SYLLABUS

ENVR 675: Air Pollution Chemistry and Physics
Fall 2020

Class meets: Mondays & Wednesdays 10:15-11:30
Instructor: Jason West
Office: 140 Rosenau
Email: jasonwest@unc.edu
Office Hours: No set office hours, send an email to request a meeting

Course Description and Goals

Air pollution has significant effects on human health and the environment, through interrelated problems of ozone and particulate matter air pollution, acid rain, visibility degradation, mercury, stratospheric ozone depletion, and climate change. Significant strides have been made in the past few decades to improve our understanding of the sources, chemical transformation, transport, deposition, and impacts of different pollutants. We now understand that many air pollutants are linked together through complex chemical interdependencies.

This course is designed for first year graduate students planning to do research on the fate and transport of air pollutants, intending to cover the basics that all such students should know – whether they are experimentalists or modelers, and regardless of their educational background. Other students can also benefit from this course, including students researching air pollution health effects and environmental modeling.

Students will be expected to show mastery of relevant concepts drawn mainly from the Earth sciences, chemistry, physics, and engineering. By the end of this course, students will be able to:

- Explain current air pollution research in the context of the history of air pollution science.
- Explain the relationships between emissions of different air pollutants from different sources, their atmospheric concentrations, and the impacts that they ultimately cause.
- Explain the factors that influence the transport of pollutants around the world.
- Explain the chemical processes that govern the formation and destruction or removal of air pollutants, principally ozone and particulate matter.
- Understand basic laboratory and field techniques in the measurement of air pollutants.
- Understand the fundamentals of air pollution models.
- Apply quantitative analyses related to air pollution through homework problems and on tests.
- Read and understand recent scientific findings from journal articles.

In completing this course, students will improve their fundamental knowledge of air pollution, and will also learn skills in analyzing chemical processes, quantitative scientific methods, and modeling.

Prerequisites

This is a graduate level course. Advanced undergraduates will be admitted to the course with permission of the instructor. Students must have:

- had at least one undergraduate course in chemistry.
- had at least one undergraduate course in physics.
- comfort with math.

Course Requirements and Evaluation

Class participation	10%
Homework assignments	40%
In-class quizzes (2)	12%
In-class exam	13%
Final exam	25%
	100%

Homeworks are expected to be turned in on time. Late homeworks will lose 10% for each day late, except for exceptional circumstances and the prior approval of the instructor. You are encouraged to work in groups for your homeworks. However, each student is responsible for writing up and turning in their own results for their homework. If you work with others, you are required to include a note on your homework with the names of the people you work with (working with others does not count against you, but you will lose a point if you fail to acknowledge them). Handing in homework identical to another student's is not acceptable.

Homeworks should be written up clearly, explaining the methods used, and answering all questions provided. When you use a spreadsheet, computer program etc. to do your homework (beyond hand calculations), those should be submitted with your homework, with the methods and results described in the main written homework submission.

Feedback on the Course

You are expected to complete the online evaluation forms for this course (and for all your courses) during the last two weeks of the semester. I also welcome your feedback at any time while the course is in progress. Please arrange to meet with me and discuss, or you may also leave comments anonymously by putting a note in my mailbox.

Readings

There is one required text:

> Daniel J. Jacob, Introduction to Atmospheric Chemistry, 1999, Princeton University Press. This book is available for free on the web: http://acmg.seas.harvard.edu/people/faculty/djj/book/index.html.

We will also read from the NARSTO PM Assessment (2004), which is available online for free: http://www.narsto.org/pm_science_assessment.

In addition, research articles will be handed out in class. Other books are not required to purchase, but are recommended for students planning to focus their research on air pollution:

John H. Seinfeld and Spyros N. Pandis, Atmospheric Chemistry and Physics: From Air Pollution to Climate Change, 3rd Edition, 2016, Wiley.

Barbara J. Finlayson-Pitts and James N. Pitts, Jr., Chemistry of the Upper and Lower Atmosphere, 1999, Academic Press.

Mark Z. Jacobson, Atmospheric Pollution: History, Science, and Regulation, 2002, Cambridge Univ. Press

Mark Z. Jacobson, Fundamentals of Atmospheric Modeling, 2nd Edition, 2005, Cambridge Univ. Press.

Course Schedule (subject to updates)

Mon., Aug. 10 Introduction to class, Historical view of air pollution problems

Wed., Aug. 12 Atmospheric structure and composition, pressure, Ideal Gas Law, units of atmospheric composition

Mon., Aug. 17 Atmospheric trace constituents: sulfur-containing and nitrogen-containing compounds

Wed., Aug. 19 Atmospheric trace constituents: halogen-containing compounds, ozone, water vapor.

Mon., Aug. 24 Atmospheric trace constituents: carbon-containing compounds

Wed., Aug. 26 Transport of pollutants, mesoscale meteorology (Tim Glotfelty)

Fri., Aug. 28 SPECIAL CLASS Mesoscale meteorology, atmospheric stability (Tim Glotfelty)

Mon., Aug. 31 Global atmospheric transport (Tim Glotfelty), Simple models, atmospheric lifetime.

Wed., Sept. 2 QUIZ 1, Chemical kinetics

Mon., Sept. 7 NO CLASS - Labor Day

Wed., Sept. 9 Chemical kinetics, Atmospheric radiation and photochemistry

Mon., Sept. 14 Atmospheric radiation and photochemistry, Stratospheric ozone chemistry

Wed., Sept. 16 Stratospheric ozone chemistry, the Ozone Hole

Mon., Sept. 21 The Ozone Hole, Tropospheric ozone chemistry

Wed., Sept. 23 Tropospheric ozone chemistry, NO_x and Radical cycles

Mon., Sept. 28 Tropospheric ozone chemistry, role of CO and VOCs

Wed., Sept. 30 EXAM

Mon., Oct. 5 Tropospheric ozone, Urban ozone sensitivity and isopleths

Wed. Oct. 7 The continuity equation and atmospheric modeling, Use of a chemical solver

Mon., Oct. 12 NO CLASS University Day

Wed., Oct. 14 Overview of Particulate Matter

Mon., Oct. 19 Air pollution measurements (Glenn Morrison)

Wed. Oct. 21 Air pollution measurements (Glenn Morrison)

Mon., Oct. 26 NO CLASS - CMAS Conference

Wed., Oct. 28 NO CLASS - CMAS Conference

Mon., Nov. 2 QUIZ 2 Overview of PM

Wed., Nov. 4 ELECTION DAY   Inorganic PM

Mon., Nov. 9 Air pollution health effects (Ilona Jaspers)

Wed., Nov. 11 Inorganic PM, acid rain

Mon., Nov. 16 Air pollution health effects, Visibility, Regulation

???? Final Exam