ATM S 558: Spring Quarter 2004
Atmospheric Chemistry

course web site: http://www.atmos.washington.edu/2004Q2/558

Class Meeting Times and Location: Mondays and Wednesdays 9:00-10:15 am in Room 610 in the Atmospheric Sciences Building.

Course Description: Graduate course providing an introduction to the physical and chemical processes determining the composition of the atmosphere and its implications for climate, ecosystems, and human welfare. We will look at the science behind several important global environmental problems: Stratospheric ozone depletion, tropospheric ozone and photochemical smog, oxidizing capacity of the atmosphere, and acid rain.

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Office hours: Tuesday and Friday 2-3 pm or e-mail me to set up a time.

Prerequisites: ATM S 501 or permission of instructor.

Grading policy: Homeworks, 60%; Project paper, 30%; Class participation, 10%.

Textbook: ***Introduction to Atmospheric Chemistry***, by D.J. Jacob, Princeton University Press, 1999. The lectures will largely follow this textbook. Each week the students will be required to read material of direct relevance to the class.

Topics covered:

1) Fundamentals (1 week). Photochemistry; Theory of gas-phase reaction rates; Multiphase chemistry; Analysis of reaction mechanisms; Timescales.

2) Stratospheric chemistry (3 weeks). Stratospheric ozone and the Chapman mechanism; Catalytic loss cycles (HO_x, NO_y and halogen chemistry); Polar and mid-latitude ozone depletion; Role of aerosol chemistry in the stratosphere.

3) Tropospheric Chemistry (3 weeks). Oxidizing capacity of the atmosphere; Tropospheric ozone; Tropospheric NO_x and hydrocarbons; Air pollution and ozone smog.

4) Aerosols (1 week). Sources and transformations of tropospheric and stratospheric aerosols; Sulfur chemistry.

5) Topic(s) chosen by students (1-2 weeks). Students will decide on 1-2 of the following topics: Global warming and atmospheric chemistry; Air quality regulation; Acid rain; Intercontinental transport of air pollutants; Use of isotopes in atmospheric chemistry; Persistant pollutants, and heavy metals; Biomass burning; Cloud chemistry; Atmospheric chemistry models; Atmospheric chemistry observations (in-situ/satellite instruments); other?

Approximate course schedule (check class web page for up-to-date information)

Date	Lecture topic	Required reading	Assignt. Due
	WEEK 1	Skim through Chapters 1, 3, 9	
M 3/29	Introduction and course overview **Fundamentals.** Photochemistry. Theory of gas-phase/multiphase reaction rates.		
W 3/31	Analysis of reaction mechanisms; Box models; Lifetimes and transport timescales		
	WEEK 2	Chapter 10	
M 4/05	**Stratospheric chemistry**. Ozone and the Chapman mechanism; Catalytic loss cycles: HOx chemistry		
W 4/07	Catalytic loss cycles: NOy, Cly, Bry chemistry		**#1**
	WEEK 3		
M 4/12	How do we test photochemical models?		
W 4/14	Paper discussion	Review by S. Solomon	
	WEEK 4		
M 4/19	Ozone depletion: Polar ozone loss		**#2**
W 4/21	Mid-latitude ozone loss; role of aerosol chemistry in the stratosphere		
	WEEK 5	Chapter 11	
M 4/26	**Tropospheric Chemistry.** Oxidizing capacity of the atmosphere		**#3**
W 4/28	The Global budgets of CO and CH4		
	WEEK 6		
M 5/03	Tropospheric ozone		
W 5/05	Paper discussion		
	WEEK 7	Chapter 12	
M 5/10	Tropospheric NOx; Tropospheric VOCs		
W 5/12	Air pollution and ozone smog		**#4**
	WEEK 8	Chapter 8	
M 5/17	**Aerosols.** Sources and sinks of aerosols. Sulfate aerosols.		
W 5/19	Paper discussion		
	WEEK 9	Chapter 13	
M 5/24	Special topic		**#5**
W 5/26	Special topic		
	WEEK 10		
M 5/31	**MEMORIAL DAY – NO CLASS**		
W 6/02	Special topic		
W 6/09	Paper presentations.		**paper due**

Other useful textbooks:
Chemistry of the Lower and Upper Atmosphere, by Finlayson-Pitts and Pitts, Academic Press, 1999.

Atmospheric Chemistry and Physics: from Air pollution to Climate change, by J.H. Seinfeld and S.N. Pandis, Wiley, 1998.

Atmospheric Chemistry and Global Change, G.P. Brasseur, J.J. Orlando, and G.S. Tyndall (eds.), Oxford University Press, 1999.

Chemistry of the Natural Atmosphere, *P. Warneck*, Academic Press, 1999.

Atmospheric Change**,** T.E. Graedel & P.J. Crutzen, Freeman, 1992.

Chemistry of Atmospheres: An Introduction to the Chemistry of the Atmospheres of Earth, the Planets, and their Satellites**,** R.P. Wayne, Oxford University Press, 2000.

Final Project.

Students will write a paper and give a 15 minute presentation during finals week. A list of possible topics is included below, or students can pick a topic of their own choosing. The paper should be at least 5 pages long (but no more than 10 pages) using ~1.5 line spacing and include at least 5 references, as well as figures to illustrate your points.

Potential topics.

- The effects of global warming on the recovery of the stratospheric ozone
- Air pollution in mega-cities
- Intercontinental transport of pollutants
- Composition of Polar stratospheric clouds
- Biomass burning, and its effect on tropospheric ozone levels in tropical regions.
- Halogen chemistry in the marine boundary layer
- Ozone depletion events in the arctic boundary layer
- Is the global oxidizing capacity of the atmosphere changing?
- Satellite observations of tropospheric composition
- Satellite observations of stratospheric composition
- Lightning and the global NO_x budget
- Recent trends in CH_4
- Planetary Photochemistry
- Effects of aerosols on tropospheric ozone
- Formation of the stratospheric ozone layer in Earth's early atmosphere (~2 billion years ago)