PHYS 622 Atmospheric Physics II 2009
3 credits: Grade Method: REG/P-F/AUD
MW.....5:00pm- 6:15pm (room PHYS201)

INSTRUCTORS:
Dr. W. Wallace McMillan (Phys 418, 410-455-6315, mcmillan@umbc.edu)
Dr. Tamas Varnai (Phys 432, 301-614-6408, varnai@climate.gsfc.nasa.gov)

COURSE OBJECTIVE:
Introduction to terrestrial atmospheric physics with emphasis on atmospheric radiative transfer, and aerosol and cloud physics.

TEXT BOOKS:
Salby, M.L., *Fundamentals of Atmospheric Physics*, Academic Press (AP), 1996.
Roger, R. R and Yau, M. K., *A Short Course in Cloud Physics*, Pergamon Press, 3rd edition, 1989.
Wallace, J. M, and Hobbs, P. V., *Atmospheric Science: An Introductory Survey*, 1st or 2nd edition.
Handouts and reading assignments from books (see list below) and scientific papers.

REFERENCES:
Twomey, S., *Atmospheric Aerosols*, Elsevier Publishing, 1977
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
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

COURSE OUTLINE

I. Atmospheric Radiative Transfer -- Basic concepts (McMillan)

A. Fundamental radiometric definitions and terms

B. Blackbody radiation

1. Kirchoff's law
2. Planck's law
3. Application to bodies not in thermodynamic equilibrium

C. Extinction, absorption, and scattering

1. Definitions and notation
2. Lambert's and Beer's laws
4. Single scattering
5. Multiple scattering
6. Atmospheric optics

D. 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

II. Basic remote sensing of the atmosphere (McMillan)

1. The radiative transfer equation in absorbing atmospheres
2. Upwelling/downwelling radiation
3. Infrared weighting functions and atmospheric remote sensing
4. The radiative transfer equation in scattering atmospheres

III. Atmospheric Aerosols (McMillan)

A. Introduction to tropospheric and stratospheric aerosols.

1. Importance in atmospheric processes
2. Radiative transfer
3. Description of mechanical generation of salt and dust particles
4. Gas-to-particle conversion
5. Sulfate and nitrate particle chemistry
6. Carbon and other particles.
7. Interactions with clouds: climate and radiation.

B. Size distributions

1. Measured and analytic

C. Evolution of size distributions

1.Homogeneous nucleation (nucleation mode)
2. Growth-diffusion, coagulation, kinematic, cloud processing (accumulation mode)
3. Removal – settling, impaction, collision with cloud and precipitating particles (Coarse mode)

IV. Clouds (Varnai)

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

V. Cloud and aerosol instrumentation (Varnai)

Grading:

Homework	20%
Term (or research) paper presentation	35%
Exams (3 x 15% each)	45%
Total	100%

Research Paper/Presentation:

1. Each student will write and present in class a paper on a research topic of their choice.
2. It is preferred if the subject is also related to this class.
3. The paper must be 15-20 pages in length (including references).
4. The presentation will be 15-20 minutes in length.
5. Topics must be submitted on or before ***February 5th***.
6. Papers must be submitted on or before ***May 4th***.
7. Presentations will occur during the last class, ***May 11th***

Where to find us

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Lab: Phys 404
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Phone: 410-455-6315

When to find us

Dr. W. Wallace McMillan
M,W: 2-3 PM and by appointment
Not: Tu/Th 12 – 6 PM (Electronics class/lab)

Expected Schedule

Classes Begin	Jan 26
Spring Break	March 16-20
Take-home Exam 1*:	Feb 25 – March 4
Take-home Exam 2*:	Apr 1 – April 8
Last Day of Classes	May 12
Final Take-home Exam	May 11 – May 18
Final Grades Due	May 24

*Dates of the first two take-home exams are estimates only; they could change by ± one week.

This gives us 14.5 weeks of classes, at 2/wk➔29 classes. We will use reserve 1-class for your presentations. Thus, the 28 lectures will be broken into the 3 major topics roughly as:

Atmospheric Radiative Transfer and Remote Sensing:	10 lectures
Atmospheric Aerosols:	8 lectures
Clouds and Precipitation:	10 lectures

You will have a few special lectures by JCET, GEST, Goddard, and/or visiting scientists whose research areas include radiative transfer, remote sensing, aerosols, clouds, and/or precipitation.