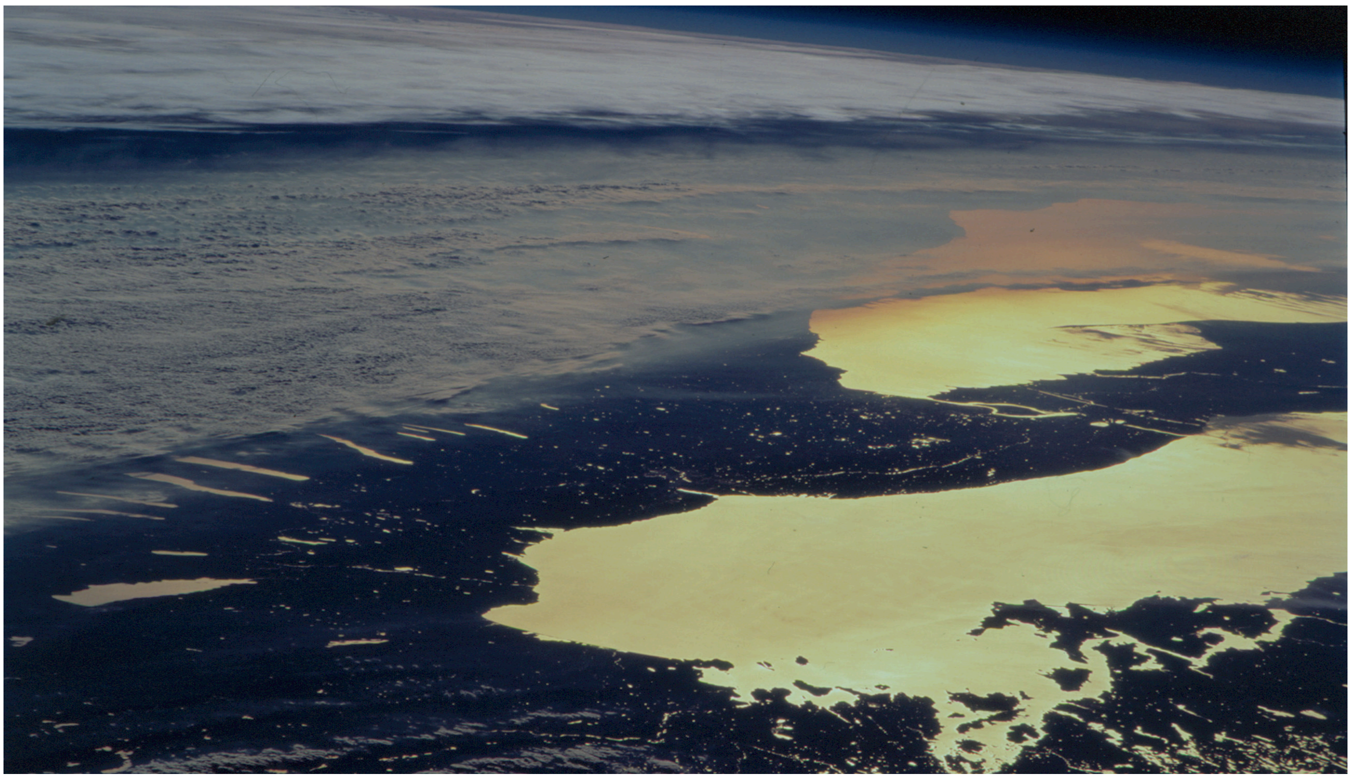
DEPT. OF EARTH & ENVIRONMENTAL SCIENCES, UNIVERSITY OF ROCHESTER

Introduction to Atmospheric Chemistry

EES 218



Pollution plume at sunset over Western New York viewed from Space Shuttle Discovery, Oct. 21, 2000.

Spring 2023

Syllabus

Last Updated: January 24, 2023

Contents

1 Overview

Course Location: Harkness Hall 210
Course Time: Tu/Th 11:05 AM-12:20 PM

Recitation Location: Hylan Hall 102
Recitation Time: W 11:50 AM-1:05 PM

Instructor: Prof. Lee T. Murray
E-mail: lee.murray@rochester.edu
Office Location: Hutchison Hall 479
Office Hours: Tu 12:30-1:30 PM, or by appointment

Teaching Assistant: Matthew Loman
E-mail: mloman@ur.rochester.edu
Office Hours: Th 12:30-1:30 PM, or by appointment
Office Location: Hutchison Hall 130B

1.1 Description

The atmosphere helps to maintain habitable temperatures on our planet's surface, shields life from destructive cosmic and ultraviolet radiation and contains gases such as oxygen and carbon dioxide, which are essential for life. In this course we will work toward an understanding of several important questions. What is in the Earth's atmosphere? What are the sources and sinks of the most important gases in the atmosphere? How does the atmosphere affect the Earth's surface climate? What is the role of photochemistry in atmospheric composition? How does the atmosphere interact with the land and oceans? How has human activity affected the atmosphere?

1.2 Pre-requisites

Required, unless granted permission by instructor:

- EES 101 (Intro. to Geology), EES 103 (Intro. to Environmental Sci.), or EES 105 (Intro. to Climate Change) or equivalent
- CHM 131 (Intro. College Chemistry I) or equivalent
- MTH 141-142 (Calculus I and II) or equivalent

Recommended, but not required:

- EES 236 (Intro. Atmospheric Physics) or equivalent
- CHM 132 (Intro. College Chemistry II) or equivalent

Permission of instructor is required for majors other than GEO, EVS and ESP.

1.3 Main Learning Goals

By the end of the course, students will understand:

- The composition of the modern atmosphere
- The basics of atmospheric structure and circulation
- The concepts of sink, source, and lifetime, and be able to make and use simple box models to describe changes in atmospheric composition
- The atmospheric budgets of the most important trace gases
- The dominant processes and chemical reactions in the stratosphere
- The dominant processes and chemical reactions in the troposphere
- The stratospheric ozone loss problem
- Major surface air-quality issues and their associated control strategies
- Earth's radiative energy budget and how the greenhouse effect works
- The sources and sinks of aerosol particles and how they affect climate
- The coupling between air quality and climate change

2 SCHEDULE

Below is the tentative class schedule, with topics for each class, associated readings, and problem set due dates. Schedule subject to change pending course progress.

Required reading assignments in **bold**. Supplemental or alternative readings in *italics*.

There is no password for the *Jacob* (1999) text. The password for the *Jacob* (2023) text is “atmchem”.

TUESDAY	THURSDAY
Jan 10th	12th **1** **Introduction and Overview** Key Topics 1. History and evolution of Earth’s atmospheric composition Reading • **Syllabus** • ***Jacob* (2023) §5.2** • ***Zahnle et al.* (2010)** • *Jacobson* (2012) §2 • *Seinfeld and Pandis* (2016) §1.1 Note: Held Tu Jan 17 @ 11:05 in Harkness 210
17th **2** **Fundamentals: Pressure and Temperature** Key Topics 1. Atmospheric pressure and density 2. Equation of state (Ideal Gas Law) 3. Changes of pressure with altitude (Barometric Law) 4. Temperature structure Reading • ***Jacob* (2023) §2** • *Jacobson* (2012) §3.1-3.4 • *Seinfeld and Pandis* (2016) §1.1-1.5 Note: Held W Jan 18 @ 11:50 over Zoom	19th **3** **Fundamentals: Composition** Key Topics 1. Measures of abundance: mixing ratio, number density, and partial pressure 2. Composition of the present-day atmosphere Reading • ***Jacob* (2023) §1** • *Jacobson* (2012) §1.3, 3.5-3.6 • *Seinfeld and Pandis* (2016) §1.6-1.8 Note: Held Th Jan 19 @ 11:05 over Zoom

Tuesday	Thursday
24th **4** **Fundamentals: Mathematical Models** Key Topics 1. Simple box models, budgets, and lifetime 2. Steady-state assumptions 3. Solution to the first-order loss problem 4. Continuity equation 5. Multi-box models Reading • ***Jacob* (2023) §3**	26th **5** **Fundamentals: Chemical Kinetics** Key Topics 1. Photodissociation 2. Bi- and termolecular reaction rates 3. Equilibrium 4. Chemical families 5. Isotope fractionation Reading • ***Jacob* (1999) §9** • *Jacobson* (2012) §1.4-1.5 • *Seinfeld and Pandis* (2016) §3.1-3.6, 4.5 • *Burkholder et al.* (2015) §1.1, 2.1-2.6, 3.1-3.2, 4.1-4.2 **PS1 Out**
31st **6** **Biogeochemical Cycles: Oxygen and Nitrogen** Key Topics 1. Global oxygen budget 2. Global nitrogen budget Reading • ***Jacob* (1999) §6.1-6.4** • *Jacobson* (2012) §2.3 • *Kerr* (2005) • *Kump* (2008) • *Seinfeld and Pandis* (2016) §2.3	Feb 2nd **7** **Biogeochemical Cycles: Carbon** Key Topics 1. Global carbon budget 2. Carbon uptake by ocean 3. Carbonate chemistry Reading • ***Jacob* (1999) §6.5** • *Seinfeld and Pandis* (2016) §22.2 **PS1 Due at 7 PM; PS2 Out**
7th **8** **Stratospheric Chemistry: Chapman Mechanism** Key Topics 1. Stratospheric ozone formation Reading • ***Jacob* (1999) §10.1** • *Jacobson* (2012) §11.1-11.3.1 • *Seinfeld and Pandis* (2016) §5.1 • *Chapman* (1929)	9th **9** **Stratospheric Chemistry: Catalytic Loss Cycles** Key Topics 1. HO_x cycles 2. NO_x cycles 3. Halogen cycles 4. Stratospheric ozone depletion Reading • ***Jacob* (1999) §10.2** • *Jacobson* (2012) §11.3.2-11.6 • *Seinfeld and Pandis* (2016) §5.2, 5.3, 5.4.1 • *WMO* (2014) **PS2 Due at 7 PM; PS3 Out**

TUESDAY	THURSDAY
14th **10** **Stratospheric Chemistry: Heterogeneous Processes** Key Topics 1. Polar stratospheric clouds (PSCs) 2. Antarctic ozone hole 3. Volcanic aerosols and geoengineering Reading • ***Jacob* (1999) §10.3-10.4** • *Jacobson* (2012) §11.7-11.9 • *Seinfeld and Pandis* (2016) §5.6-5.8	16th **11** **Tropospheric Chemistry: Background Photochemistry** Key Topics 1. Photostationary state (NO, NO_2, O_3) 2. OH production and budget 3. HO_x and NO_x in the troposphere 4. CO oxidation and production of ozone 5. Tropospheric ozone budget Reading • ***Jacob* (1999) §11.1, 11.3-11.3.2, 11.4-11.5** • *Jacobson* (2012) §4.1-4.2.1 • *Seinfeld and Pandis* (2016) §6.1-6.3, 6.6 **PS3 Due at 7 PM; PS4 Out**
21st **12** **Tropospheric Chemistry: Oxidized Nitrogen** Key Topics 1. NO_x budget: sources, sinks, and trends 2. Daytime NO_x chemistry 3. Nighttime NO_x chemistry 4. Reservoir species (NO_y) Reading • ***Jacob* (1999) §11.4** • *Jacobson* (2012) §4.2.2-4.2.3, 4.2.8 • *Seinfeld and Pandis* (2016) §6.5, 6.10-6.11	23rd **13** **Tropospheric Chemistry: Reduced Carbon** Key Topics 1. CO budget: sources, sinks, and trends 2. CH_4 budget: sources, sinks, and trends 3. Non-methane VOCs (isoprene, monoterpenes) Reading • ***Jacob* (1999) §11.2, 11.3.3** • *Jacobson* (2012) §4.2.4-4.2.7 • *Seinfeld and Pandis* (2016) §6.4, 6.10-6.11 **PS4 Due at 7 PM**
28th **14** **Tropospheric Chemistry: Aerosol Particles I** 1. Particle composition, size distributions and morphology 2. Physiochemical properties of aerosol particles Reading • ***Zhang et al.* (2022) §1-2.2, 3** • *Jacobson* (2012) §5.1-5.5	Mar 2nd **15** **Tropospheric Chemistry: Aerosol Particles II** 1. Growth and partitioning of organic aerosol particles 2. Multiphase and heterogeneous reactions Reading • ***Zhang et al.* (2022) §4-5** • *Jacobson* (2012) §5.1-5.5 **PS5 Due at 7 PM; PS6 Out**
7th **Spring Break**	9th **Spring Break**

TUESDAY	THURSDAY
14th **16** **Tropospheric Chemistry: Halogens** 1. Chlorine 2. Bromine 3. Iodine Reading • ***Wang et al.* (2021)**	16th **17** **Air Pollution: Particulate Matter** Key Topics 1. Human health effects of aerosol particles 2. Aerosol particles and urban air pollution 3. Acid rain impacts, chemistry, and physics 4. Atmospheric fertilization: eutrophication and stresses Reading • ***Zhang et al.* (2022) §6.3-6.7** • ***Jacob* (1999) §13** • ***Gruber and Galloway* (2008)** • *Jacobson* (2012) §10 • *Seinfeld and Pandis* (2016) §20.5-20.6 • *Bowman et al.* (2008) **PS6 Due at 7 PM**
21st **18** **Air Pollution: Photochemical Smog** Key Topics 1. Surface ozone pollution: impacts 2. Urban O_3 pollution chemistry 3. NO_x- vs. VOC-limited regimes Reading • ***Jacob* (1999) §12** • *Jacobson* (2012) §4.3-4.5 • *Seinfeld and Pandis* (2016) §6.4, 6.10-6.11 • *Sillman* (2002) • *National Research Council Committee on Tropospheric Ozone* (1991)	23rd **Midterm** **In Class** **PS7 Out**
28th **19** **Air Pollution: Heavy Metals and Persistents** Key Topics 1. Lead: Impacts and global budget 2. Mercury: Impacts, budget and chemistry 3. Persistent organic pollutants (POPs) 4. Perfluoroalkyl and polyfluoroalkyl substances (PFAS) Readings • ***Riva et al.* (2012)** • ***Selin* (2009)** • ***UNEP/AMAP* (2011)** §1-3, 7 • ***Chambers et al.* (2021)** • *Gaffney and Marley* (2014)	30th **20** **Air Pollution: Impact of Meteorology** Key Topics 1. Forces, winds and global circulation 2. Vertical pollutant transport 3. Horizontal pollutant transport Reading • ***Jacob* (2023) §4** • *Jacobson* (2012) §6 • *Seinfeld and Pandis* (2016) §16, 21 **PS7 Due at 7 PM; PS8 Out**

<table>
<tr><th>Tuesday</th><th>Thursday</th></tr>
<tr><td>Apr 4th 21
Air Pollution: Indoor Air Quality
1. Photochemical pollutants
2. Carbon monoxide
3. Radon
4. Asbestos
Reading
• Tran et al. (2020)
• Tham (2016)
• Jacobson (2012) §9</td>
<td>6th 22
Atmospheric Radiation: Shortwave
Key Topics
1. Solar radiation spectrum
2. Atmospheric scattering of radiation
3. Visibility
4. Colors in the atmosphere
Reading
• Jacob (1999) §8.2
• Jacobson (2012) §7
PS8 Due at 7 PM; PS9 Out</td></tr>
<tr><td>11th 23
Atmospheric Radiation: Longwave
Key Topics
1. Atmospheric absorption of radiation
2. Black body radiation (Planck's Law)
3. Earth's radiative balance and effective temperature
4. The greenhouse effect
Reading
• Jacob (1999) §7.1-7.3
• Jacobson (2012) §12.1-12.2</td>
<td>13th 24
Chemistry-Climate Interactions: Chemical Forcing of Climate
Key Topics
1. Radiative forcing
2. Global warming potential (GWP)
3. Global temperature potential (GTP)
4. Climate feedbacks
5. Forcing agents
Reading
• IPCC (2021) §6.1-6.4, §7 Exec. Summ.
• Jacob (1999) §7.4-7.6
• Zhang et al. (2022) §6.2
• Jacobson (2012) §12.3-12.7
PS9 Due at 7 PM; PS10 Out</td></tr>
<tr><td>18th 25
Chemistry-Climate Interactions: Climate Forcing of Chemistry
Key Topics
1. Anticipated future emissions
2. Changing chemical regimes and air-quality "climate penalties"
3. Mitigation strategies
4. The future of air pollution
Reading
• IPCC (2021) §4 Exec. Summ., §6.5-6.8
• Jacob and Winner (2009)
• Shindell et al. (2012)
• Seinfeld and Pandis (2016) §23.10
• Fiore et al. (2012, 2015)</td>
<td>20th 26
Air Quality Policy: Regulations
Key Topics
1. Regulation in the United States (the Clean Air Act and its Amendments)
2. Regulation and pollution trends elsewhere in the world
3. International treaties
Reading
• Kuklinska et al. (2015)
• OECD (2017) (Air Pollution Sections)
• Jacobson (2012) §8</td></tr>
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TUESDAY	THURSDAY
25th **27** **Air Quality Policy: Technology** Key Topics 1. Atmospheric measurement techniques 2. Pollution control technologies 3. Clean, low-risk, sustainable energy systems Reading • ***MJ Bradley & Associates* (2005)** • *Heard* (2006) • *Jacobson* (2012) §13 **PS10 Due at 7 PM**	27th **Reading Period**
May 2nd **28** **Final Exam Date TBD by Registrar**	4th **29**

2.1 Recitation

In addition to lectures, there will be a 1-hr recitation session held each week, in which the TA will go over example problems similar to the homework and exams, and answer any questions from the class.

3 Readings

3.1 Required

Book

IPCC (2021), *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, 2391 pp., Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, doi:10.1017/9781009157896.

Jacob, D. J. (1999), *Introduction to Atmospheric Chemistry*, 1st ed., Princeton University Press, Princeton, NJ, `https://acmg.seas.harvard.edu/education/introduction-atmospheric-chemistry`.

Jacob, D. J. (2023), *Introduction to Atmospheric Chemistry*, 2nd ed., `https://acmg.seas.harvard.edu/education/2nd-edition`.

Zhang, Y., P. Liu, Y. Han, Y. Li, Q. Chen, M. Kuwata, and S. T. Martin (2022), *Aerosols in Atmospheric Chemistry*, American Chemical Society, Washington, DC, USA, doi:10.1021/acsinfocus.7e5020.

Articles and Excerpts

Chambers, W., J. Hopkins, and S. Richards (2021), A review of per- and polyfluorinated alkyl substance impairment of reproduction., *Front Toxicol*, *3*, 732,436, doi:10.3389/ftox.2021.732436.

Gruber, N., and J. N. Galloway (2008), An Earth-system perspective of the global nitrogen cycle, *Nature*, *451*(7176), 293–296, doi:10.1038/nature06592.

Jacob, D. J., and D. A. Winner (2009), Effect of climate change on air quality, *Atmos Environ*, *43*(1), 51–63, doi:10.1016/j.atmosenv.2008.09.051.

Kuklinska, K., L. Wolska, and J. Namiesnik (2015), Air quality policy in the U.S. and the EU – a review, *Atmos Poll Res*, *6*(1), 129–137, doi:10.5094/APR.2015.015.

MJ Bradley & Associates (2005), Best Available Technology for Air Pollution Control: Analysis Guidance and Case Studies for North America , *Tech. rep.*, Manchester, NH, http://www3.cec.org/islandora/en/item/2195-best-available-technology-air-pollution-control/.

Riva, M., A. Lafranconi, M. D'Orso, and G. Cesana (2012), Lead poisoning: historical aspects of a paradigmatic occupational and environmental disease., *Saf Health Work*, *3*(1), 11–16, doi:10.5491/SHAW.2012.3.1.11.

Selin, N. E. (2009), Global Biogeochemical Cycling of Mercury: A Review, *Annu Rev Env Resour*, *34*(1), 43–63, doi:10.1146/annurev.environ.051308.084314.

Tran, V., D. Park, and Y. Lee (2020), Indoor air pollution, related human diseases, and recent trends in the control and improvement of indoor air quality., *Int J Environ Res Public Health*, *17*(8), 2927, doi:10.3390/ijerph17082927.

UNEP/AMAP (2011), *Climate Change and POPs: Predicting the Impacts*, 62 pp., Report of the UNEP/AMAP Expert Group. Secretariat of the Stockholm Convention, Geneva, https://www.amap.no/documents/doc/climate-change-and-pops-predicting-the-impacts/753.

Wang, X., et al. (2021), Global tropospheric halogen (Cl, Br, I) chemistry and its impact on oxidants, *Atmospheric Chemistry and Physics*, *21*(18), 13,973–13,996, doi:10.5194/acp-21-13973-2021.

Zahnle, K., L. Schaefer, and B. Fegley (2010), Earths earliest atmospheres., *Cold Spring Harb Perspect Biol*, *2*(10), a004,895, doi:10.1101/cshperspect.a004895.

Zhang, Y., P. Liu, Y. Han, Y. Li, Q. Chen, M. Kuwata, and S. T. Martin (2022), *Aerosols in Atmospheric Chemistry*, American Chemical Society, Washington, DC, USA, doi:10.1021/acsinfocus.7e5020.

3.2 Supplemental

Books

Heard, D. E. (Ed.) (2006), *Analytical Techniques for Atmospheric Measurement*, Blackwell Publishing, Oxford, UK, doi:10.1002/9780470988510.

Jacobson, M. Z. (2012), *Air Pollution and Global Warming: History, Science, and Solutions*, 2 ed., Cambridge University Press, Cambridge, doi:10.1017/CBO9781139109444.

OECD (2017), *Best Available Techniques (BAT) to Prevent and Control Industrial Pollution: Policies on BAT or similar concepts Across the World*, vol. OECD Environment, Health and Safety Publications Series on Risk Management, Organisation for Economic Cooperation and Development, Paris, https://www.oecd.org/chemicalsafety/risk-management/policies-on-best-available-techniques-or-similar-concepts-around-the-world.pdf.

Seinfeld, J. H., and S. N. Pandis (2016), *Atmospheric Chemistry and Physics: From Air Pollution to Climate Change*, 1152 pp., Wiley, Hoboken, NJ, https://ebookcentral.proquest.com/lib/rochester/detail.action?docID=4462549.

Zhang, Y., P. Liu, Y. Han, Y. Li, Q. Chen, M. Kuwata, and S. T. Martin (2022), *Aerosols in Atmospheric Chemistry*, American Chemical Society, Washington, DC, USA, doi:10.1021/acsinfocus.7e5020.

ARTICLES

Bowman, W. D., C. C. Cleveland, Ĺ. Halada, J. Hreško, and J. S. Baron (2008), Negative impact of nitrogen deposition on soil buffering capacity, *Nat Geosci*, *1*(11), 767–770, doi:10.1038/ngeo339.

Burkholder, J. B., et al. (2015), Chemical Kinetics and Photochemical Data for Use in Atmospheric Studies: Evaluation Number 18, *Tech. Rep. JPL Publication 15-10*, Jet Propulsion Laboratory, Pasadena, CA, https://jpldataeval.jpl.nasa.gov/pdf/JPL_Publication_15-10.pdf.

Chapman, S. (1929), A theory of upper-atmospheric ozone, *Memoirs of the Royal Meteorological Society*, *3*(26), 103–125.

Fiore, A. M., et al. (2012), Global air quality and climate, *Chem Soc Rev*, *41*(19), 6663–6683, doi:10.1039/c2cs35095e.

Fiore, A. M., V. Naik, and E. M. Leibensperger (2015), Air Quality and Climate Connections, *JAPCA J Air Waste Ma*, *65*(6), 645–685, doi:10.1080/10962247.2015.1040526.

Gaffney, J., and N. Marley (2014), In-depth review of atmospheric mercury: sources, transformations, and potential sinks, *Energy and Emission Control Technologies*, p. 1, doi:10.2147/eect.s37038.

Kerr, R. A. (2005), The Story of O_2, *Science*, *308*(5729), 1730–1732, doi:10.1126/science.308.5729.1730.

Kump, L. R. (2008), The rise of atmospheric oxygen, *Nature*, *451*(7176), 277–278, doi:10.1038/nature06587.

National Research Council Committee on Tropospheric Ozone (1991), *Rethinking the Ozone Problem in Urban and Regional Air Pollution*, National Academy Press, Washington, DC, doi:10.17226/1889.

Seinfeld, J. H., and S. N. Pandis (2016), *Atmospheric Chemistry and Physics: From Air Pollution to Climate Change*, 1152 pp., Wiley, Hoboken, NJ, https://ebookcentral.proquest.com/lib/rochester/detail.action?docID=4462549.

Shindell, D. T., et al. (2012), Simultaneously mitigating near-term climate change and improving human health and food security., *Science*, *335*(6065), 183–189, doi:10.1126/science.1210026.

Sillman, S. (2002), Chapter 12 The relation between ozone, NO_x and hydrocarbons in urban and polluted rural environments, in *Air Pollution Science for the 21st Century*, pp. 339–385, Elsevier, doi:10.1016/S1474-8177(02)80015-8.

Tham, K. W. (2016), Indoor air quality and its effects on humans—A review of challenges and developments in the last 30 years, *Energy and Buildings*, *130*, 637–650, doi:10.1016/j.enbuild.2016.08.071.

WMO (2014), Scientific Assessment of Ozone Depletion: 2014, *Tech. Rep. Report No. 55*, Geneva, Switzerland.

4 Grading

Your final grade will be calculated with the following breakdown

Problem Sets:	40 %
Midterm:	20 %
Final Exam:	25 %
Quizzes:	10 %
Participation:	5 %
Total:	100 %

4.1 Problem Sets

The aim of the problem sets is to help you learn the course concepts. **Working together with your classmates is thus strongly encouraged**, although problem sets should always be solved and written up individually. **If you collaborate, write who you worked with on your submission**.

Show all work, explaining in sufficient detail how you arrived at the answer. Describe the rational behind each step using language like "Convert from kg to molecules" or "Apply the hypsometric equation to determine layer thickness." Partial credit for ultimately wrong answers will be assigned based on work shown. **A correct answer with no work shown earns no credit.** A numerical answer without units is incorrect.

Problem sets are due to Gradescope at 7 PM on the day indicated. After that, 10% is deducted off the possible total score for each day late. No credit is given after one week late.

Your lowest problem set score will be dropped from your final grade calculation. You may use this at your discretion as a free pass for a busy week or to try to maximize your mean problem set grade.

No exceptions to the late policy will be accepted, except with a medical note or request via the disabilities office.

4.2 Exams

All exams will be comprised of a multiple-choice section, a short-answer section, and a longer quantitative problem section.

4.2.1 Midterm

There will be one midterm exam administered in class, which will test qualitative content from Lectures 1-18 and quantitative questions derived from Problem Sets 1-6.

4.2.2 Final

There will be one comprehensive final exam. The final will contain content from throughout the course, with a greater emphasis on the second half. Quantitative questions will be derived from the Problem Sets.

4.3 Quizzes

At the end of each class, there will be a short quiz on the main concepts covered by the reading and/or lecture. Please bring calculators to class to use for in-class problems. Unexcused absences will result in a zero on that day's quiz. Quizzes on days of an excused absence (see below) will have zero weight in final quiz grade.

4.4 Participation

The participation score will reflect the following activities:

1. Attendance to class as reflected by quiz participation, and attendance to recitation. I must be informed via e-mail of any absences ahead of time. Illness, other educational/research experiences, and observance of religious holidays are examples of excusable absences.

2. General participation: e.g., by asking or answering questions during class, and/or by asking questions during office hours.

5 Classroom Policies

5.1 Diversity and Inclusion

This class is an inclusive and welcoming learning environment for all students regardless of background or ability, consistent with University policy, state and federal laws and the instructors' personal beliefs. Students must respect the different experiences, identities, beliefs and values expressed by their peers, and refrain from derogatory comments about other individuals, cultures, groups, or viewpoints.

Please make sure that I am pronouncing your name correctly, and let me know if you have any preferred nicknames and/or pronouns that you would like me to use.

In the event you encounter any barrier(s) to full participation in this course due to the impact of a disability, please contact the Office of Disability Resources. The access coordinators in the Office of Disability Resources can meet with you to discuss the barriers you are experiencing and explain the eligibility process for establishing academic accommodations. You can reach the Office of Disability Resources at: disability@rochester.edu; (585) 276-5075; Taylor Hall; `http://www.rochester.edu/college/disability`.

5.2 COVID-19

You are expected to adhere to all University policies regarding the COVID-19 pandemic (vaccination, masking, distancing, staying home if you have any symptoms, etc.). Please make sure you stay up to date on these policies, as they continually evolve.

Given the extraordinary circumstances of the ongoing COVID-19 pandemic, I acknowledge that students may be subject to a host of pressures and difficulties that will make learning this semester difficult. I encourage you to meet with me about any concern or situation that affects your ability to complete your academic work successfully.

5.3 Electronic Devices

Cell phones must be silenced. You may use a laptop or tablet to take notes. Mobile devices and laptops may also be used for prepared active learning activities. However, they should not be used for anything else during class. If a peer tells me your actions on your laptop are distracting during a lecture, you will lose the privilege.

6 Academic Honesty

All assignments and activities associated with this course must be performed in accordance with the University of Rochester's Academic Honesty Policy. A comprehensive description of the University of Rochester's Academic Honesty Policy is available at: `http://www.rochester.edu/college/honesty`. For this course, all exams and reports need to be completed individually, but I encourage collaboration on the problem sets.

7 Initial Meeting

I would like to learn about your background and goals, both for this course and for the future, to help tailor the semester to those interests. You are encouraged to schedule (via e-mail) a quick 5-minute meeting early in the semester. The meeting is entirely optional and will not impact your participation grade.

8 Feedback

I want you to get the most out of this class. Students are encouraged to offer feedback at any time about the course and my instruction to me in person, through e-mail to lee.murray@rochester.edu, or via an anonymous note placed in my departmental mailbox located in Hutchison Hall 227. At the end of the course, I would greatly appreciate if you were to fill out the course review.