ATMS/ENVR 326 - Spring 2023

Air Pollution Formation and Impacts

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Course Description: We often talk about air pollution as though it is a single hazard, but there is great diversity in air pollutants. Some are emitted directly from cars and power plants, while others are formed in the atmosphere. Some air pollutants exist as gases, while others are tiny particulates that, when inhaled, can lead to heart and respiratory disease.

In this course, we will learn the formation processes of major air pollutants and how they negatively impact the environment, including public health. Along the way, we will encounter the US Clean Air Act, see exactly how CFCs created the ozone "hole," and discover how climate change will likely make air pollution worse.

A basic understanding of chemistry and physics will be helpful, but is not required for this course.

Prerequisite: ATMS 103, ATMS 113, or ENVR 130
Credit Hours: 3

Class Meetings: M and W – 12:30 to 1:45 p.m. – 014 Zeis Hall

Online Course Site: classroom.google.com, Class Code: jjbigzb

Required Texts

1. Jacobson, M. (2012). *Air Pollution and Global Warming: History, Science, and Solutions* (2nd ed.). New York, NY: Cambridge University Press. ISBN: 978-1-107-69115-5.

2. Other assigned readings will correspond to weekly topics. These readings will be posted on Google Classroom.

Student Learning Outcomes

By participating in class, engaging with course materials, and asking lots of questions, you will:

1. understand how air pollution adversely affects human health;
2. describe the characteristics of air pollution formation, including photochemical chemical mechanisms and aerosol growth;
3. trace the evolution of air pollution management, including major provisions in the Clean Air Act and other important US regulatory efforts;
4. explain the causes of and solutions to air pollution challenges, including acid rain and stratospheric ozone depletion.

Assignments (100 points total)

1. Problem Sets (45 points): Three problem sets will be assigned throughout the semester. They will require you to answer questions using what you have learned in class and from the assigned reading. Each problem set is due at the start of class on the day listed in the Course Calendar. I encourage you to collaborate on the problem sets because group problem solving can lead to a greater understanding of the course material. If you work together, follow these guidelines:

    - Include the names of all students that worked together on your paper.
    - The work you submit must be your own. That is, explanations must be written in your own words and diagrams must be your own creation.
    - Your work should reflect your understanding of the problem. If you turn in a complete answer - because, say, you worked with someone who understood the problem - you are signaling to me that you understand all aspects of the answer. If you do not, the answer you turned in is somebody else's, and that is a violation of the University's Policy on Academic Misconduct.
    - Take these opportunities to learn from each other. The class's collective knowledge is greater than any individual's. Be assertive when you don't understand something; ask "how" and "why" often.

2. Midterm Exam (30 points): Your midterm exam is closed-book, but you may bring one sheet of handwritten notes. The midterm will take place during one of our regularly scheduled class periods (**Wednesday, March 1**).

3. Air Quality Trends Project (25 points): You will work with a small group of students to analyze recent air pollution measurements in North Carolina. Details will be provided in class, but some of your tasks will include acquiring ambient monitoring data, comparing pollutant concentration levels for several years, graphing air pollution trends, and presenting your findings to the class. You will present your data analysis during the final exam period (**Monday, May 1**).

Grading Policy

	B+ 88-89	C+ 78-79	D+ 68-69	F <60
A 92-100	B 82-87	C 72-77	D 62-67	
A- 90-91	B- 80-81	C- 70-71	D- 60-61	

Expectations

1. Attendance: Active engagement during class is critical to your success. Preparation for class is essential to your ability to be fully engaged. I expect you to come to class, but I understand there may be times when you are absent. If you miss class (for whatever reason), you are still responsible for the material we cover.

2. Readings: All readings are to be done before class on the day that reading will be discussed. The assigned readings are underlined in the Course Calendar below.

3. Academic Honesty: You signed up for this class because the course description sounded interesting, and I am excited that you want to learn more about air pollution! Learning, though, can be hard work, and there are no short cuts. Plagiarism, cheating, and other forms of academic dishonesty are disrespectful and carry strict consequences from failing an assignment to failing the class. The Center for Teaching and Learning has a guide on plagiarism (https://ctl.unca.edu/resources/plagiarism/). Additionally, the 2018-2019 UNC Asheville Catalog (http://catalog.unca.edu/) says the following about academic honesty in the Academic Policies and Procedures section:

   > As a community of scholars dedicated to learning and the pursuit of knowledge, UNC Asheville relies on the honesty and academic integrity of all the members of its community. Any act of plagiarism, cheating, or use of unauthorized materials or assistance is academic dishonesty. A person who knowingly assists another in academic dishonesty is likewise guilty of dishonesty. According to the instructor's view of the gravity of the offense and the instructor's syllabus policy, a student may be punished by a failing grade or a grade of zero for the assignment or test, or a failing grade in the course. The faculty member may also require that the student complete additional sanctions, such as the completion of an online course on plagiarism or resubmission of the original assignment.

4. Ask Questions: Lots of them. Become curious, and satisfy that feeling.

Course Calendar

Week 1 **Atmospheric Basics**

Jan 9 · Introduction (syllabus, Google Classroom)

Jan 11 · atmospheric structure
· Jacobson pp xvii-xviii, 1-3, 45-52

Week 2 **More Atmosphere Basics**

Jan 16 NO CLASS - MLK Jr. Day

Jan 18 · atmospheric composition
· Jacobson pp 55-71, skip 3.6.2.3

Week 3 **Urban Air Pollution**

Jan 23 · important air pollutants
· air pollution history
· hand out Problem Set 1
· Jacobson pp 73-84

Jan 25 · air pollution history (cont.)

Week 4 **O_3 Chemistry**

Jan 30 · begin photochemistry and O_3 formation
· Jacobson pp 85-88

Feb 1 · O_3 formation from basic compounds
· Jacobson pp 85-88 (yes, again)

Week 5 **O_3 Formation from Volatile Organic Compounds**

Feb 6 · photochemical smog **Problem Set 1**
· Jacobson pp 88-92

Feb 8 · alkanes, alkenes, aromatics, terpenes, alcohols
· Jacobson pp 93-99

Week 6 **O_3 Chemistry in the Real World**

Feb 13 · hands-on modeling O_3 formation
· hand out Problem Set 2

Feb 15 · Houston's O_3 problem
· Couzo et al. (2013), "Houston's rapid ozone increases: preconditions and geographic origins"

Week 7	**Particle Pollution**	
Feb 20	· aerosol types and emissions · Jacobson pp 101-111	
Feb 22	· aerosol growth/removal processes · Jacobson pp 119-124	
Week 8	**Particulate Control**	
Feb 27	· pollution control technology	**Problem Set 2**
Mar 1	you'll be fine...	**MIDTERM EXAM**
Week 9	**Spring Break**	
Mar 6	NO CLASS	
Mar 8	NO CLASS	
Week 10	**Covid-19 and Aerosols | O_3 Modeling**	
Mar 13	· viral spread through aerosols · 0-dimensional box modeling	
Mar 15	guest lecture from Savannah Bindas (UNCA alumna)	
Week 11	**Air Pollution Disasters**	
Mar 20	· history and chemistry of acidic air pollution · cap-and-trade · Jacobson pp 221-228	
Mar 22	· stratospheric O_3 depletion · the Chapman Cycle · hand out Problem Set 3 · Jacobson pp 237-242 (just finish Chapman Cycle), 243-245 (section 11.4)	
Week 12	**Air Pollution Regulations**	
Mar 27	· CFCs and O_3 depletion · UNEP's Ozzy Ozone · Jacobson pp 245-261	

Mar 29	· National Ambient Air Quality Standards · ambient monitoring networks	**Problem Set 3**

Week 13 **The Clean Air Act**

Apr 3 The Clean Air Act and regulatory mechanisms
· Jacobson pp 175-184, through section 8.1.11

Apr 5 pollutant trends, CAA successes
· Jacobson 183-189, through section 8.1.16

Week 14 **Wild Fires | Indoor Air Pollution**

Apr 10 (possible guest lecture)

Apr 12 · indoor pollutants
· Jacobson 207-217
· World Health Organization "Household Air Pollution"
https://www.who.int/news-room/fact-sheets/detail/household-air-pollution-and-health

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Week 15 **Air Quality and Climate Change**

Apr 17 · the climate penalty
· guest lecture from Dr. Fernando Garcia Menendez (NC State University)

Apr 19 · work on AQ Trends project

Week 16 **Air Quality Trend Presentations**

Apr 24 · VOCs from the cannabis industry

Final Exam **Monday, May 1, 11:30 a.m. - 2:00 p.m.**

Accommodations for Students with Disabilities: University of North Carolina at Asheville is committed to making courses, programs and activities accessible to persons with documented disabilities. Students requesting accommodations and/or academic adjustments must do so through the Office of Academic Accessibility and may be required to provide supporting documentation. All information provided will remain confidential. For more information please contact the Office of Academic Accessibility at 828.232.5050 or academicaccess@unca.edu, visit them in the OneStop Student Services Center or at their website https://oaa.unca.edu/.

Promoting Gender Equity, Addressing Sexual Misconduct: UNC Asheville is dedicated to cultivating and maintaining a safe, respectful, and inclusive environment, free from harassment and discrimination. We strive to ensure that all have equal access to the educational and employment opportunities the University provides. If you or someone you know has been affected by sexual misconduct, including sexual or gender-based harassment, sexual assault, dating or domestic violence, or stalking, please know that help and support are available. UNC Asheville strongly encourages all members of the community to take action, seek support, and report incidents of sexual harassment to the Title IX Office. You may contact the Title IX Office or Heather Lindkvist, the Title IX Coordinator, directly at 828.232.5658 or at titleix@unca.edu. Learn more by visiting https://titleix.unca.edu.

As a faculty member, I am a "responsible employee" and private resource. This means that if you share any information or discuss an incident with me regarding sexual or gender-based harassment, I must disclose this information to the Title IX Coordinator. Our goal is to ensure you are aware of the range of options available to you and have access to the resources you may need.

If you wish to speak with a confidential resource, contact University Health and Counseling Services at 828.251.6520. Off-campus confidential resources include Our Voice (24-Hour Hotline at 828.255.7576) and HelpMate (24-Hour Hotline at 828.254.0516).

University Academic Policies and Procedures: Students are expected to abide by UNC Asheville academic policies and procedures, especially those regarding academic honesty and in-class behavior. They can be summarized as don't cheat and come to learn. See http://catalog.unca.edu/ for the exact wording of the policy.