AOS 2 offers an introduction to some of today’s most pressing environmental problems, such as the ozone hole, smog, climate change, etc., which are typically classified under the common term Air Pollution. Throughout the class, the different aspects of air pollution, their causes, effects, and possible solutions will be introduced.

This quarter’s AOS 2/2L course on the UCLA campus will be taught as both a hybrid online class (online lectures, on-ground discussion sections) and fully online for both UCLA and non-UCLA students. Discussion sections for the hybrid model will be held in-person, in a regular classroom. UCLA students taking the fully online version will enroll in special online discussion sections, while cross-campus-enrolled students will attend any of these online discussions but will not need to actually choose the specific discussion time.

Enrollment

UCLA students enroll in either conventional discussion sections or online discussion sessions, corresponding to “LEC 1” in the Schedule of Classes. Cross-campus students enroll in the online course through the UC Online cross-campus site and are sent to “LEC 2” and discussion section 2A at UCLA. They will not be presented with a choice of discussion times, but will simply attend any one of the online sections offered on Wednesdays at 2:30 and 8:00 pm or Thursday at 7:00 pm. Wait-listed students are not enrolled in the class and are not guaranteed enrollment. Wait-lists are erased after the second week of classes.

Please note that some of these sections may become full. There is no preferential enrollment; no PTEs will be issued for full sections. If you are dropped for any reason (usually a late fee payment), you will not be able to immediately re-enroll in a section that has a closed or wait-listed status. You will have to get on any open section or wait list; you will not be given preferential enrollment. This includes students dropped due to registrar/computer error or other administrative problems.

Online “lecture” content and “homework”: Access by logging in to our CCLE site via https://ccle.ucla.edu

Online lectures will consist of a series of short videos (or electronic slide modules), with each video having embedded quiz questions or followed by separate activities and quiz questions. This approach is intended to engage students with the material and thus improve the learning experience. To ensure progress, credit for completing content is closed according to the schedule appearing later in this syllabus. In some cases, the activities may need to be completed satisfactorily before students advance to the next instructional module. Viewing the videos and completing the activity questions accurately before the lessons close will earn completion points and contribute to the overall grade. Keeping a schedule is necessary so that everyone is at the same level during the discussion sections. It is strongly suggested that at the latest, lessons be attempted and completed during the week before they are scheduled to close. Leaving them until a few hours before they close puts you at risk of not being able to complete the lessons due to network congestion and technical difficulties.

Some of the between-lesson activities are labeled “homework assignments”. These include a mix of fill-in-the-blank, multiple-choice, and essay questions that combine recall and application of material in the preceding set of lessons, and carry somewhat higher point totals per assignment than the lesson activities.

Students who require accommodations due to physical disabilities should contact the UCLA Center for Accessible Education (or your local campus’ disabilities office) for access to specialized equipment that will enable you to use our CCLE website and the lesson videos. In lieu of closed-captioning of videos, transcripts of the audio track along with slide images are available for hearing-impaired students on request, and to all students after each lesson set closes.

Discussion sections

Discussion sections are conducted in-person (or online for cross-campus students) by teaching assistants. They will direct individual and group activities related to course material, and review the online lecture material as needed. Discussion sections WILL meet during Week 1 (April 1–5, 2019).

You must attend the section in which you enroll because of space restrictions and the way certain activities take place in the discussion sections (exception: attendance of the online discussion section). Please check your
Official Study List to ensure that you are attending the correct section, since you will not get credit if you attend the wrong section.

Students attending online discussion sections will access them via Zoom. See Dr. Lew’s online office hours information below for access information. You must have a webcam, microphone, speakers, and a good Internet connection. The Thursday online section is also the makeup discussion section for UCLA students who did not attend their Monday–Thursday discussion section during the week. No special permission is required to attend Thursday’s online section.

UCLA students who want the fully online experience must enroll in one of the online discussion sections. However, they may attend any of the scheduled online discussion sections in any week.

**In-person** (UCLA students)

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<thead>
<tr>
<th>Section</th>
<th>Day</th>
<th>Time</th>
<th>Location</th>
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<tbody>
<tr>
<td>1A</td>
<td>Monday</td>
<td>1:00–1:50 pm</td>
<td>MS 7124B</td>
</tr>
<tr>
<td>1B</td>
<td>Tuesday</td>
<td>10:00–10:50 am</td>
<td>MS 7124B</td>
</tr>
<tr>
<td>1C</td>
<td>Tuesday</td>
<td>1:00–1:50 pm</td>
<td>MS 7124B</td>
</tr>
<tr>
<td>1D</td>
<td>Tuesday</td>
<td>2:00–2:50 pm</td>
<td>MS 7124A</td>
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</tbody>
</table>

**Online** (UCLA and cross-campus students enrolled in Section 2A)

<table>
<thead>
<tr>
<th>Section</th>
<th>Day</th>
<th>Time</th>
<th>Location</th>
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<tbody>
<tr>
<td>1J</td>
<td>Wednesday</td>
<td>2:30–3:20 pm</td>
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<tr>
<td>1K</td>
<td>Wednesday</td>
<td>8:00–8:50 pm</td>
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<tr>
<td>1E</td>
<td>Thursday</td>
<td>7:00–7:50 pm</td>
<td>(online + makeup section)</td>
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Group activities completed during discussion section will be graded. Close interaction with fellow students and the teaching assistants to complete the activities is strongly encouraged.

**Discussion activities schedule by week (online section will be during the following week)**

1. Introduction (April 1–5)
2. Activity #1 (April 8–12)
3. Activity #2 (April 15–19)
4. Activity #3 (April 22–26)
5. Review for midterm (April 29–May 3)
6. No discussion, midterm (May 6–10)
7. Activity #4 (May 13–17)
8. Activity #5 (May 20–24)
9. No discussion, holiday (May 27–31)
10. Activity #6 (June 3–7)

**Laboratory section**

An optional lab section AOS 2L may be added upon enrollment in the AOS 2 lecture/discussion. This 1-unit section satisfies the “lab/demo” requirement for the General Education “Foundations of Scientific Inquiry”. This lab section does not have formal classroom meetings, since all assignments are posted and submitted online in our CCLE site for 2L. However, this lab section must be taken during the same quarter as the lecture/discussion. For cross-campus students, check your local campus approvals for degree credit and whether or not you need to enroll in this lab section (some of these data is in our course listing at https://crossenrollcourses.universityofcalifornia.edu).

**Instructional team**

Dr. Jeffrey Lew  
Math Science 1961  
310-825-3023  
lew@atmos.ucla.edu

Mr. Danny Leung  
Mr. Danny Leung@ucla.edu

Ms. Clara Si  
Ms. Clara Si@atmos.ucla.edu
Office hours

Dr. Lew

<table>
<thead>
<tr>
<th>Mon 2:15–4:30 pm, Tue/Thu 2:00–4:00 pm, or by appt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(these times are for both in-person and online office hours and are Pacific time zone)</td>
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</table>

*In-person: MS 1961*

*Online via Zoom: Meeting ID 882-261-6568* or from a web browser, [https://ucla.zoom.us/my/aosjefflew](https://ucla.zoom.us/my/aosjefflew)

Zoom is a web conference service that offers free accounts to all people. Information about installing client apps for various desktop/laptop computers and mobile devices are at [http://zoom.us/download](http://zoom.us/download)

UCLA students can log in and set up their account profile at [https://ucla.zoom.us](https://ucla.zoom.us) (UCLA students do not need to register a free account at [http://zoom.us](http://zoom.us); this will be done when you first log in at the ucla.zoom.us site, using your UCLA logon credentials). All others can register for a free account at [http://zoom.us](http://zoom.us)

Textbook (optional)

Jacobson, M.Z., *Air Pollution and Global Warming: History, Science, and Solutions*, 2nd ed. Available at the UCLA Store, various booksellers. Also on reserve at the UCLA College Library (Powell Hall) and as a free e-text through the UCLA Library.

Grades

Course grades are based on 1000 points earned from:

- Discussion section group activities: 120 points (12% of total grade)
- Online Lessons and Homework: 230 points (23% of total grade)
- Midterm examination: 250 points (25% of total grade)
- Final examination: 400 points (40% of total grade)

The optional lab section (2L) adds 200 points to this total. Students enrolled in the 2L lab section in addition to the regular course (2) will have a course grade computed from a percentage of the 1200 points earned during the quarter. These students will have the same final course grade posted on their transcripts for both 2 and 2L.

The course will be graded on a curve, following UCLA’s average undergraduate grade distribution. Generally, the B–/C+ cutoff occurs at around the class average, but this could change if the score distribution is unusually narrow or wide. Students who take the course “P/NP” will pass the course after earning 650 points or better, or with the equivalent of a “C” or better grade, whichever requires the lower minimum score.

Homework

We expect that students submit homework that represents what you as an individual would write, as if the assignment was given to you in an examination. It is permissible to consult with other students in the course or with tutors or instructors; however, it is not permissible for you to simply copy another student's answers, or text from another source (internet, books, etc.) and submit it as your own. It is also not permissible for other students to write up your homework assignment for you, unless this has been arranged through the Center for Accessible Education (CAE).

Examinations

- **Midterm** (through ozone hole) Monday, May 6, 2019, 6:00–7:15 pm (Haines 39)
- **Final** (cumulative) Thursday, June 13 2019, 6:30–9:30 pm (room TBA)

Cross-campus students will take an online version of the exams through ProctorU.com, an online service that monitors the examination process through a student’s webcam. There is a fee for using this service, and the student must provide an appropriate testing environment, computer equipment including webcam and microphone, and identification documents. See [www.proctoru.com](http://www.proctoru.com) for further information.

Examination Policies

1) There will be no makeup and no alternate-scheduled (i.e., “early”) exams, unless otherwise required by CAE and California Education Code Section 92640(a).
2) Students who normally require the assistance of CAE to take exams must consult with the instructor as soon as possible regarding test-taking procedures.

3) Examinations are multiple-choice, fill-in-the-blank, and short-essay. They include material from the lecture, homework, and the discussion sections.

4) Examinations are closed-book. Reference materials, such as notes, textbooks, and online course materials are prohibited.

5) To take the exam, you must present your photo identification, either student ID, driver's license, or passport.

**Laboratory Assignments (for students enrolled in 2L)**

The 1-unit 2L laboratory section is an optional add-on to the standard 4-unit course, essentially making this course into a 5-unit physical science GE course with lab/demo credit. Students who do not need the lab/demo credit because they have already satisfied or intend to satisfy it with a different 5-unit GE science course may opt to not enroll in the 2L section and instead earn only 4 units of credit with the regular course. Those students do not need to complete any laboratory assignments.

The 2L laboratory section must be taken during the same quarter as the A&O Sci 2 lecture/discussion course because the scores are combined into one grade, as if one was taking a single 5-unit course. Attempting to take 2L during a quarter separate from 2 will result in a failing grade (and no lab/demo credit) in 2L.

Students enrolled in the 2L laboratory section will perform four experiments or simulations during the quarter. These assignments will be posted online in our CCLE site; there are no formal classroom meetings associated with the lab assignments. At the end of each assignment, a report will be submitted electronically via our CCLE site, either as a PDF file or Microsoft Word/Office document. Students may also submit a hardcopy report to any of the instructors. The report may include numerical computations, graphs, and short-answer/short-essay questions. The purpose of the laboratory is to learn how to perform experiments to test scientific hypotheses, interpret observations, and summarize results in a concise, written form.

**Lab 1: Atmospheric Methane Increase**

The importance of methane as a greenhouse gas and the increase of its mixing ratio over the past 300 years raise the following questions:

- How much methane is released each year into the atmosphere?
- How can one explain the rise of atmospheric methane?
- How does this relate to global population growth?
- By how much will methane increase over the next fifty years?

In this laboratory assignment, you will learn the methods scientists use to answer these questions. In the first part of the assignment you will use the steady state box model to determine the source rates (or emission rate; source and emission rate are terms for the same quantity) for the years 1700 and 2000. The second part of the assignment will show you how one can simulate the increase of methane in the atmosphere.
Lab 2: Ozone Layer Measurements

An important part of scientific work is the presentation and analysis of observations in the atmosphere, such as those of the total ozone column (TOC). The observations reveal how the atmosphere works and thus improve our understanding of atmospheric processes. In addition, these measurements are used to monitor air pollution effects such as the ozone hole.

In this laboratory assignment, we will study how the ozone layer varies over different parts of the Earth, and learn how scientists present and interpret observational data. We will use observations from NASA’s Aura satellite that is currently flying around the Earth making measurements of total ozone columns.

Specifically, we want to answer the following questions:

- How does the TOC change with latitude?
- How does the TOC change with longitude?
- How does the TOC change over the period of a year?

Lab 3: Atmospheric Stability and Dispersion

In this lab, we will test the stability of a simulated atmospheric environment by pushing around an air parcel that is at equilibrium. We will also set up typical cases of positively buoyant air parcels and see how well they convect under different environmental conditions. Finally, we will study a case of a temperature inversion aloft and how afternoon heating of the ground affects dispersion in this type of atmosphere.

You will be plotting graphs of environmental temperature vs. altitude, called temperature soundings. These soundings can represent environmental temperature profiles with a single lapse rate (environmental lapse rate, ELR or $\Gamma_e$ or $\gamma$) or multiple lapse rates. On these plots, you will also be plotting the temperature inside a rising air parcel as a function of altitude. These plot lines will represent temperature trajectories of the air parcels, and will have a fixed, common slope that corresponds to the dry adiabatic lapse rate (ALR or $\Gamma_d$ or just $\Gamma$).

For the temperature inversion cases, we will use an online air parcel motion simulator that allows us to configure different types of temperature inversion profiles and shows the expected motion of buoyant air parcels released in those environments.

Lab 4: Photochemical Smog Modeling

In this laboratory assignment, we are going to learn how scientists simulate the behavior of ozone in the atmosphere as the emission rates of various primary pollutant reactants are changed.

This assignment formerly used an interactive online module that computed smog concentrations with a numerical simulation. Due to the untimely death of the module’s author, the server running the module has been decommissioned, so we are now providing the data that would have been obtained by students running the model.
Schedule of Topics

Lessons will begin opening sequentially as of the start of the quarter (March 27, 2019). Lessons close at **12 pm (Noon)** on the closing date. Ideally, you will have started each lesson set about the time they open and gradually work through each section day-to-day until the closing date of that section. **Note that you may not be able to start lessons until the previous lesson or homework assignment in sequence has been completed.** See the CCLE course website for specific opening/closing dates of individual lessons and homework assignments.

<table>
<thead>
<tr>
<th>Section</th>
<th>WEEK 1</th>
<th>Closing date</th>
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<tbody>
<tr>
<td>1. <strong>Introduction / Motivation</strong></td>
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<td>MON., 4/8/19</td>
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<tr>
<td>1.1. What is “Air Pollution”?</td>
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<tr>
<td>1.2. How does air pollution impact our lives?</td>
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<tr>
<td>2. <strong>Measurements, Chemistry, and Concentrations</strong></td>
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<td>MON., 4/8/19</td>
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<tr>
<td>2.1. Introduction / Definitions</td>
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<tr>
<td>2.2. Chemistry</td>
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<tr>
<td>2.3. The Steady State Box Model</td>
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<th>WEEK 2</th>
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<tr>
<td>3. <strong>Atmospheric Evolution</strong></td>
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<tr>
<td>3.1. Primordial Atmosphere</td>
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<td>3.2. Secondary Atmosphere</td>
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<td>3.3. Nitrification</td>
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<td>3.4. Catastrophic Atmosphere-changing Events</td>
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<td>3.5. Human Impact</td>
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<td>4. <strong>The Atmosphere</strong></td>
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<td>4.1. Atmospheric Structure</td>
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<td>4.2. Atmospheric Gases</td>
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<td>4.3. Aerosol Particles</td>
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**HOMEWORK ASSIGNMENT #1**

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<tr>
<th>WEEK 3</th>
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<tbody>
<tr>
<td>5. <strong>Global Climate Change</strong></td>
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<tr>
<td>5.1. Introduction</td>
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<tr>
<td>5.2. Atmospheric Radiation</td>
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<tr>
<td>5.3. Atmospheric Greenhouse Effect</td>
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<tr>
<td>5.4. Global Climate Change</td>
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<td>5.5. Remediation</td>
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**HOMEWORK ASSIGNMENT #2**

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<tr>
<th>WEEK 4</th>
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<tbody>
<tr>
<td>6. <strong>Stratospheric Ozone Depletion</strong></td>
</tr>
<tr>
<td>6.1. Introduction</td>
</tr>
<tr>
<td>6.2. Ozone Layer</td>
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<tr>
<td>6.3. Health Effects</td>
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<tr>
<td>6.4. Chlorofluorocarbons (CFCs)</td>
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<td>6.5. Ozone Chemistry and the Ozone Hole</td>
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<tr>
<td>6.6. Regulation and Abatement</td>
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**HOMEWORK ASSIGNMENT #3**

<table>
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<tr>
<th>WEEK 5</th>
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<tr>
<td>No online lessons this week…study for midterms!</td>
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</table>
WEEK 6
MIDTERM EXAMINATION
Monday, May 6, 2019, 6:00–7:15 pm
Covers Sections 1–6 and Homework #2

7. Air Pollution Toxicity
   7.1. Risk Assessment Tools
   7.2. Quantifying Health Effects
   7.3. Physiological Effects on Humans
   7.4. Examples

WEEK 7

8. Air Pollution Meteorology
   8.1. Transport Processes
   8.2. Atmospheric Stability and Convective Dispersion
   8.3. Temperature Inversions
   8.4. Impact on Daily and Seasonal Smog Variation
   8.5. Application: Chimney Plumes
   8.6. Plume Type vs. Stability
   8.7. Enhancing Plume Dispersion

HOMEWORK ASSIGNMENT #4

WEEK 8

9. Acid Rain / London Smog
   9.1. Brief History
   9.2. London Smog
   9.3. Acids / Bases
   9.4. The Sulfur Cycle
   9.5. The Nitrogen Cycle
   9.6. Acid Rain
   9.7. Environmental and Health Effects
   9.8. Abatement

WEEK 9

10. Los Angeles Smog
    10.1. History of Smog in Los Angeles
    10.2. Components of Los Angeles Smog
    10.3. Ozone Formation
    10.4. Smog and Visibility
    10.5. Smog Meteorology
    10.6. Air Pollution Mitigation
    10.7. The Future of LA Smog

HOMEWORK ASSIGNMENT #5

WEEK 10

11. Indoor Air Pollution
    11.1. Indoor Air Pollution
    11.2. Sources and Health Effects
    11.3. Indoor Air Pollution Remediation

FINAL EXAMINATION: Thursday, June 13, 2019, 6:30–9:30 pm (covers everything in the course)