THE DEPARTMENT OF ENERGY'S ATMOSPHERIC SCIENCE PROGRAM

Chemical and Microphysical Processes Affecting Atmospheric Aerosols and their Influences on Atmospheric Radiation and Climate

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This poster is available electronically at http://www.asp.bnl.gov/GRC_ASP_poster_2005.pdf

SCIENTIFIC BACKGROUND

Atmospheric aerosols affect climate and climate change directly, by ***scattering and absorbing shortwave (solar) radiation***, and indirectly, by ***modifying the microphysical properties of clouds***, influencing cloud reflectivity, precipitation development, and the like.

The radiative forcing of climate change by anthropogenic aerosols--that is, changes in components of Earth's radiation budget--is substantial in the context of other forcings of climate change over the industrial period, principally longwave forcing by incremental greenhouse gases.

However the aerosol forcing is much more uncertain, and ***the uncertainty in aerosol forcing is the greatest source of uncertainty in radiative forcing of climate change over the industrial period.***

Key sources of uncertainty are changes in the amount (mass loading), geographical distribution, chemical composition, and microphysical structure of atmospheric aerosols resulting from anthropogenic emissions of aerosols and aerosol precursors.

These uncertainties are squarely in the realm of atmospheric chemistry!

PROGRAMMATIC BACKGROUND

In recognition of the importance of aerosol forcing and the need for improved understanding and model-based representation of the chemistry and physics of atmospheric aerosols the Department of Energy (DOE) Atmospheric Science Program (ASP) is ***focusing on the chemical and microphysical processes of atmospheric aerosols governing their radiative forcing of climate change.***

This program consists of some 32 Science Projects together with supporting infrastructure activities. Principal components of the program are ***field studies***, ***instrument development***, ***laboratory studies and theory***, and ***modeling***. Topical working groups are:

- Gas-Particle Interactions
- New Particle Formation
- Aerosol Optical Properties
- Cloud-Aerosol Interactions
- Modeling

Projects are selected competitively in response to solicitations announced from time to time by DOE. Present ASP investigators include scientists from the DOE National Laboratories, other Federal agencies, universities, and the private sector.

ASP PROGRAM DELIVERABLES

Models and parameterizations suitable for representing aerosol properties and processes required to compute aerosol radiative forcing of climate in large-scale climate models, together with an assessment of their accuracy and limitations. . .

- Relating ***aerosol light scattering and absorption***, including dependence on relative humidity and other controlling variables, to aerosol chemical and microphysical properties.
- Relating ***cloud microphysical properties*** and dependence on controlling variables, to concentration, and chemical and microphysical properties of pre-cloud aerosol.
- Relating the ***evolution of aerosol composition and microphysical properties***, and optical and cloud nucleating properties, to concentrations of precursor gases, properties of the pre-existing aerosol, cloud processing, and other controlling variables

ASP SCIENCE DELIVERABLES

FIELD MEASUREMENTS

- Measurements of ***concentrations and properties of aerosols and aerosol precursors*** and other pertinent variables (e.g., insolation, meteorological and micrometeorological data) suitable for ***developing and/or evaluating model-based representation of the processes controlling the loading and properties of atmospheric aerosols*** especially pertinent to their direct and indirect radiative forcing.
- These data sets will be ***intensive in space, time***, and multivariate, encompassing ***multiple measurements by multiple techniques***,

LABORATORY STUDIES

- Laboratory measurements of ***concentrations and properties of aerosols and aerosol precursors*** and other pertinent variables (e.g., insolation, meteorological and micrometeorological data) suitable for ***determination of derived products such as rate constants and mechanisms***, suitable for ***incorporation in and/or evaluation of model-based representation*** of the processes controlling the amount and properties of atmospheric aerosols especially pertinent to their direct and indirect radiative forcing.
- These studies examine aerosol properties and of their evolution under ***controlled laboratory conditions***, together with a specification of those conditions, permitting ***qualitative and quantitative descriptions of aerosol processes in the atmosphere, their rates, and their dependence on governing conditions***.

INSTRUMENT DEVELOPMENT

- Development of ***new instruments and methods*** for measurement of properties of atmospheric aerosols pertinent to direct and indirect radiative forcing and precursors of these aerosols pertinent to their formation and evolution.
- These activities ***design, construct, deploy, evaluate, and determine the accuracy*** of new instruments and methods for measurement of properties of atmospheric aerosols (especially properties pertinent to direct and indirect radiative forcing) and precursor species, including comparison with alternative measurement approaches.

MODELS, MODULES, AND PARAMETERIZATIONS

- ***Modules*** representing chemical reactions and microphysical processes of atmospheric aerosols ***suitable for incorporation in large-scale chemical transport models and climate models*** representing aerosol direct and indirect radiative forcing, together with ***uncertainty estimates***.
- Computer codes that describe aerosol properties and the evolution of aerosol properties on local scales--***box-models or 0-D models***.
- Models are as ***input to investigators examining aerosol radiative forcing and climate response*** on regional global scales.
- Modules must be ***applicable in higher-dimensional models***.

RECENT AND FUTURE ASP FIELD PROJECTS

MASE, MArine Stratus Experiment; Marin County CA, July, 2005 http://www.asp.bnl.gov/MASE.html
MAX-Mex, Megacity Aerosol eXperiment, Mexico City, March, 2006 http://www.asp.bnl.gov/MAX-Mex.html
MAX-Tex, Megacity Aerosol eXperiment, Texas; Houston, Summer2006 http://www.asp.bnl.gov/Houston.html
NEAQS, New England Air Quality Study 2002 http://www.al.noaa.gov/NEAQS/default.html
NAOPEX, Nighttime Aerosol-Oxidant Production EXperiment 2002 http://www.pnl.gov/atmos_sciences/raz/research/naopex02.html
NEAX, NorthEast Aerosol Experiment, July, 2004 http://www.atmos.anl.gov/ASP/files/NEAX.pdf
ARM-ACP Aerosol IOP, Oklahoma, May, 2003 http://www.db.arm.gov/cgi-bin/IOP/selectExecSummary.pl?iopName=sgp2003aerosol

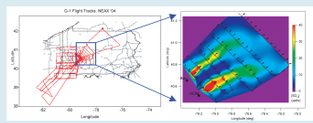
Publicly available data files from previous ASP field studies are available by anonymous FTP at ftp://ftp.asd.bnl.gov/pub/ASP%20Field%20Programs/

GRUMMAN GULFSTREAM G-1 RESEARCH AIRCRAFT

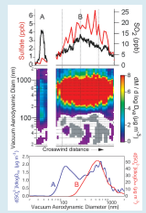
Forward and aft views of instrument installation in G-1 Research Aircraft

Scientists and flight crew participating in 2005 MArine Stratus Experiment (MASE) off California coast

RECENT MEASUREMENTS AND DATA PRODUCTS

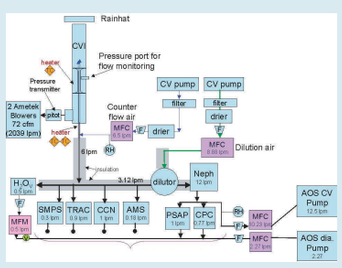


Two-dimensional reconstruction of SO_2 mixing ratio in plumes downwind of Keystone and Homer power plants from aircraft transects



SO_2 and sulfate in newly emitted (A) and aged (B) plumes. Measurements were made 25 km east of the MA - NH coastline under offshore flow conditions during the New England Air Quality Study on July 22, 2002 using the Aerodyne, Inc. aerosol mass spectrometer on the DOE G-1 aircraft platform; altitude for (A) 400 m, and for (B) 1200 m.
John Jayne, Aerodyne, Inc.

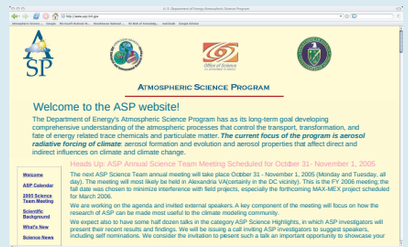
SURFACE MEASUREMENTS AT POINT REYES CA DURING MASE



Cloudwater virtual impactor (CVI) for surface measurements

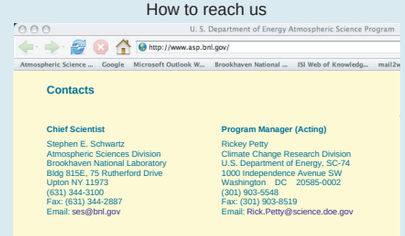
Aerosol optical instruments and CVI aerosol rack
A collaboration between NOAA-CMDL and PNNL

Visit ASP on the web. www.asp.bnl.gov

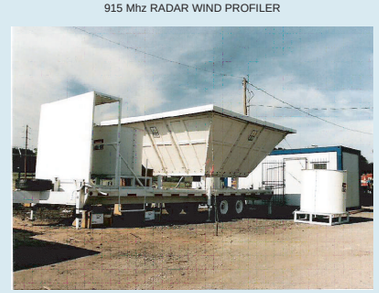


Please join us in research of mutual interest

How to reach us



915 Mhz RADAR WIND PROFILER



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