

Atmospheric Physics II  
Fall 2020: PHYS 622 - Credit Hours 3.0  
Monday/Wednesday: 9– 10:15 AM;  
Rm Web: <https://umbc.webex.com/meet/bdemoz>

Instructor's Contact Information: Dr. Belay Demoz, [bdemoz@umbc.edu](mailto:bdemoz@umbc.edu) or 410-455-2715.

Office Hour: WEB - By arrangement

**COURSE OBJECTIVE:** Introduction to basics of Earth's atmosphere with emphasis on (1) aerosol, (2) clouds, (3) radiation, and (4) cloud instrumentation.

**SUGGESTED TEXT:**

Roger and Yau, *A Short Course in Cloud Physics* Pergamon Press, 3rd ed.  
Handouts and reading assignments from books (see list at the end).  
*Physics and Chemistry of Clouds*, By Dennis Lamb, Johannes Verlinde  
*Handouts from Storm and cloud Physics* (WR Cotton, CSU)

**REFERENCE BOOKS:**

Salby, M.L., *Fundamentals of Atmospheric Physics*, Academic Press (AP), 1996  
Twomey, S., *Atmospheric Aerosols*, Elsevier Publishing, 1977  
Rogers, R.R., and M. K. Yau, *A Short Course in Cloud Physics*, Pergamon Press, 1989  
Pruppacher, H.R., and J.D. Klett, *Microphysics of Clouds and Precipitation*  
Liou, K.N. *An Introduction to Atmospheric Radiation*, AP, 1980  
Houghton, H.G., *Physical Meteorology*, MIT Press, 1985  
Wallace, J. M. and P. Hobbs, *Atmospheric Sciences: An Introductory Survey*, AP 1977  
Charlson, R. J. and J. Heintzenberg, Editors, *Aerosol Forcing of Climate*, Wiley and Sons 1995  
Goody, R. M. and Y. L. Young, *Atmospheric Radiation: Theoretical Basis*, Oxford Univ. Press, 1989  
Stephens, G. L., *Remote Sensing of the Lower Atmosphere*, Oxford Univ. Press 1994  
Petty, G. W.: *A Short Course in Cloud Physics*. Sundog Publishing. 2nd ed.  
Seinfeld, J. H., S. N. Pandis; *Atmospheric Chemistry and Physics*. 2<sup>nd</sup> ed. Wiley and Sons 2006

## **COURSE OUTLINE**

### **I. Atmospheric Aerosols**

A good collection of aerosols discussion is available in the following link:

<http://biophysics.sbg.ac.at/transcript/aerosol2.pdf>

***Read: Twomey – Chapter1-3; Pruppacher – Chapter-8; Seinfeld – Chapter-8 (Dynamics of single aerosols);***

#### ***A) Introduction to atmospheric aerosols***

- i) Importance of atmospheric processes
- ii) Description of mechanical generation of salt and dust particles
- iii) Gas-to-particle conversion

#### ***B) Size distributions***

- i) Measured and analytic
- ii) Evolution of size distributions
- iii) Homogeneous nucleation and growth: nucleation mode; Growth by diffusion, coagulation, kinematic, cloud processing (accumulation mode)
- iv) Removal: settling, impaction, collision with cloud and precipitating particles (coarse mode)

- C) *Aerosol measurements*: selected topics given as a reading assignment.  
D) *Aerosols and climate*: Global aerosol distributions and their Impacts

## **II. Clouds**

### ***A. Warm cloud processes***

1. Cloud droplet microphysics (homogenous/heterogeneous nucleation, Kelvin equation, solute effect, CCN)
2. Droplet growth by condensation
3. Initial cloud droplet size distributions (CCN spectrum measurements, effect of CCN on cloud droplet concentration)
4. Droplet coagulation and warm cloud precipitation processes

### ***B. Ice cloud processes***

1. Homogeneous/heterogeneous nucleation, ice nuclei
2. Ice particle growth by deposition
3. Crystal habits
4. Riming, aggregation, breakup

C. *Cloud modeling and current topics in cloud physics*: A general discussion given by students; guest lecturer, or as project

D. *Cloud and aerosol instrumentation*: In-situ; Active and passive remote and examples of application. A general discussion given by students; guest lecturer, or as project

## **III. Atmospheric Radiative Transfer: Basic concepts**

### ***A) Fundamental radiometric definitions and terms***

- 1) Blackbody radiation
- 2) Kirchoff's law
- 2) Planck's law
- 3) Application to bodies not in thermodynamic equilibrium

### ***B) Molecular absorption***

- 1) Summary of important absorbing gases in the atmosphere
- 2) Descriptive summary of molecular absorption principles (vibration- rotation etc)
- 3) Overview of spectral line shapes

### ***C) Extinction, absorption, and scattering***

- 1) Beer's law
- 2) Radiative properties of atmospheric components
- 3) The radiative transfer equation solution methods
- 4) Atmospheric optics

## **IV. Cloud Instrumentation:**

An introduction and discussion of selected instruments. This section will rely on student-centered lecture on cloud and aerosol instrumentation.

## **Grading**

- Student grades will be based on their performance in the following activities or examinations:

|  |          |
|--|----------|
| Homework   | 20%      |
| <sup>1</sup> Student research paper/presentation | 20%      |
| Term exams (3)                                   | 20% each |
| Total  | 100%     |

<sup>1</sup>Each student will report and present in class a term paper on a research topic of choice but in cloud physics (broadly defined) - agreed on early during the semester. It is desirable to choose a research topic close to the student's research area.

Note: There are four sections in this class, and you will be delivering 4-presentations of 20minute duration each. Each of these talks are going to be on a current topic related to the section (i.e. Clouds, aerosol, radiation, instrumentation). Please contact me early so I can help you chose a topic for you to choose.

Students are required to attend all class sessions, unless illness or emergency prevents it (in which case the student must provide a written explanation to the instructor upon next class attendance, or by telephone or e-mail in case of extended absence).

**REGISTERED STUDENTS:**

- Roshan Mishra: [kn82613@umbc.edu](mailto:kn82613@umbc.edu)
- Alrick Green: [agreen15@umbc.edu](mailto:agreen15@umbc.edu)
- Greema Regmi [gregmil@umbc.edu](mailto:gregmil@umbc.edu)
- Rhonda Plofkin [rhondap1@umbc.edu](mailto:rhondap1@umbc.edu)

*Please also note the following important statements on Academic Integrity, Accessibility, and harassment. While this are university wide faculty approved language I want you to know that I am in complete agreement and will adhere to the letter and spirit of the statements.*

**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>

**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 & ADAAG) 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](https://sds.umbc.edu) for registration information and office procedures.

SDS email: [disAbility@umbc.edu](mailto: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.

### **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.