270.330
Atmospheric Chemistry
Spring 2014
Monday and Wednesday 1:30-2:45

FACULTY

Prof. Richard Stolarski, ext 67552, rstolar1@jhu.edu

COURSE DESCRIPTION

Atmospheric Chemistry

This course will examine the structure and composition of the atmosphere and the processes that determine how the composition has changed in the past and might change in the future. Emphasis will be on the chemistry of the stratospheric ozone layer. The chemistry of the troposphere and air pollution will also be covered.

Prerequisite: Calculus I and II.

BOOKS

Required: Jacob, Daniel J. *"Introduction to Atmospheric Chemistry"*, Princeton University Press, 1999 [QC879.6.J33]
Additional Material: Scientific Assessment of Ozone Depletion: 2010, World Meteorological Organization Global Ozone Research and Monitoring Project-Report No. 52. Available online at http://acdb-ext.gsfc.nasa.gov/Documents/O3_Assessments/

I will cover the basic material in D. Jacob's book but will place more emphasis on stratospheric chemistry and the ozone layer and less emphasis on tropospheric chemistry. Supplemental reading material will be assigned in class and either distributed in the class or via the course webpage.

ASSESSMENT

The final grade will be determined from

Class Participation	10%
Homework	30%
Quizzes	30%
Final Exam	30%

Homework assignments will be made on a weekly basis. Quizzes will take up part of a course period and will occur approximately every 3 weeks as shown in the course schedule below. Homework can be done collaboratively as long as you list your collaborators.

COURSE SCHEDULE (Approximate)

Week 1: Introduction and History
- Description of atmosphere and history of ozone research
- Simple model of the atmosphere as a reaction vessel

Week 2: Radiative Processes in the Atmosphere
- Solar radiation
- UV and visible radiation; scattering, absorption and photodissociation

Week 3: Photochemistry of Stratospheric Ozone I
- Brief overview of chemical kinetics
- Chapman mechanism of pure oxygen reactions; production and loss of ozone

Quiz on basics of radiation, kinetics and the oxygen reactions

Week 4: Photochemistry of Stratospheric Ozone II
- Catalytic cycles and ozone loss rates (hydrogen, nitrogen, chlorine and bromine oxides)
- Ozone balance equation

Week 5: Photochemistry of Stratospheric Ozone III
- Formation of reservoir species; HCl, HNO_3, $ClONO_2$, $BrONO_2$, etc.
- Sensitivity of ozone to changes in catalytic rates

Week 6: Source Gases for Catalytic Oxides: The Biological Connection
- Biogeochemical cycling and emission to the atmosphere (N_2O, CH_4, CH_3Cl, CH_3Br)
- Industrial production (CFCs and HCFCs)

Quiz on stratospheric photochemistry, catalysis and source gases

Week 7: Atmospheric Dynamics and Transport of Chemical Species
- Basic wind and temperature structure of the atmosphere
- Transport of chemicals; advection, convection and mixing

Week 8: Heterogeneous Chemistry and Polar Ozone
- Structure of the Antarctic and Arctic polar vortices
- Impact of heterogeneous chemistry on polar ozone; formation of the ozone hole

Week 9: Factors that Impact Long-Term ozone Change
- CFCs and the Montreal Protocol
- Volcanic eruptions, solar cycle and dynamical variability

Quiz on atmospheric transport, polar ozone and long-term changes in ozone

Week 10: Photochemistry of Tropospheric ozone
- Methane oxidation and the production of ozone
- The hydroxyl radical (OH) and the oxidizing capacity of the atmosphere

Week 11: Models and the Prediction of Ozone Change I
- Hierarchy of models box, 1, 2 and 3 dimensional
- Boundary conditions, parameterizations and assumptions

Week 12: Measurements of Atmospheric Constituents
- Ozone measurements
- Other constituent measurements

Week 13: Using Atmospheric Measurements to Evaluate Models
- Critical tests of processes and assumptions
- Evaluation of long-term projections

Final

ETHICS

The strength of the university depends on academic and personal integrity.
In this course, you must be honest and truthful. Ethical violations include cheating on exams, plagiarism, reuse of assignments, improper use of the Internet and electronic devices, unauthorized collaboration, alteration of graded assignments, forgery and falsification, lying, facilitating academic dishonesty, and unfair competition.

Report any violations you witness to the instructor. You may consult the associate dean of students and/or the chairman of the Ethics Board beforehand. See the guide on "Academic Ethics for Undergraduates" and the Ethics Board web site (http://ethics.jhu.edu) for more information