Atmospheric Physics II
Spring 2019: PHYS 622 - Credit Hours 3.0
Tuesday and Thursday 8:30 – 9:45 AM Rm 201 public Policy
Instructor's Contact Information: Dr. Belay Demoz, bdemoz@umbc.edu or 410-455-2715
Office Hours: Tuesdays and Thursday 10am – 11pm; other hours arranged by email.

COURSE OBJECTIVE: Introduction to basics of Earth's atmosphere with emphasis on aerosol, clouds, radiation, and cloud instrumentation. The goal of this topic is to primarily cover the three areas (aerosol, clouds, intro to radiation) and give the students a strong foundation for the interaction between the aerosol-clouds-radiation and operational applications. Most of the new information will be coming from recent papers/reports but also from reports and operational documents/web resources. The students are required to participate by brining recent findings to class for discussion. The text books listed here are references that will form the basis for the fundamental science in aerosol, clouds and introductory radiation. Depending on amount of time remaining at the end of the course, we will incorporate the science of lightning and atmospheric electrification.

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).

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. 2nded.
Seinfeld, J. H., S. N. Pandis; Atmospheric Chemistry and Physics. 2nd 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 – Chapter-2; Pruppacher – Chapter-8; Seinfeld – Chapter-8 (Dynamics of single aerosols)

A) Introduction to atmospheric aerosols
i) Importance in 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

Grading

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

Home works	20%
[1]Student research paper presentation	20%
Term exams (3)	20% each
Total	100%

[1]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.

- 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).