

## Syllabus – Spring 2005

### CHEM/ATOC 5151 – Atmospheric Chemistry

University of Colorado at Boulder – Department of Chemistry and Biochemistry &  
Program in Atmospheric and Oceanic Sciences

Tuesdays & Thursdays 9:30-10:45 am  
Ekeley M203

**Taught by:**

Prof. Jose-Luis Jimenez  
Ekeley M329

[jose.jimenez@colorado.edu](mailto:jose.jimenez@colorado.edu)

303-492-3557

Office Hours: Tue 11 am-noon  
& Thu 3-5 pm

**TA'ed by:**

Jessica Gilman

Ekeley M2B50

[Jessica.gilman@colorado.edu](mailto:Jessica.gilman@colorado.edu)

303-492-1422

Office Hours: Mon 3-4 pm

### Course Objective

After taking this course you should have a working knowledge of the principles of atmospheric chemistry and some in-depth knowledge on some areas of current interest. A good gauge of this accomplishment is for you to be able to understand the current research literature, or atmospheric chemistry seminars in Boulder (CU, NOAA, and NCAR).

Boulder is one (perhaps “the”) of the world’s capitals for atmospheric chemistry. If you are doing research in this area, make an extra effort to take advantage of the fact that you are here to attend seminars and get to know local and out-of-town atmospheric scientists.

### Course prerequisites

The course prerequisites are undergraduate physics (including thermodynamics, fluid mechanics, heat and mass transfer, and electromagnetism), chemistry, calculus (especially differential equations), probability and statistics, and physical chemistry (especially kinetic theory). You are responsible for supplemental work that you may need to catch up in any of the prerequisite areas.

### Plan for this offering of the course

This is the first time that I teach this course. Since I want to develop the lectures notes in powerpoint and those do not currently exist from previous offerings of the course, I will be preparing the course from scratch as we go. We will be following the Finlayson-Pitts textbook for most lectures, although for a few we may follow the recommended Seinfeld and Pandis textbook instead. In addition, I will frequently introduce more current information from recent journal articles or conference presentations.

## CHEM-5151 Atm. Chem. Course Schedule for Spring 2005

#		DATE	TOPIC	Read	More Refs.	HA	HD
1	Tue	11-Jan-05	Introduction to the Atmosphere	F1	S1,14		
2	Thu	13-Jan-05	Overview of the Main Problems	F2	S2		
3	Tue	18-Jan-05	Global Circulation		B2		
4	Thu	20-Jan-05	Chemical Transport		S17	1	
5	Tue	25-Jan-05*	Spectroscopy and Photochemistry I	F3	S3, W2, Wa3		
6	Thu	27-Jan-05	Spectroscopy and Photochemistry II	F3	S3, W2, Wa3		
7	Tue	1-Feb-05	Spectroscopy and Photochemistry III	F4	S3, W2,Wa3	2	1
8	Thu	3-Feb-05	Kinetics I	F5	S3.5, W2,Wa3		
9	Tue	8-Feb-05	Kinetics II	F5	S3.5, W2,Wa3		
10	Thu	10-Feb-05	Kinetics III	F5	S3.5, W2,Wa3	3	2
11	Tue	15-Feb-05	Gas Phase chemistry of organic + NO <sub>x</sub> + UV – I	F6	S5		
12	Thu	17-Feb-04	Gas Phase chemistry of organic + NO <sub>x</sub> + UV– II	F6	S5		
13	Tue	22-Feb-05	Inorganic nitrogen chemistry	F7	S5, W9, B7	4	3
14	Thu	24-Feb-05	MIDTERM EXAM				
15	Tue	1-Mar-05	Student Presentations	TBD			
16	Thu	3-Mar-05	Acid Deposition I	F8	S20.6, B10		
17	Tue	8-Mar-05	Acid Deposition II	F8	S20.6, B10	5	4
18	Thu	10-Mar-05	Aerosols I	F9	S7-13,22, B4		
19	Tue	15-Mar-05	Aerosols II	F9	S7-13,22, B4		
20	Thu	17-Mar-05	Aerosols III	F9	S7-13,22, B4	6	5
21	Tue	22-Mar-05	<i>NO CLASS – SPRINGBREAK</i>				
22	Thu	24-Mar-05	<i>NO CLASS – SPRINGBREAK</i>				
23	Tue	29-Mar-05	Student Presentations	TBD			
24	Thu	31-Mar-05	Cloud and Fog Chemistry I	S6	S6, S15, W8		
25	Tue	5-Mar-05	Cloud and Fog Chemistry II	S6	S6, S15, W8	7	6
26	Thu	7-Apr-05	Stratospheric Chemistry	F12	S4, W3		
27	Tue	12-Apr-05	Instrumentation	F11	B11		
28	Thu	14-Apr-05	Atmospheric Chemistry & Climate	F14	S21, B15		
29	Tue	19-Apr-05	Atmospheric Chemistry & Climate	F14	S21, B15	7	8
30	Thu	21-Apr-05	Buffer Lecture				
31	Tue	26-Apr-05	Buffer Lecture				
32	Thu	28-Apr-05	Student Presentations	TBD			
33		Finals Wk	FINAL EXAM				

- HA: homework assigned; HD: homework due. Dates on the homeworks supersede these.
- Note on the reading from Finlayson-Pitts textbook: unless we give more detailed instructions in class, the whole chapter is required reading for the chapters listed.
- Key to the reading and references: F: Finlayson-Pitts; S: Seinfeld and Pandis; W: Warneck; B: Brasseur; Wa: Wayne

## Textbooks and Reference Books for the Course

### Required textbook:

Author	Publisher	Title	\$ on Amazon (Used)	Comments
Finlayson-Pitts	Academic Press	Chemistry of the Upper and Lower Atmosphere (QC879.6 .F57 2000)	\$99 (\$79)	VERY good and comprehensive reference, more "chemical" than S&P

*Highly recommended additional textbook.* Get it if you are going to do research in atmospheric chemistry, you will use both of the textbooks for many years!

Seinfeld & Pandis	Wiley	Atmospheric Chemistry and Physics: From Air Pollution to Global Change (QC879.6 .S45 1998)	\$89 (\$78)	VERY good an comprehensive reference, more physics than F-P&P
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*Other very good reference books at the graduate level.* I considered all of these as possible textbooks for the course. The two textbooks above and these four additional books below are in reserve at Norlin Library Circulation.

Brasseur (Ed.)	Oxford	Atmospheric Chemistry and Global Change (QC879.6 .A85 1999)	\$99 (\$94)	Edited book, good review of many current topics
Warneck	Academic Press	Chemistry of the Natural Atmosphere, 2 <sup>nd</sup> Ed. (QC879.6 .W37 2000)	\$157 (\$100)	Good alternative reference
Wayne	Oxford	Chemistry of Atmospheres, 3 <sup>rd</sup> Ed. (QC879.6 .W39 2000)	\$67 (\$27)	Very good alternative reference
Jacobson	Cambridge	Fundamentals of Atmospheric Modeling (QC861.2 .J3 1999)	\$65 (\$63)	Excellent textbook & reference on Atm. Physics and Chemistry (from a modeling perspective)

*Additional reference books.* These are also very good, but are not in reserve because I did not want to immobilize the entire Atm. Chem. collection in the libraries.

Author	Publisher	Title	\$ on Amazon (Used)	Comments
Brasseur	Reidel	Aeronomy of the Middle Atmosphere, 2 <sup>nd</sup> Ed. (QC881.2.S8 B73 1986)	\$151	Very good, if older, reference to the chemistry of the stratosphere & mesosphere
Houghton (Ed.)	Cambridge	Climate Change 2001: The Scientific Basis (QC981.8.C5 C511345 2001)	(\$31)	Latest IPCC report on science of climate change, many excellent & relevant (to this course) chapters. Also on the web for free.
Brasseur	Springer-Verlag	Atmospheric Chemistry in a Changing World (QC879.6 .A854 2003)	\$101	Edited book summarizing the latest research in Atm. Chem.

### Part II: Good introductory books on atmospheric chemistry

Jacob	Princeton	Introduction to Atmospheric Chemistry (QC879.6 .J33 1999)	\$57 (\$34)	Very good introductory reference. Also on the web for free.
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Hobbs	Cambridge	Introduction to Atmospheric Chemistry (QC861.2 .H635 2000)	\$30 (\$11)	Alternative introductory reference
Hobbs	Cambridge	Basic Physical Chemistry for the Atmospheric Sciences (QC861.2 .H63 2000)	\$30 (\$15)	Good introductory reference on relevant P-Chem
Jacobson	Cambridge	Atmospheric Pollution: History, Science, and Regulation (TD883 .J37 2002)	\$43 (\$40)	Good introduction at the (Stanford) undergraduate level
Hemond	Academic Press	Chemical Fate and Transport in the Environment, 2 <sup>nd</sup> Ed. (TD193 .H46 2000)	\$70 (\$59)	Very good introduction from a different perspective, includes air, water and soils

*Part III: Good introductory or reference books topics very related to atmospheric chemistry*

Author	Publisher	Title	\$ on Amazon (Used)	Comments
Houghton	Cambridge	The Physics of Atmospheres, 3 <sup>rd</sup> Ed. (QC880 .H68 2002)	\$37 (\$32)	Classic introductory book on the subject
De Nevers	McGraw-Hill	Air Pollution Control Engineering, 2 <sup>nd</sup> Ed. (TD883 .D42 2000)	\$116 (\$48)	Good introductory book on control technology
Heck & Farrauto	Wiley	Catalytic Air Pollution Control: Commercial Technology, 2 <sup>nd</sup> Ed. (TD889 .F37 1995)	\$110 (\$84)	Excellent reference on catalysts (such as in cars)
Liou	Academic Press	An Introduction to Atmospheric Radiation, 2 <sup>nd</sup> Ed. (QC912.3 .L56 2002)	\$79 (\$74)	Recent book, widely used as textbook on the topic
Pruppacher	Kluwer	Microphysics of Clouds and Precipitation, 2 <sup>nd</sup> Ed. (QC921.5 .P78 1997)	\$99 (\$71)	Classic reference on the subject
Holland	Princeton	The Chemical Evolution of the Atmosphere and Oceans (QC879.6 .H63 1984)	(\$50)	Classic reference on the evolution of the atmosphere
Yung	Oxford	Photochemistry of Planetary Atmospheres (QB603.A85 Y86 1999)	\$94 (\$14)	Very good recent book on that topic, puts the Earth's atmosphere in context
De Patter	Cambridge	Planetary Sciences (QB601 .D38 2001)	\$62 (\$55)	Good chapter on planetary atmospheres
Hinds	Wiley	Aerosol Technology, 2 <sup>nd</sup> Ed. (TD884.5 .H56 1999)	\$100 (\$84)	Good reference on aerosols, less detailed than Baron
Baron & Willeke	Wiley	Aerosol Measurement (TD884.5 .A33 1993 – this is 1 <sup>st</sup> ed. I requested purchase of 2 <sup>nd</sup> Ed. On 8/04)	\$186 (\$99)	BIBLE of aerosol measurements, a 'must have' if you work in this area
Brown (Ed.)	Imperial College	Ultrafine Particles in the Atmosphere (not in CU libraries – I requested its purchase on 8/04)	\$74 (\$70)	Good recent "survey" edited book

**Web page for the course**

<http://cires.colorado.edu/jimenez/AtmChem>

Right now it has a few links to relevant resources. I will post the lecture notes as we go, as well as homeworks. Suggestions for useful links are very welcome.

**Email list for the course**

The email list for the course is: [chem-5151@lists.colorado.edu](mailto:chem-5151@lists.colorado.edu)

It is *essential* that you be subscribed to the email list as some announcements will only be sent by email. I will subscribe all the students that are registered at the beginning of the course. You

can also subscribe on your own by sending a message to [listproc@lists.colorado.edu](mailto:listproc@lists.colorado.edu) with the following message contents (the subject line doesn't matter):

*Subscribe chem-5151 Your Name*

If you drop the course you can unsubscribe from the list by sending a message to [listproc@lists.colorado.edu](mailto:listproc@lists.colorado.edu) with the following message contents (the subject line doesn't matter):

*Unsubscribe chem-5151*

You should also remove yourself from the list at the end of the course.

### **Course Grading Policy**

The grade will be determined as the weighed average of:

- 22% homework
- 20% midterm
- 30% final exam
- 8% presentation of a paper to the class
- 10% class participation
- 10% final project (if there is one, otherwise will increase other fractions proportionally)

Late homeworks will not be graded unless we have agreed to an extension ahead of time. If they are graded, the grade will be multiplied by 0.75 to discourage lateness. No exceptions except in cases of personal (not academic) hardship.

### **Prize for Best Grade in the Course**

I will recognize the student with the highest grade at the end of the course with a prize TBD, perhaps a copy of a relevant book.

### **Some Information About Grades**

Grading is absolute, I don't grade on a curve. Not everyone has gotten an A in past offerings of my other graduate course (although I would be very happy if that was the case), and from experience a good grade requires hard work. FYI in the previous three years of CHEM-5181 I gave in total 2 A, 7 A-, 13 B+, 4 B, 4 B-, and 2 C+. You need to get at least a B- for the course to count towards graduate credit.

*Please don't obsess about grades!* They are much less important in grad school than they were in undergrad. They should not become an end in themselves (the "professional student syndrome"), rather they should be a feedback tool to help you identify your strengths and weaknesses and to learn.

I determine the grading policy, and always make an effort to grade all students with the same criteria. For this reason we cannot change your grades unless we made a mistake. So please don't tell us something like "yes, it is true I made that mistake in that question, but I think you should only discount 2 points instead of the 4 you took for it."

## **Homework and Exam Legibility**

It is often a significant problem to “decode” homeworks and exam if the writing is too small or messy, or if they are poorly organized. We may take points out for poor legibility at our discretion. For homeworks, we prefer if you type them in a computer, although this is not required. A neat handwritten homework is just as good. The current homework will be posted on the course page in Word to save you the typing, should you decide to type your homework.

Please list the units of all results (SI units if possible).

## **Reading Assignments**

Every lecture will have a reading assignment, as indicated in the course schedule below. Since we will be following the book quite closely, reading the whole assignment before the lecture may be overkill. However you should look at it briefly, and if you are not able to understand a specific topic, you should look for appropriate background reading and read it before the lecture. If you have trouble understanding the reading assignment, start by reading on the same topic in one of the introductory books above. The Jacob book in particular is excellent.

## **Structure of Student Presentations**

Students will be required to present a recent journal paper on an atmospheric chemistry topic to the class. The purpose is to gain familiarity with current topics in the field as well as to understand and practice scientific presentation skills. Students should begin considering articles for presentation as soon as possible, preferably selecting one related to proposed research, and check with the instructors for their suitability no later than a week prior to presentation.

## **Changes to the Course during the Semester**

As with life, this syllabus is subject to change. I may make some changes to the course during the semester as appropriate, including to lectures, assignments, presentations, and exams.

## **Policy on Course Auditing**

I prefer that you take the course for credit as you will get more out of it this way and it also makes it easier for me to teach it. However I may allow interested people who do not have enough time to take the course for credit to audit the course. Please talk to me if you are interested in auditing. If you do audit the course, I will ask you to fill the feedback questionnaire at the end of the course to help us improve it for next offering.

## **Feedback on the Course**

This is the first time that this course is offered, and I will be developing it as we go, partially based on my experience with teaching CHEM-5181. The only purpose of having a course is that it will be useful to you, the students, thus don't hesitate to give me feedback early on about what's working or not working – I may be able to fine-tune the course as we go along.

At the end of the course I will send you an email questionnaire with lots of specific questions about the course, so that we can use your experience to improve the next offering. You will need to return the questionnaire to someone other than me (typically a student in last year's course). That person will remove your name and forward to us only after we have turned in the

grades to the registrar's office. I ask that you take this seriously as it really helps me improve the course. You will get a small class credit for doing this as part of the class participation grade. A summary and all the responses will be posted on the class web page.

### **Students with Disabilities:**

If you qualify for accommodations because of a disability, please submit to me a letter from Disability Services (DS) early in the semester so that your needs may be addressed. Disability Services (303-492-8671, Willard 322) determines accommodations based on documented disabilities.

### **CU Policy on Sexual Harassment**

The University of Colorado Policy on Sexual Harassment applies to all students, staff and faculty. Sexual harassment is unwelcome sexual attention. It can involve intimidation, threats, coercion, or promises or create an environment that is hostile or offensive. Harassment may occur between members of the same or opposite gender and between any combination of members in the campus community: students, faculty, staff, and administrators. Harassment can occur anywhere on campus, including the classroom, the workplace, or a residence hall. Any student, staff or faculty member who believes s/he has been sexually harassed should contact the Office of Sexual Harassment (OSH) at 303-492-2127 or the Office of Judicial Affairs at 303-492-5550. Information about the OSH and the campus resources available to assist individuals who believe they have been sexually harassed can be obtained at: <http://www.colorado.edu/sexualharassment/>