Atmospheric Chemistry 16:375:540 & 11:375:346
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Course Goals
Use models to understand transport and transformation of components of the atmosphere
Identify and explain atmospheric processes, Earth surface processes, and interactions with outer space that change the composition of the atmosphere
Interpret atmospheric concentration data effectively and understand if more info is needed
Appreciate the complexity of atmospheric chemical processes and how they affect life on Earth

Course Assignments

Pre and Post Assessments	4%
6 Collaborative Problem Sets, due Wednesdays	48%
3 Open-Note Exams, Wednesdays	48%

Reference texts are available electronically as Course Reserves or on the Canvas site. *Modeling Atmospheric Chemistry* by Brasseur and Jacob (2017), *Biogeochemistry* by Schlesinger (2020), *Atmospheric Chemistry and Physics* by Seinfeld & Pandis (2016), and *Atmospheric Chemistry* by Daniel Jacob (1999)

Schedule and Goals

Week	Topics/*Assessments*/*Reading*	Goals
0	Atmospheric composition *Pre-course Assessment* *Read Schlesinger Ch 3*	Recall the composition of the atmosphere Appreciate the trace nature of trace gases Understand how pressure is measured, the concept of partial pressure contrasted with mixing ratio
1	Atmospheric Structure *Read Brasseur Ch 2*	Review the structure of the atmosphere and terminology Apply single and double box models to solve for lifetime Calculate changes in concentration from an initial condition to a steady state
2	Emission and Deposition *Problem Set #1 due* *Read Seinfeld 19.1, 19.2, 20.2.1, 20.2.2* *Brasseur Ch 9*	Review chemical kinetics Link what we know about states of matter with wet deposition Recall Henry's Law and incorporate this into our understanding of partial pressures
3	In Situ Chemical Processes *Problem Set #2 due* *Read Brasseur Ch 3*	Investigate the balance of noble gases in the atmosphere Contrast the "visible" and "invisible" parts of the atmosphere Categorize the various chemical processes that occur in the atmosphere and what variables control their rates
4	Light *Exam: Composition and Structure* *Read Feracci et al (2018) and Li et al (2018)*	Analyze the spectroscopic signatures of different gases, aerosols, and their radiative effects Recall the role of isotopic signatures in chemical processes Review and discuss seasons, uneven distribution of sunlight Introduce the role of OH, identify important light reactions
5	Photosynthesis/Respiration carbon and water Links *Read Walker et al (2020) Box 1 and 2*	Sketch out the carbon cycle fast and slow components Interpret the Mauna Loa record, carbon and oxygen isotope data, and the "flying carpet" Critique current evidence for carbon fertilization Incorporate what we know about water vapor/cloud feedbacks into what we know about photosynthesis
6	Nitrogen and Oxygen *Problem Set #3 due*	Recall the role of plate tectonics and the evolution of life in the evolution of Earth's mostly nitrogen atmosphere

	Read Lyons et al (2014)	Critique what we know about the history of the atmosphere and the rise of oxygen Explore the relative importance of photosynthesis and rock weathering to the oxygen cycle
	Spring Break	
7	Global Warming Potential and Lifetime *Problem Set #4 due* *Read Shine et al (2005)*	Explicitly link atmospheric composition to greenhouse effect Appraise the different impacts of gases on the radiative balance of the atmosphere taking into account lifetime Compare different government climate change strategies in light of different base times for global warming potential
8	Aerosols, bioaerosols, biomass burning *Exam: Tropospheric Chemistry* *Read Seinfeld Ch 8*	Define aerosol, life cycle, composition, and structure Identify reactions that happen with the aid of aerosols Weigh the direct and indirect effects of aerosols on radiative balance Investigate the variation of aerosol loading and El Niño events
9	Chemical Kinetics and Precipitation *Read Jacob Ch 9*	Examine precipitation data to hypothesize what reactions affect rainfall composition Appreciate the historical problem of acid rain and response Formulate equations for the reaction rates for gas-phase and mixed phase reactions Classify key radical-assisted reactions
10	Halogens and reactions in the stratosphere *Problem Set #5 due* *Read Seinfeld Ch 5*	Appreciate the discovery of the ozone hole and the international response Investigate the Chapman reactions, catalytic loss cycles Examine data from the WMO report to assess the current state of the ozone hole Contrast the role of aerosols in the stratosphere to those in the troposphere
11	Oxidation in the Atmosphere *Problem Set #6 due* *Read McNorton et al (2016)*	Review what we know about the OH radical Relate the concentration of OH to lifetime of methane and carbon monoxide Contrast the role of NOx in the troposphere vs stratosphere Examine data related to the long term transport of NOx
12	Sulfur and Mercury *Read Schlesinger Ch 13*	Explore the historical evolution of acid rain and solutions Compare the fate and transport of mercury and sulfur to nitrogen
13	Remote sensing the atmosphere *Exam: Chemical Reactions and Transport* *Read A-Train, ISS, CubeSat*	Review available atmospheric composition satellite products Interpret data and modeled interpretations for global and regional sources/sinks of trace gases
14	Synthesis and Review *Course Post Assessment*	Review course goals and assess how well we have done, what outstanding questions remain

This serves the environmental science learning goals

1. Apply knowledge, skills and techniques from the sciences and mathematics to identify, characterize and provide solutions for environmental problems

The two problems treated in this course are (1) climate change as it is related to changing atmospheric composition and (2) human and environmental health as it is related to atmospheric pollution. In problem sets and exams, students are asked to use published data to characterize these problems and critique applied solutions.

3. Communicate technical information effectively

Combined with written exams, students have 6 opportunities to practice written communication and oral presentation skills. How effective students are at this task will be determined by how well they are able to communicate technical answers to questions accurately and will achieve an appropriate grade.

4. Function effectively on teams to accomplish collaborative tasks

Problem sets in this course are collaborative: students are assigned to working groups for every problem set and asked to present their results to the class. Their success will result in a cohesive message and will be assigned an appropriate grade.