ATMOSPHERIC CHEMISTRY

CHEM F606 (cross listed as ATM F606) Overview and Schedule ---- Fall 2018

Instructor	Dr. Jingqiu Mao (Reichardt 188, 907-474-7118, jmao2@alaska.edu)
Office Hours	Tu, Th 11:20A-12:20P and any other time by appointment
Class	Tu, Th, 9:45A-11:15A, REIC 207
Text:	Introduction to Atmospheric Chemistry, Daniel J. Jacob
	(Available online: http://acmg.seas.harvard.edu/people/faculty/djj/book/index.html)
Supplements	Atmospheric Chemistry and Physics: from Air Pollution to Climate Change, John H. Seinfeld and Spyros N. Pandis, 3rd Edition.

Course Description (from catalog):

Chemistry of the lower atmosphere (troposphere and stratosphere) including photochemistry, kinetics, thermodynamics, box modeling, biogeochemical cycles and measurement techniques for atmospheric pollutants; study of important impacts to the atmosphere which result from anthropogenic emissions of pollutants, including acid rain, the “greenhouse” effect, urban smog and stratospheric ozone depletion. Special fees apply. Prerequisites/Co-requisite: ATM F601 or permission of instructor. (Cross-listed with ATM F606. Stacked with CHEM F406.) (3+0)

Course objectives / Learning Goals:

By the end of the semester, you will have a basic knowledge of:

- The atmospheric chemical composition
- The transformations of these compounds
- The importance of chemicals in the atmosphere for climate, human health, and ecosystem health
- Air pollution and atmospheric removal of pollutants

You will be able to understand the conversations of atmospheric chemists, seminars on atmospheric chemistry, and discussions with fellow students studying atmospheric chemistry. You will also develop skills in higher-order analysis that will assist both in chemistry pursuits and general studies.

Prerequisites:

Because students may come to this class with a variety of backgrounds, I have made accommodations for students who are either from a pure atmospheric or a pure chemistry background. In either case, I will provide tutorials on the topic that you are missing. A fully prepared student will have the following:

- Interest in understanding the atmosphere’s chemical composition and transformations
- Basic atmospheric structure (Atmospheric layers, vertical profiles of pressure and temperature) (A)
- Basic Chemistry (periodic table, simple compound naming) (B)

If you feel you have a lack in either (A: Atmospheric structure) or (B: Basic chemical principles), you should attend the tutorial sessions. These sessions will be held during the first three weeks of classes at a time that is convenient for interested students. In addition to these basic topics, we will cover the following topics, but some knowledge in this area would be beneficial:

Chemical equilibrium, Chemical kinetics, Oxidation states, Chemical catalysis, Basic photochemistry

Course Structure

Classroom sessions, held twice a week, discuss theoretical and practical aspects of atmospheric chemistry. The class-time lectures and discussions will follow the course's textbook. Problem sets are assigned every two weeks. The solutions to problem sets are due at the beginning of class on Tuesday. Please begin the problem set early so that you do not have a deadline crunch and are able to ask questions regarding the problems.

The other half of the material will come from a term paper and an AGU-type presentation. The guideline is attached at the end.

Course Policies

Behavior and Collaboration- Students are expected to conduct themselves professionally at all times. Disrespect of the classroom learning environment, instructors, and fellow students is not tolerated! Collaboration and working in small groups is a key component of classroom time.

Honor code and Academic integrity- Students are expected to conduct themselves in accordance with the UAF Honor code. The Chemistry Department policy states: Any student caught cheating will be assigned a course grade of F. The student's academic advisor will be notified of this failing grade and the student will not be allowed to drop the course.

Instructor-Initiated Withdrawals- Any time up to and including the final date to drop a course with a "W," the professor has the right to withdraw a student that "...has not participated substantially in the course."

Problem sets and Late work: You are welcome, and encouraged, to discuss the problem sets with each other. However, problem sets should always be solved and written up individually. All calculations, graphs, etc., should be completed individually. Show all work, explaining in sufficient detail how you arrived at the answer. Some questions will be easy to answer, and you may be able to do them in your head but you must still explain how you arrived at your answer.
Homework problem sets are due on Tuesdays at the beginning of class. **Ten points will be deducted (out of 100 total points) for each day late, up to the third day, after which the problem set will receive no credit.** If you have to travel for a conference or have another emergency, I will make every reasonable attempt to accommodate these issues as long as you either inform me before a planned absence or immediately after an emergency. Meeting deadlines is important to allow for timely correction and return of the problem sets. **Everyone is allowed to hand in one problem set late (by 5pm Sunday) without penalty.**

Grading Criteria:

Midterm exam	15%
Final exam	15%
Problem sets	40%
Term Paper	15%
Presentations	15%

Graduate-level students also lead a term project and give in-class presentation, which is a graded activity, and all students are given credit for participation in the in-class discussions of oral presentations.

Tentative Grade Scale:

A	90 - 100%
B	80 - 89%
C	70 - 79%
D	60 - 69%

If I find that students are close to a borderline between grades, I may choose to lower the threshold for the higher grade, but I will not raise the thresholds above the scale listed above.

Disability Services- I will work with the Office of Disabilities Services (208 Whitaker Bldg, 474-5655) to provide reasonable accommodation to students with disabilities. It is the student's responsibility to make an appointment with me to discuss appropriate accommodations. A letter from disabilities services must be provided.

Tentative Schedule:

Wk	Dates	Topic	Reading
1	28,30 Aug	Introduction/ Atmospheric chemical composition	1,2
2	4,6 Sep	Simple atmospheric models; lifetimes	3
3	11,14 Sep	Atmospheric Transport and geochemical cycling	4.2,4.3
4	18,20 Sep	Oxidation states of elements and geochemical cycles	6
5	25,27 Sep	Aerosol particles / Radiative forcing	7
6	2,4 Oct	Aerosol particles	8
7	9,11 Oct	Kinetics & Equilibrium & **Midterm Exam**	9.1-9.2
8	16,18 Oct	Photochemistry / Stratospheric ozone	9.3, 10.1
9	23,25 Oct	Stratospheric ozone	10.2-10.3
10	30Oct,1Nov	Aqueous / heterogeneous reactions	10.4
11	6,8 Nov	Tropospheric oxidation	11
12	13,15 Nov	Ozone Air pollution	12
13	20 Nov	Acid deposition and aerosol production	13
14	27,29 Nov	Arctic atmospheric chemistry/Student Presentations	
15	4,6 Dec	Student Presentations/Review	
16		**Final Exam**	

Guidance for Term paper and Presentation (Aug 2018)

In-depth review of narrow topic, showing familiarity with at least 3 journal papers, or a paper describing and drawing conclusions from your own research project.

Due Friday NOV 30 by MIDNIGHT in my inbox [jmao2@alaska.edu.](mailto:jmao2@alaska.edu)

Do not turn in late. If you do, each day late will be marked down one whole letter grade.

Overall Objective of final project:

Practice communicating science in the two major ways scientists exchange ideas

- Writing a scientific paper
- Presentation in style of major scientific conference (AGU)

Both writing and speaking effectively require a clear, concise expression of ideas presented in a logical flow.

Assume your audience and readers have knowledge of all material covered in CHEM/ATM F606

"AGU-style" Presentation:

- 12 minute talk
- 10 slides maximum (animations welcome but time carefully)
- 3 minutes for questions
- High quality pictures
- Brief text, large enough to be read from a distance

[[Some additional resources, perhaps even more useful to you later if you continue on in a scientific career… See guidelines for giving a good talk ("Schoeberl_Toon_Guidelines_for_good_Talk"). And powerpoint presentation from Daniel Jacob, both available on Blackboard. Many great tips, some differences of opinion, if nothing else, they raise our awareness on many aspects of giving presentations.]]

Paper: 8 page maximum 1.5 spaced with 1-inch margins (text only; figures, tables, references do not count towards the max, but note you are limited to 4 figures or tables (combined)) in the style of a scientific publication so choose carefully. Suggest using Times New Roman font (what I'm using here) – nothing narrower!

Please use active voice in your writing – so much more interesting to read – e.g., 'I conclude', 'We find', despite what you may have learned elsewhere about scientific writing.

Paper structure:

- **Title** should describe in a specific manner the content you are covering. If you are focusing on a specific location or season, be sure to include that in the title.

- **Abstract** should include a brief statement of the scientific question to be addressed and why it matters; the approach(es) to address this question; and must summarize key messages and findings.

- **Introduction** provides the context for the question being addressed. What background information must the reader know in order to understand the rest of the paper? Remember to assume the reader has taken this course, so it should not be a textbook discussion. What work has previously been done, and what questions remain, that you are addressing here? It's often effective to end your first paragraph of the intro with a statement communicating the objective of the paper so the reader immediately knows where you're headed. The objective and how you are tackling it can be elaborated on in the final paragraph of the introduction.

- **Approach** (or "Methods") describes the techniques or methods used to address the question. Be sure to discuss their strengths and limitations. Include any background material the reader may need – i.e., few sentences on how the instrument works or how the lab experiment was set up, or what goes into the model (with references that point to more detailed information).

- **Results and Discussion**. (*A side point on writing style -- I'm generally not in favor of having a section titled "Results" and then a separate section of "Discussion". This is clearly a difference from the typical structure for a scientific publication! I prefer to organize headings summarizing what is actually in the section and discussing the results where they are presented, but again, this is my own style.*)
  Subsections are appropriate, even under Results and Discussion headings. For example:

  2. Sensitivity of climate to changes in air pollutant emissions
  Include text describing general points here.
  2.1 Ozone precursors (subsections here of NOx, CO+NMVOC, CH4)
  Include specific points on ozone here.
  2.2 Aerosols
  Include specific points on aerosols here, or even have further subsections on individual aerosol components.

  The key goal here is to communicate your ideas and your assessment of the papers you've read in a clear, concise, and logical manner. Structure accordingly.

  I will be looking to see that you are using precise language to describe results, and that wherever possible you are including quantitative information. For example, rather than 'big difference', try to quantify it – 50%, factor of 2, order of magnitude?

If a model matches observations, can you report a correlation coefficient or an amplitude of a seasonal cycle as observed vs. modeled? Note that the papers you are reviewing may not do this (but they should!). If you are presenting your own research results, try to do so quantitatively by reporting statistics where possible.

- **Conclusions** The first paragraph should briefly remind the reader of the problem being addressed (in other words, for the readers who skip the paper and only read the abstract and conclusions [though of course I will read carefully your every word☺☺]). Here is where you should focus each paragraph on a different key message. What are the implications? What questions remain? How might these knowledge gaps be filled? What observations are needed? Tests with models? Lab experiments? Theory? i.e., you can discuss what future work is needed to advance your understanding beyond what you've learned from the papers you've studied.

- **Figures and Tables. You may include up to 4 figures and tables (combined)**. A picture is worth 1000 words… if it's a good one! This is a critical review, so it's certainly ok to include figures from the papers you're reading but they must be properly cited (i.e., in the caption, "reproduced from…"). I encourage you to be creative. Can you design your own schematic to illustrate the question or the findings synthesized from all of the papers you've read? A summary table?
    - **These don't count towards your page limit and you will find that 8 pages is very short, so here's a chance to convey some information succinctly**. Remember the saying, a picture [or a nice summary table?] is worth 1000 words.
    - **Be sure to add captions to tables & figures in your own words (not just cut & pasted from the article you are reviewing** – make it clear why you are choosing the figure and why it is relevant here; don't worry if your captions are lengthy – I'm not counting it toward your page limit.
    Do be sure to explain any colors/lines/symbols).

- **References.** Use AGU-style for citations in the text [*Mao et al*., 2013] and reference list (alphabetized), e.g.:
  Mao, J., F. Paulot, D. J. Jacob, R. C. Cohen, J. D. Crounse, P. O. Wennberg, C. A. Keller, R. C. Hudman, M. P. Barkley, and L. W. Horowitz (2013), Ozone and organic nitrates over the eastern United States: Sensitivity to isoprene chemistry, *Journal of Geophysical Research: Atmospheres*, *118*(19), 2013JD020231, doi:10.1002/jgrd.50817.

<u>EXAMPLE TOPICS</u>

A review of the literature on:
Role of denitrification in stratospheric ozone hole
Polar stratospheric cloud formation and chemistry
Lightning NOx and atmospheric oxidizing capacity
Very-short lived halogen species and stratospheric chemistry
Stratosphere-troposphere exchange and impacts on chemical budgets

Oxidizing capacity as determined from observed methyl chloroform or ^{14}CO
Isotopes in atmospheric chemistry (sulfate, nitrate, water, or hydrocarbons)
Methane trends (paleo, preindustrial-to-present, or recent decades)
Methane role in oxidizing capacity and/or air quality
Chemistry occurring on dust or other aerosols
Sources of baseline ozone levels in surface air
Atmospheric budgets of oxygenated volatile organic compounds (e.g., acetone, ethanol, methanol, glyoxal, etc.)
Tropospheric halogen chemistry
Peroxy acetyl nitrate and long-range pollution transport
Isoprene oxidation and secondary aerosol or ozone formation
Monoterpene oxidation and formation of secondary organic aerosols
Paleo atmospheric composition
Planetary atmosphere (choose a planet or set of chemical reactions)
Radiative forcing from non-CO_2 species
Trends in regional air pollution (choose a pollutant/region)
Mercury budgets or oxidation pathways
Persistent organic pollutants Dry deposition
Wet removal (gases or aerosol)
Emissions from the biosphere: soil NOx, isoprene, terpenes, wildfires, or methane

Alternative – write a research paper on your own project:
Describe and draw conclusions from a short data analysis project from a field campaign, monitoring network, applying a simple model, or your own relevant research. You are encouraged to use this project as an opportunity for a seed project that could turn into thesis work. Talk to the instructor if you'd like to take on your own project but need help finding a dataset or model to use.