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DOE research on atmospheric aerosols

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The Department of Energy has a statutory obligation "to assure incorporation of national environmental protection goals in the formulation and implementation of energy programs and to advance the goal of restoring, protecting, and enhancing environmental quality and assuring public health and safety" and to conduct a "comprehensive program of research and development on the environmental effects of energy technology." In fulfillment of these obligations the Department supports environmental research through grants and contracts administered within its Environmental Processes and Effects Research Program. Key components of that Program are an programs dealing with atmospheric science, subsurface science, environmental radon, ocean margins, and ecosystem research.

Atmospheric aerosols are the subject of a significant component of research within DOE's environmental research activities, mainly under two programs within the Department's Environmental Sciences Division, the Atmospheric Radiation Measurement (ARM) Program and the Atmospheric Chemistry Program (ACP). Research activities conducted under these programs include laboratory experiments, field measurements, and theoretical and modeling studies. The objectives and scope of these programs are briefly summarized here: ARM--Atmospheric Radiation Measurement Program. The ARM Program is the Department's major research activity focusing on atmospheric processes pertinent to understanding global climate and developing the capability of predicting global climate change in response to energy related activities. The objectives of this program are:

- 1) To relate observed radiative fluxes and radiances in the atmosphere, spectrally resolved and as a function of position and time, to the temperature and composition of the atmosphere, specifically including water vapor and clouds, and to surface properties, and sample sufficient variety of situations so as to span the range of climatologically relevant possibilities; and
- 2) To develop and test parameterizations that can be used to accurately predict the radiative properties and to model the radiative interactions involving water vapor and clouds within the atmosphere, with the objective of incorporating these parameterizations into general circulation models (GCMs) and other models capable of describing and predicting climate change.

The Arm approach consists mainly of testing and improving models using long-term measurements of atmospheric radiation and controlling variables at highly instrumented sites in north central Oklahoma, in the Tropical Western Pacific, and on the North Slope of Alaska. Although characterization of atmospheric aerosols or their direct and indirect radiative influence are not specific objectives of ARM, the role of aerosols in influencing atmospheric radiation has been broadly recognized in formulating the program, and several research projects within the ARM program are addressing these influences, in some instances as a major component of their activity. It must be conceded, however, that atmospheric aerosols are a relatively minor focus of the overall ARM program.

ARM activities dealing with atmospheric aerosols include:

- Measurement of aerosol properties at the ARM site in Oklahoma, modeling the radiative effects of these aerosols, and comparison of modeled and measured radiation.
- Description of aerosol loadings and properties in subhemispheric to global scale chemical models and model evaluation by comparison with in-situ and remote sensing.
- Examination of aerosol climatic influences in studies with GCMs and in examination of spatial and temporal patterns of change in climatic records vis-a-vis aerosol loadings.

Further information on the ARM program is presented in ARM (1995) and Stokes and Schwartz (1994).

ACP--Atmospheric Chemistry Program. Atmospheric chemistry research within DOE addresses primarily the issue of atmospheric response to emissions from energy-generation sources. As such this program deals with the broad topic known commonly as the atmospheric source-receptor sequence. This sequence consists of all aspects of energy-related pollutants from the time they are emitted from their sources to the time they are redeposited at the Earth's surface. The objective of this program is:

To quantify the physical, chemical, geological, and biological processes governing transport, dispersion, and transformation of energy-related materials in the atmosphere, with emphasis on continental and oceanic fates of energy-related air pollutants.

Atmospheric processes governing source-receptor relations include air-surface exchange, heterogeneous and homogeneous reactions, and precipitation scavenging. A substantial component of the ACP research activity is directed to atmospheric aerosols. Specific aerosol issues include:

- Attainment/non-attainment of standards for PM-10 (particulate matter having aerodynamic diameter less than 10 μm).
- Transformation and deposition processes and their influences on pollutant lifetimes and fates.
- Direct aerosol influence on the atmospheric radiation balance.
- Effects of aerosols and aerosol precursors on cloud formation and properties.

More detail on the Atmospheric Chemistry Program and on projects being conducted within this program is given in DOE (1995).

The accompanying material briefly reports on some 25 research projects dealing with atmospheric aerosols that are conducted under the ARM or ACP Programs, outlining their objectives and key findings, and providing an e-mail address as a contact for further information on each project.

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