

*Sonnet  
UCLA Environmental  
Chem Lab*

**Atmos. Sci. 151: Environmental Chemistry Laboratory**

**Winter, 1994**

**Instructor:** Suzanne Paulson  
Jeffery Lew Ph. 825-3023  
Richard Turco Ph. 825-6936; 7157 MathSciences

**Time and Place:** Tu — 9:00-10:50; 4202 MathSciences  
Th — 9:00-11:50; 4202 MathSciences

**References:** List attached

**Exams:** TBD

**Lab Exercises:** See Schedule of Meetings and Syllabus

**Homework:** Problems in Data Analysis and Interpretation

## Schedule of Meetings

Jan. 11, Tue.	Introduction; Laboratory Facilities and Safety
Jan. 13, Thu.	Basic Instrumentation Demonstrations
Jan. 18, Tue.	Error Analysis
Jan. 20, Thu.	Modeling Systems Analysis: Stella
Jan. 25, Tue.	Precipitation Scavenging: Background
Jan. 27, Thu.	Precipitation Shaft Scavenging Experiment
Feb. 1, Tue.	Aqueous Chemistry in Clouds and Precipitation
Feb. 3, Thu.	Acid Rain Experiment
Feb. 8, Tue.	Photochemical Smog: Background
Feb. 10, Thu.	Smog Chamber Experiment
Feb. 15, Tue.	Diurnal Variation of Smog Chemistry
Feb. 17, Thu.	Sensitivity Experiment for Smog Formation
Feb. 22, Tue.	Modeling Smog Chemistry and Transport
Feb. 24, Thu.	Numerical Simulation of Air Pollution
Mar.1, Tue.	Stratospheric Ozone Photochemistry: Background
Mar.3, Thu.	Ozone Chapman Cycle Experiment
Mar.8, Tue.	Stratospheric Ozone Depletion
Mar.10, Thu.	Chlorofluorocarbon/Ozone Experiment
Mar.15, Tue.	Modeling Ozone Photochemistry
Mar.17, Thu.	Numerical Simulation of CFC/Ozone Experiment
Mar.21, Mon.	<b>Finals Week</b>

## Course Syllabus

### I. Introduction

Basic laboratory instrumentation and measurement techniques are discussed: thermometry; gas and liquid chromatography; ionic conductivity; spectrometry. Data collection and error analysis techniques are introduced. The major instruments to be used during the course are described.

### II. Urban Air Pollution Chemistry

A simple Haagen-Smit experiment consisting of a chamber with the pollutant gases found in urban air shows the importance of aromatic hydrocarbons to the production of urban ozone. The concept of steady-state atmospheric chemical processes is studied in this experiment by varying the concentrations of primary reactants and comparing the resulting secondary constituent concentrations with predictions made by a crude tropospheric chemistry model. In a more sophisticated experiment, the concentrations of secondary and primary constituents are monitored over time while photochemical light source intensity is varied to simulate the sun's track over the course of a day. The presence of pollutants in ambient air is tested using samples collected on the laboratory building roof.

### III. Pollution Scavenging and Deposition

A simple precipitation shaft experiment using pure water drops falling through an atmosphere of sulfur dioxide and other water-soluble gases demonstrates pollutant scavenging by precipitation drops. The effects of naturally-occurring compounds dissolved in the rainwater are studied by doping the water droplets with hydrogen peroxide and other chemicals. Another variation of the precipitation scavenging experiment involves substitution of the soluble gas by a colloid of soluble and non-soluble aerosol particles.

### III. Chemistry of Stratospheric Ozone

The destruction mechanisms for stratospheric ozone are studied in a closed chamber containing ozone and chlorine compounds such as the chlorofluorocarbons (CFCs). First, the natural pure-oxygen photochemistry is investigated. Next, chlorine species are introduced and the effects on ozone concentrations are recorded. A basic model of the relevant chemistry is used to interpret the data from these experiments. The computer simulation is linked with the experiment as a useful analytical tool.

## References

"Physical Chemistry", P. W. Atkins, W. H. Freeman & Co. (1986).

"Atmospheric Chemistry: Fundamentals and Experimental Techniques", B. J. Finlayson-Pitts and J. N. Pitts, Jr., John Wiley, New York (1986).

"Atmospheric Change: An Earth System Perspective," T. Graedel and P. Crutzen, Freeman, 1993.

"Atmospheric Chemistry and Physics of Air Pollution", J. H. Seinfeld, John Wiley, New York (1986).

"Aeronomy of the Middle Atmosphere: Chemistry and Physics in the Stratosphere and Mesosphere", G. Brasseur and S. Solomon, D. Reidel, Dordrecht (1986).

## Environmental Chemistry Laboratory Atmospheric Sciences 151

**Objective:** A number of lecture courses in several academic departments attempt to educate students on environmental issues, such as the role of air pollution in regional health issues and in global climate. However, none of these courses provide students with hands-on experience using scientific instruments and analytical techniques in a laboratory specifically dedicated to environmental problems. This course is designed to offer such an experience for lower and upper division undergraduates in disciplines that fall under the broad umbrella of Earth System Science and Environmental Sciences. The proposed course may be taken concurrently, or consecutively, with any of the following courses already offered:

Atmospheric Sciences/Earth and Space Sciences: *Introduction to the Earth System* (interdepartmental general education course, beginning in Spring, 1994)

Atmospheric Sciences 2: *Air Pollution*

Atmospheric Sciences 144: *Micrometeorology and Air Pollution Meteorology*

Atmospheric Sciences 145: *Atmospheric Physics*

Atmospheric Sciences C152/C203B: *Physics of Clouds and Precipitation*

Atmospheric Sciences M203A: *Introduction to Atmospheric Chemistry*

Chemistry 103: *Environmental Chemistry*

Earth and Space Sciences 1: *Introduction to Earth Science*

Earth and Space Sciences 153: *Oceans and Atmospheres*

Environmental Health Sciences 255: *Atmospheric Transport and Transformations of Airborne Chemicals*

Geography 1: *Physical Environment*

Mechanical, Aerospace, and Nuclear Engineering 2: *Toxic Waste Control*

A major objective of the course is to provide laboratory experience for students interested in environmental problems, who may wish to pursue a career in this area. Essential laboratory procedures will be performed in the context of timely problems, involving smog formation, acid rain and ozone depletion. Thus, the student is brought into contact with an experimental setting, and is offered a deeper scientific knowledge of important environmental issues. In addition to the intrinsic educational value of laboratory work, students taking the course will be better prepared to make career decisions.

**Method of Evaluation:** Students will be required to prepare and submit reports on each laboratory experiment performed during the course. The student's grade will be based on the quality of the reports and participation in laboratory activities.

**Textbook:** No specific text is assigned for the course. References that will be made available include texts describing the scientific issues, including:

"Atmospheric Change: An Earth System Perspective," T. Graedel and P. Crutzen, Freeman, 1993.

"Earth Under Siege: Air Pollution and Global Change," R. Turco, Oxford, 1993.

A set of notes will be developed as a laboratory guide, with descriptions of experimental procedures and exercises for the student. Class discussions of measurement precision and error analysis during the introductory segment of the course will be accompanied by lecture notes.

## Course Outline

### I. Introduction (weeks 1-2)

- A. Instrumentation
- B. Laboratory Procedures
- C. Error Analysis

### II. Urban Air Pollution (weeks 3-5)

- A. The Haagen- Smit Experiment: Effects of Air Pollution
- B. Generating the Pollutants in Photochemical Smog
- C. Measurement of Los Angeles Air Pollution

### III. Removal of Pollution (weeks 6-7)

- A. Scavenging by Rain — Precipitation Shaft Experiment
- B. The Chemistry of Clouds and Rain

### IV. Stratospheric Ozone Depletion (weeks 8-10)

- A. Atmospheric Observation of Ozone and Ozone Loss
- B. Photolysis of Chlorofluorocarbons and the Chlorine Catalytic Cycle
- C. Numerical Simulation of a Laboratory Experiment on Ozone

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