A New Environmental Chamber Facility for Atmospheric Chemical Mechanism Evaluation

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Importance of Environmental Chambers to Air Pollution Models

Atmospheric chemical mechanisms are critical components of air pollution models that predict how emissions affect formation of secondary pollutants such as O_3, and PM.

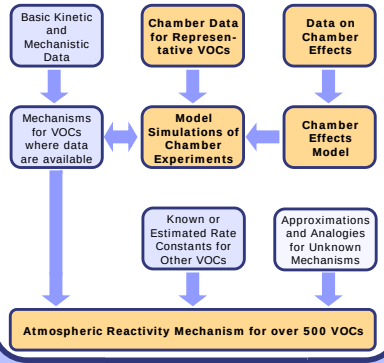
Basic Mechanistic data are insufficient to develop complete predictive mechanisms. Therefore, such mechanisms need to have many uncertain estimates and approximations.

Environmental chambers that simulate atmospheric reactions under **controlled conditions**, are essential to:

- Developing predictive mechanisms when basic mechanistic data are insufficient, e.g. for aromatics.
- Testing the predictive capabilities of complete mechanisms under varied atmospheric conditions.
- Testing predictions of reactivities of individual compounds.

But chamber experiments are influenced by **chamber effects**, which must be taken into account when testing mechanisms.

Use of Chamber Data in VOC Reactivity Mechanism Development



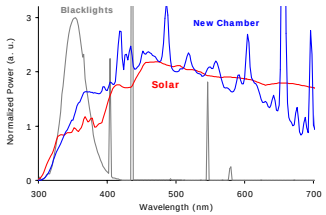
Objectives for New UCR Environmental Chamber Facility

Environmental chambers used previously for mechanism development have **limitations** affecting the range of conditions and comprehensiveness of mechanism evaluation.

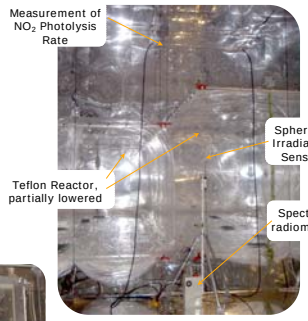
Therefore, the U.S. EPA funded the development of a new "next generation" facility at UCR to address these limitations. The major objectives are:

- To obtain data to test mechanisms under lower concentration conditions than previously possible;
- To provide better tests of predictions of reactivities of VOCs for forming O_3, PM, and other secondary pollutants;
- To evaluate model predictions of temperature and humidity effects on O_3, PM, and other secondary pollutants;
- To test the ability observational based methods (OBMs) to predict sensitivities of ambient O_3 to emissions changes.
- To evaluate interactions between aerosol and gas-phase processes under a range of representative conditions; and
- To provide a facility to test ambient air monitoring equipment under controlled but representative conditions.

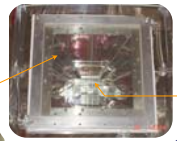
Filtered Argon Arc Spectrum

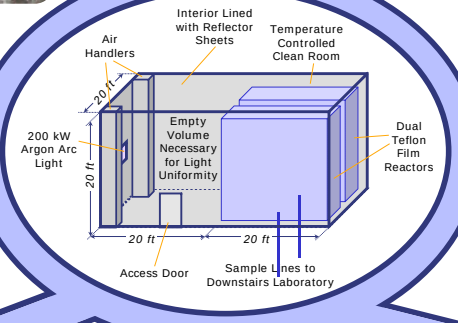


Light Measurements

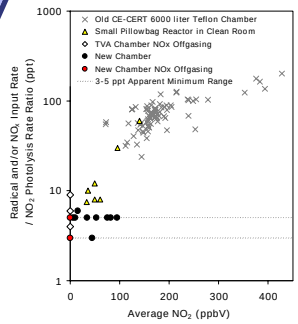


Argon Arc Light





Wall Effects in Different Chambers



Unique Advantages of the UCR Atmospheric Reaction Chamber

The **indoor chamber design** allows control of temperature and lighting conditions.

Currently the **largest indoor chamber available** for model evaluation. Minimizes wall effects, PM wall losses, and provides the sample volume necessary for specialized measurements.

A **200 kW filtered argon arc** simulates the intensity and spectrum of sunlight better than commonly used blacklights.

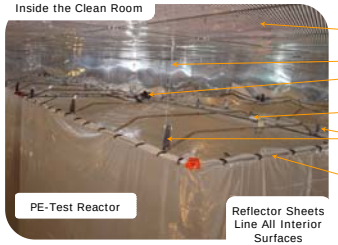
Replaceable Teflon® film reactors inside a **clean room** permit experiments at much lower concentrations than previously possible.

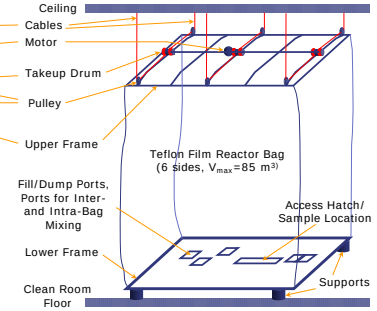
Temperature control to ±1ºC in the range 4–50ºC allows systematic studies of temperature and humidity effects on PM, O_3 and other pollutants for the first time in a large chamber.

A variety of advanced **PM and gas-phase instrumentation** is available, with provision for other instrumentation for special studies, intercomparisons, and evaluations.

Extensive **in-house expertise** on use of environmental chambers for model development, O_3 reactivity and PM studies, chamber instrumentation and operations, and quality control.

Reactor Construction





Chamber Building

Current Analytical Instrumentation

Ozone, CO, NO, NO_y, Humidity, Temperature, Total Hydrocarbons	Commercial Ambient Monitoring Instruments
Hydrocarbons	2 GC-FID, GC-ECD
NO (20 ppt MDL)	ECO Physics Chemiluminescence Analyzer
NO_2 and PAN	2 Luminol-GC Instruments
Computerized Data Acquisition and Reactor Control System	
NO_2 (<0.2 ppb MDL) HNO_3 (1–2 ppb MDL) HCHO (0.5–1 ppb MDL) H_2O_2 (1–2 ppb MDL)	2 Dual Channel Mid-IR TDLAS Systems
Light Spectrum	Spectroradiometer
Light Intensity	Spherical Irradiance Sensor Quartz Tube $J(NO_2)$ Monitor
Aerosol size and number distribution	2 Scanning Electrical Mobility Spectrometers
Particulate Matter Characteristics	Tandem Differential Mobility Analyzer

Instrument Bench in Downstairs Laboratory

Inside Clean Room (see "Light Measurements")

Inside Clean Room (To avoid temperature change for PM)