment Dates and Deadlines

Students must be familiar with the academic policies and enrollment dates and deadlines as published in the Undergraduate Catalog and the Academic Calendar. They are also responsible for managing their course enrollment(s) accordingly.

Accessibility and Disability Accommodations, Guidance and Resources

Support services for students with disabilities are provided for all students qualified under the Americans with Disabilities Act (ADA & ADAAA) and Section 504 of the Rehabilitation Act who request and are eligible for accommodations. The Office of Student Disability Services (SDS) is the UMBC department designated to coordinate accommodations that would create equal access for students when barriers to participation exist in University courses, programs, or activities.

If you have a documented disability and need to request academic accommodations in your courses, please refer to the SDS website at sds.umbc.edu for registration information and office procedures.

SDS email: disAbility@umbc.edu

SDS phone: (410) 455-2459.

If you will be using SDS approved accommodations in this class, please contact me (instructor) to discuss implementation of the accommodations. During remote

instruction requirements due to COVID, communication and flexibility will be essential for success.

Please note: Shady Grove campus (USG) student accommodation needs are arranged through the UMBC main campus SDS office.

Hate, Bias, Discrimination and Harassment

UMBC values safety, cultural and ethnic diversity, social responsibility, lifelong learning, equity, and civic engagement.

Consistent with these principles, UMBC Policy prohibits discrimination and harassment in its educational programs and activities or with respect to employment terms and conditions based on race, creed, color, religion, sex, gender, pregnancy, ancestry, age, gender identity or expression, national origin, veterans status, marital status, sexual orientation, physical or mental disability, or genetic information.

Students (and faculty and staff) who experience discrimination, harassment, hate or bias or who have such matters reported to them should use the online reporting form to report discrimination, hate or bias incidents; reporting may be *anonymous.*

Sex and Gender Based Violence, Harassment and Discrimination

Any student who is impacted by sexual harassment, gender-based harassment, sexual assault, sexual coercion, relationship violence, domestic violence, sexual exploitation, sexual intimidation, sex, gender-based stalking or retaliation or gender or pregnancy discrimination is encouraged to seek support and resources.

You can access support and resources even if you do not want to take any further action. You will not be forced to file a formal complaint or police report. Please be aware that the University may take action on its own if essential to protect the safety of the community.

As an instructor, I am considered a *Responsible Employee*, per UMBC's Policy on Prohibited Sexual Misconduct, Interpersonal Violence, and Other Related Misconduct I am required to report disclosures of possible violations of the Policy to the Title IX Coordinator, even if the experience occurred before you attended UMBC.

While I want you to be able to share information related to your life experiences through discussion and written work, I also want you to understand that I must report Sexual Misconduct to the Title IX Coordinator so that the University can inform you of your rights, resources and support.

If you need to speak with someone in confidence, who does not have an obligation to report to the Title IX Coordinator, about an incident, UMBC has the following Confidential Resources available to support you: The Counseling Center: 410-455-2742; University Health Services: 410-455-2542; For after-hours emergency consultation, call 301-314-7651.

Other on-campus supports and resources: The Women's Center (for students of all genders): 410-455-2714; Title IX Coordinator, 410- 455-1250.

Child Abuse and Neglect
Please note that Maryland law requires that I report all disclosures or suspicions of child abuse or neglect to the Department of Social Service and/or the police.

Pregnancy

UMBC's Sexual Misconduct, Interpersonal Violence, and Other Related Misconduct Policy expressly prohibits all forms of Discrimination and Harassment on the basis of sex, including pregnancy. Resources for pregnant students are available through the University's Office of Equity and Inclusion.

In addition, students who are pregnant may be entitled to accommodations under the ADA through the Student Disability Service Office, and/or under Title IX through the Office of Equity and Inclusion.