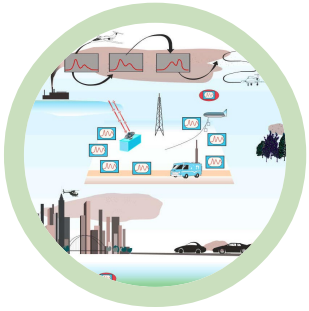
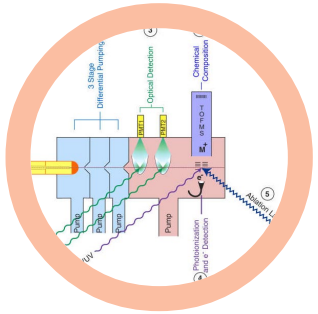


AEROSOL RESEARCH AT BNL



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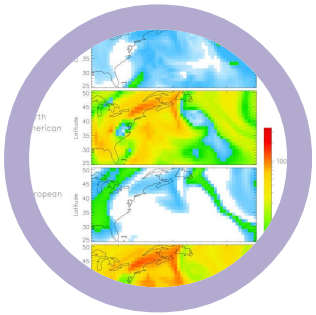


Importance of Atmospheric Aerosols

- Aerosols (haze, smog) in the troposphere (lower part of the atmosphere) derive from a variety of sources, natural and anthropogenic (i.e. resulting from human activity), including energy-related activities.
- These aerosols are important because of their influence on ***human health*** (through inhalation) and welfare (impairment of ***visibility***; ***acid deposition***), and because of their influence on ***climate***.
- Improved understanding of aerosols is needed to quantify these influences and to enable development of efficient and effective strategies to meet existing and proposed air quality regulations.

BNL Aerosol Research

BNL research is directed to improving the understanding of tropospheric aerosols and their climate influence.

BNL research focuses on:

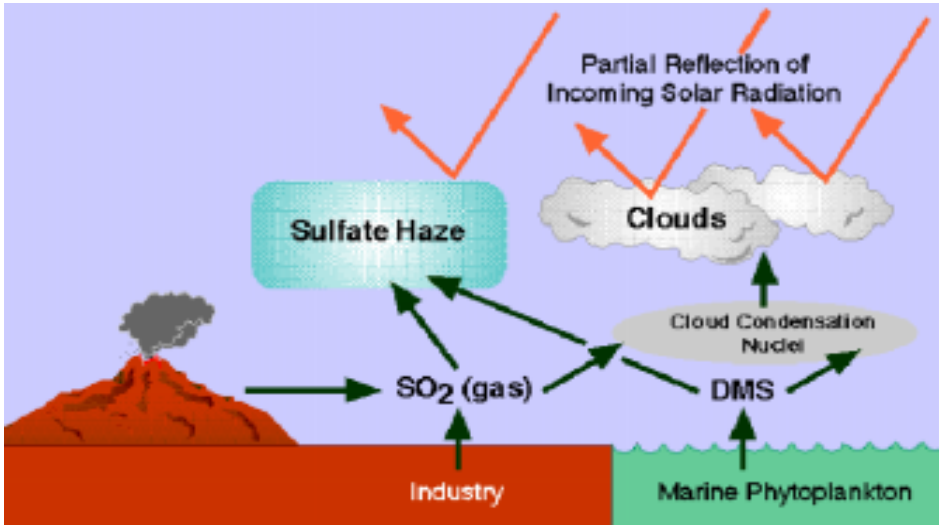
- ***Understanding processes*** responsible for the loading, composition, microphysical properties, and geographical distribution of tropospheric aerosols.
- ***Characterizing the chemical, physical, and optical properties*** of aerosols in the laboratory and the field.
- ***Developing the ability to represent*** aerosol loading and properties in chemical transport models and climate models.
- ***Measuring the radiative influence*** of aerosols and comparing to theory.

Climate Influence of Aerosols

Aerosols scatter solar radiation. Some of this scattered radiation is scattered upward, out of the Earth's atmosphere.

The presence of these aerosols leads to a ***cooling effect on climate***, or a "negative forcing" of climate change.

Aerosols also increase the concentration of droplets in clouds, ***enhancing the brightness of and lifetimes of clouds***, leading to further cooling influence on climate, known as "indirect forcing" of climate change.

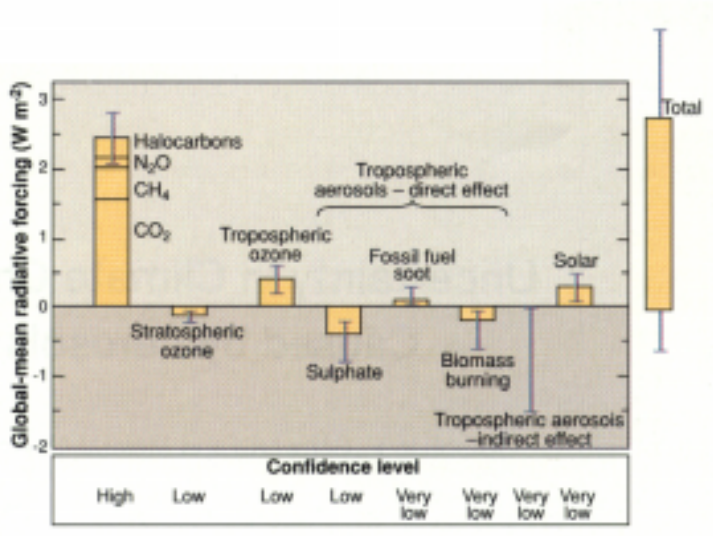


Forcing is the change in absorbed solar irradiance due to the aerosol.

Uncertainty in Aerosol Forcing of Climate Change

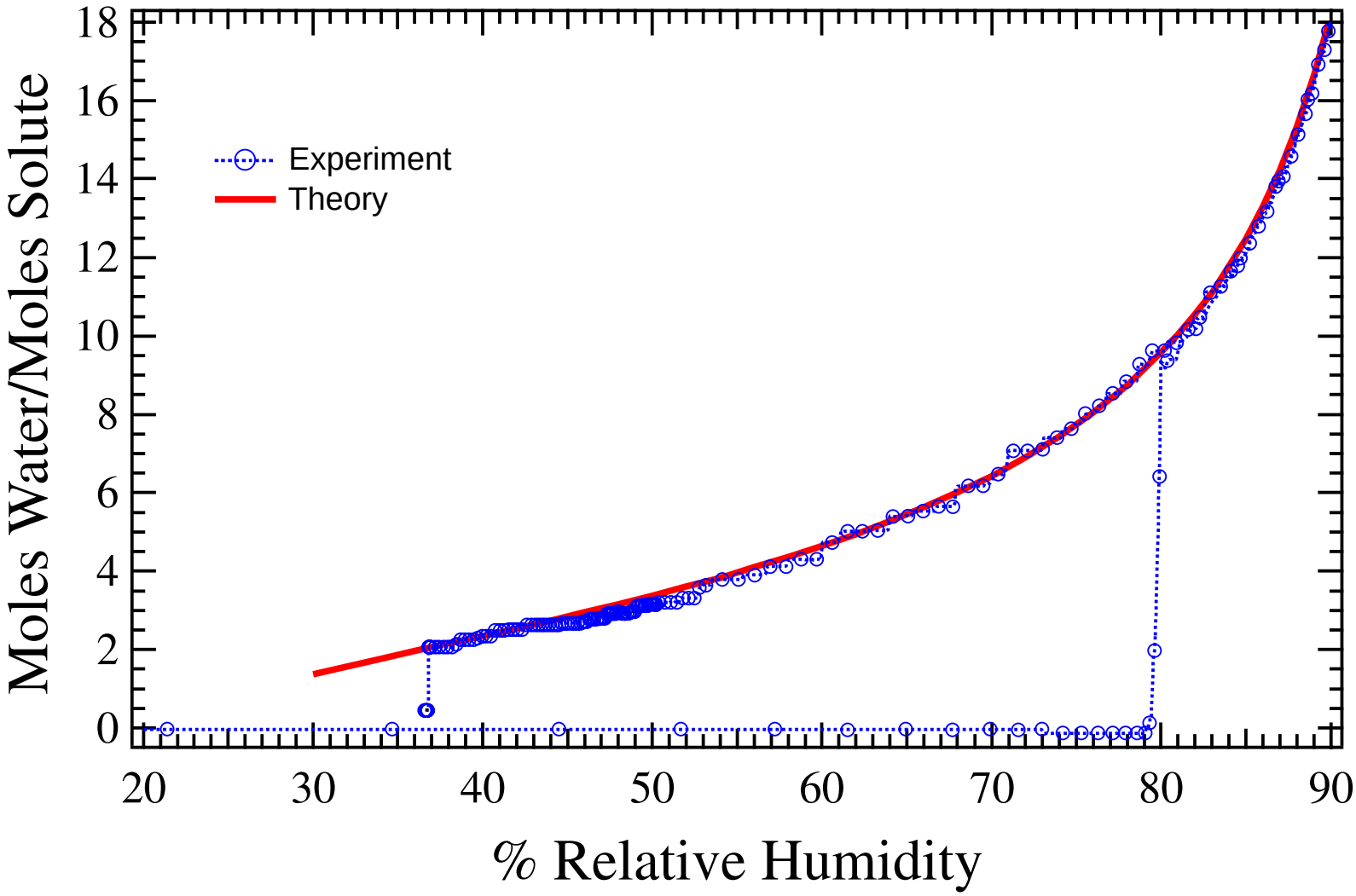
The cooling influence of anthropogenic aerosols (aerosols resulting from human activities) is thought to be of comparable magnitude to the warming influence of anthropogenic greenhouse gases over the industrial period.

However the aerosol influence is highly uncertain, much more uncertain than the warming influence of greenhouse gases.



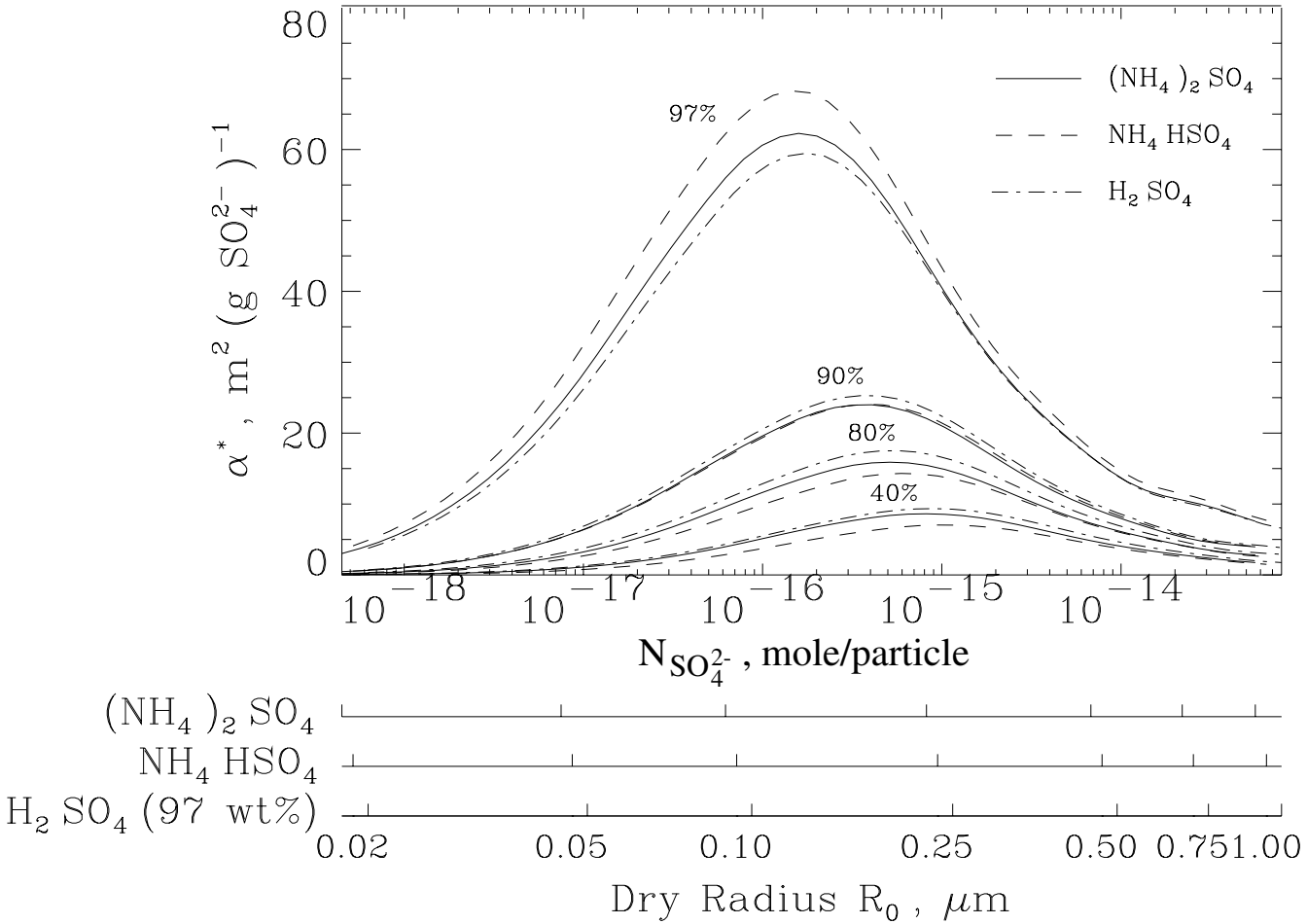
Climate forcing by anthropogenic aerosols is considered to be the greatest forcing of climate change over the industrial period.

Laboratory Studies of Aerosol Properties



Note unstable supersaturated solution phase present only as relative humidity is decreased.

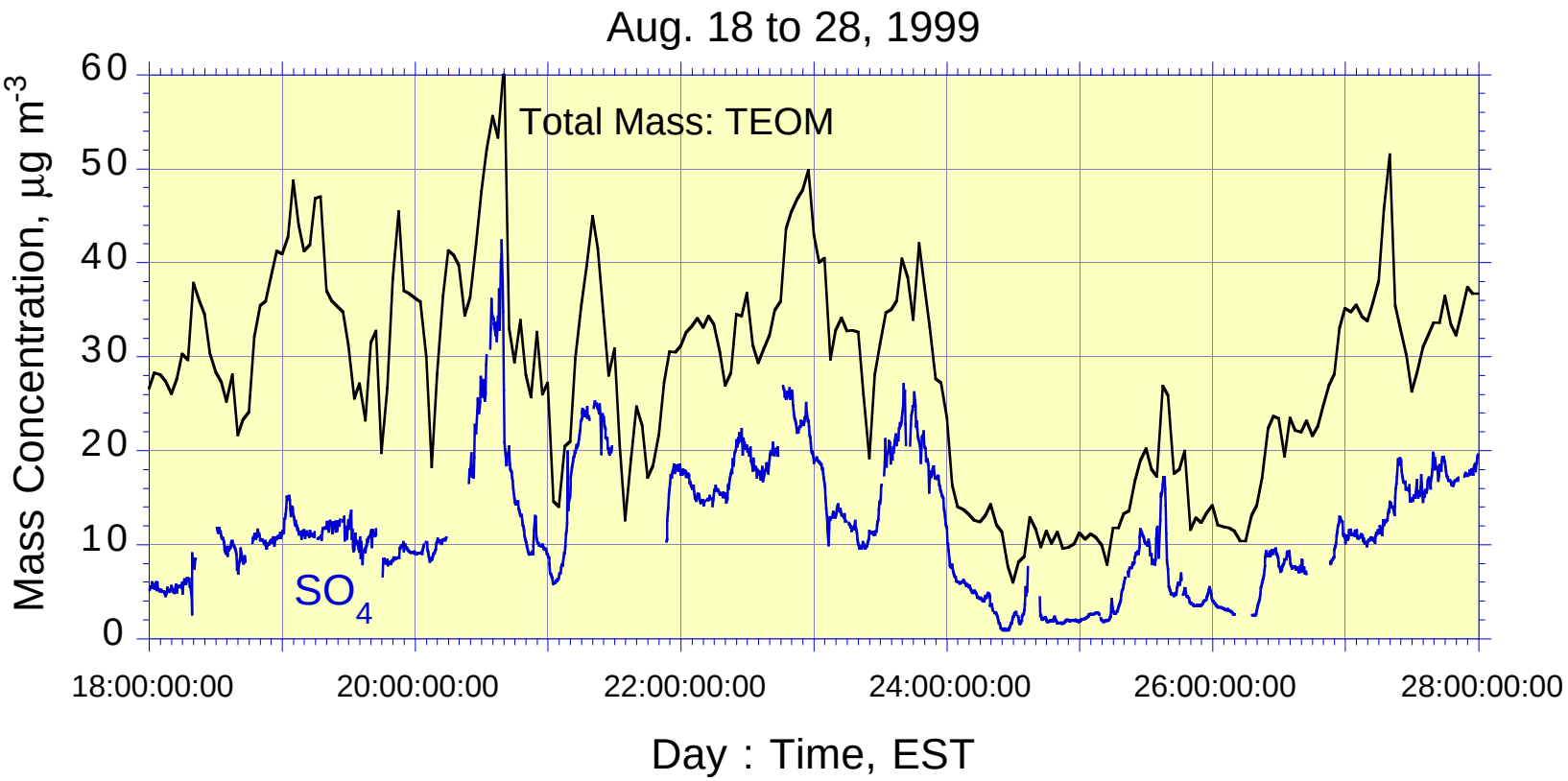
Calculation of Properties of Atmospheric Aerosols



These properties are required to represent aerosol influences in radiation transfer models.

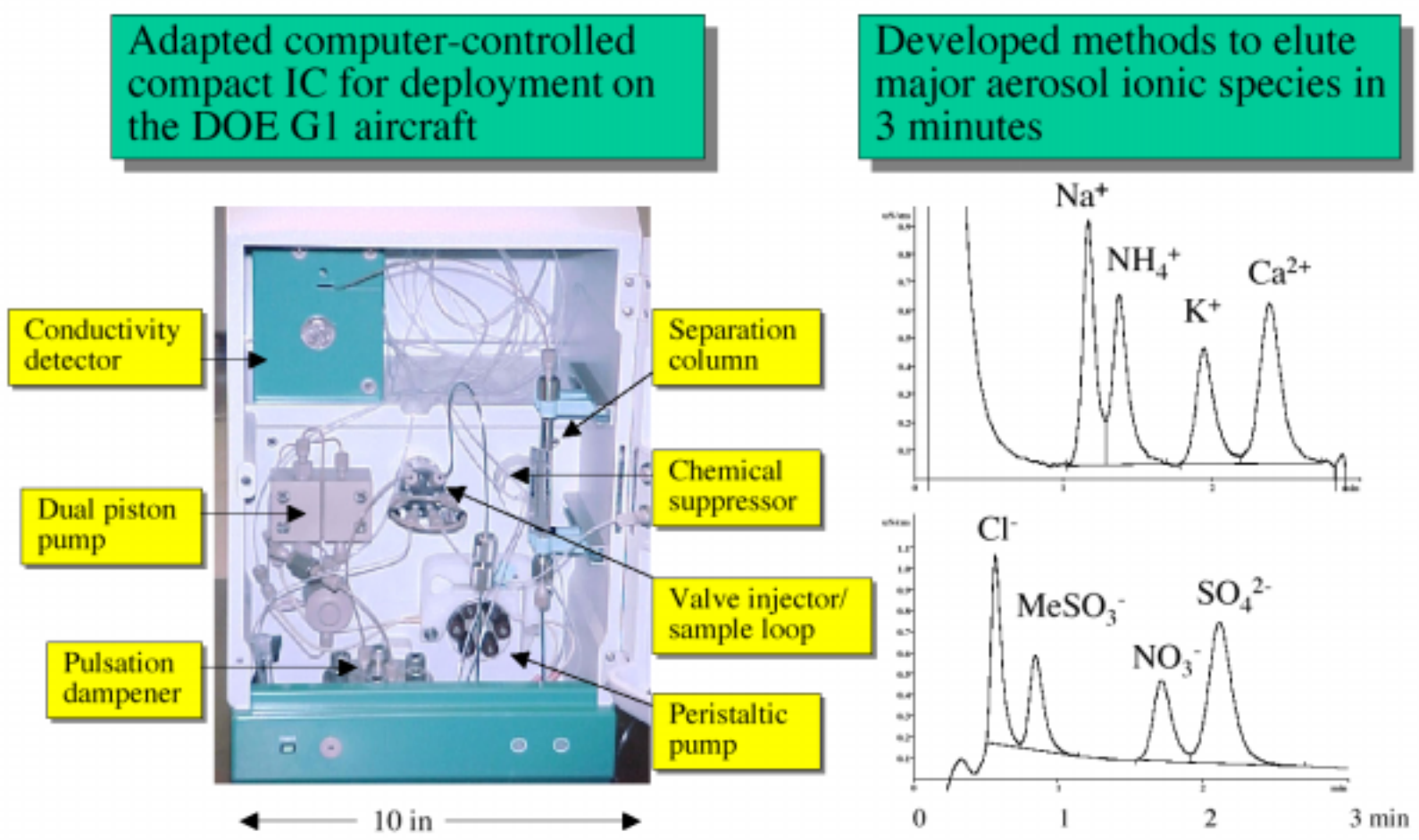
Instrument Development and Testing

BNL has recently developed a new method for rapid continuous determination of aerosol composition:



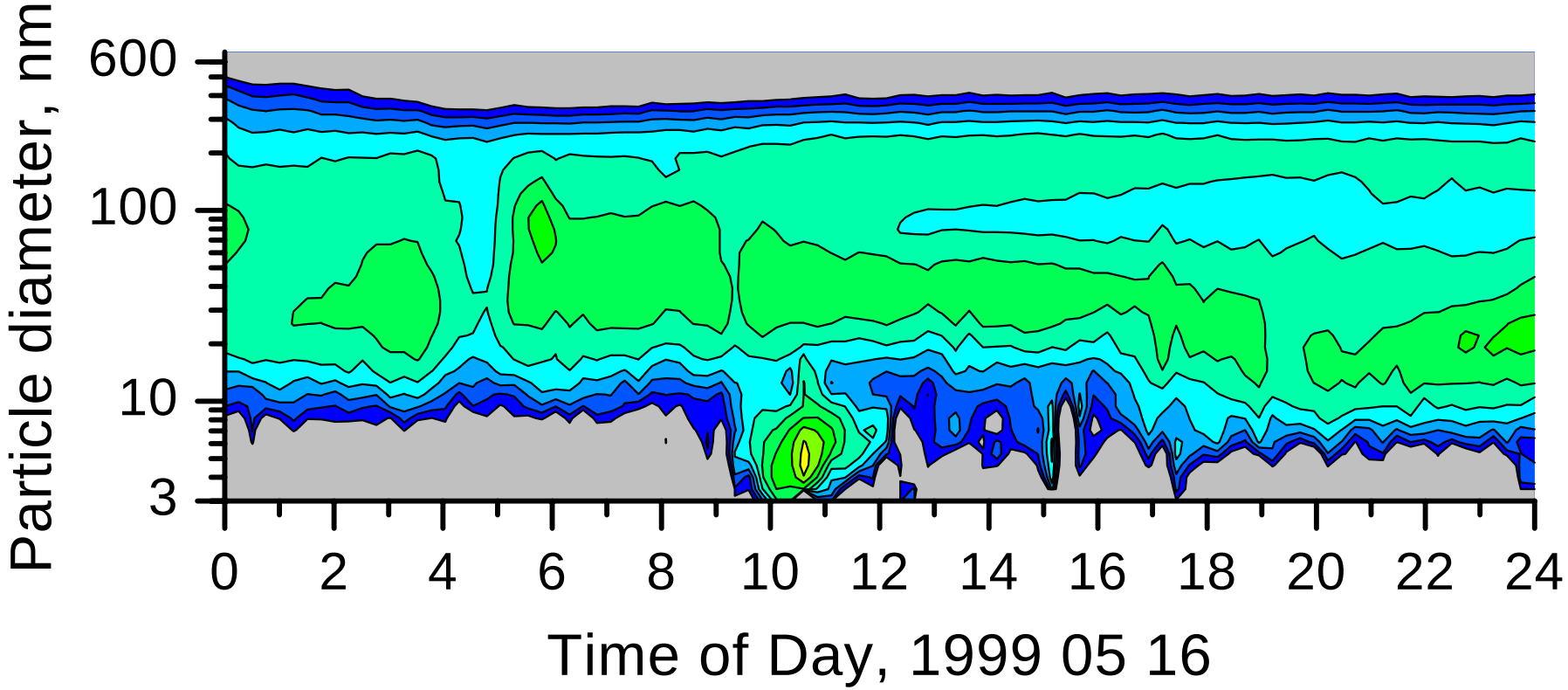
Note tracking of sulfate concentration with total aerosol mass. ***Such information would not be available with conventional filter sampling.***

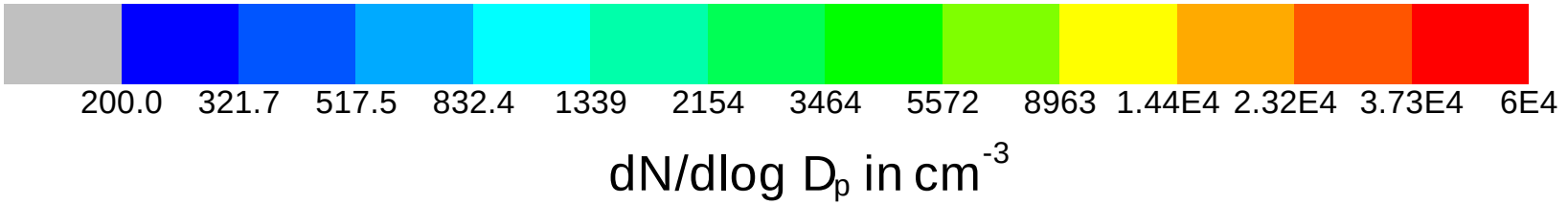
Adaptation for Aircraft Use



A compact instrument is being developed for use on the DOE G-1 research aircraft.

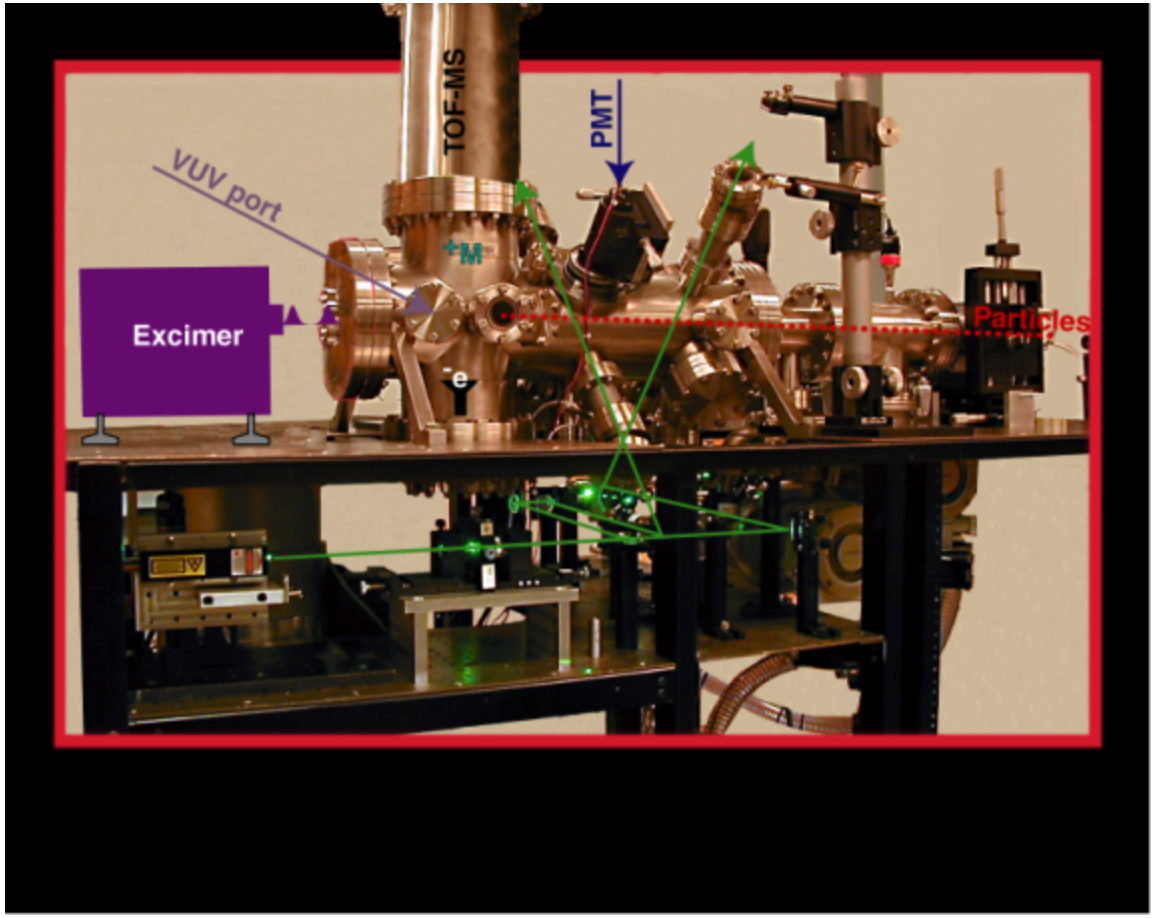
Measurement of Aerosol Size Distribution





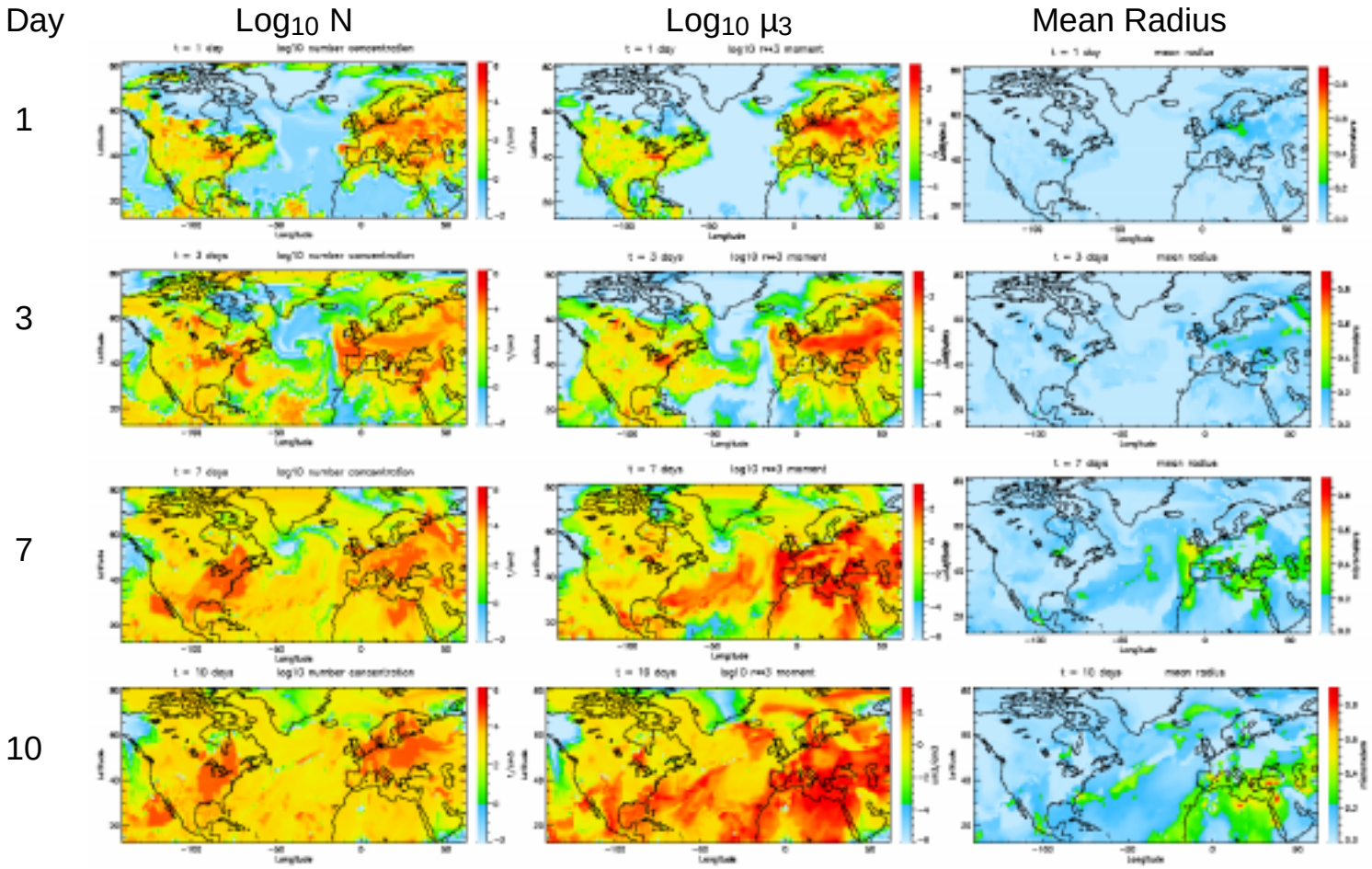
Note burst of new particles in mid morning.

SPLAT: **S**ingle **P**article **L**aser **A**blation **T**ime-of-flight-mass-spectrometer



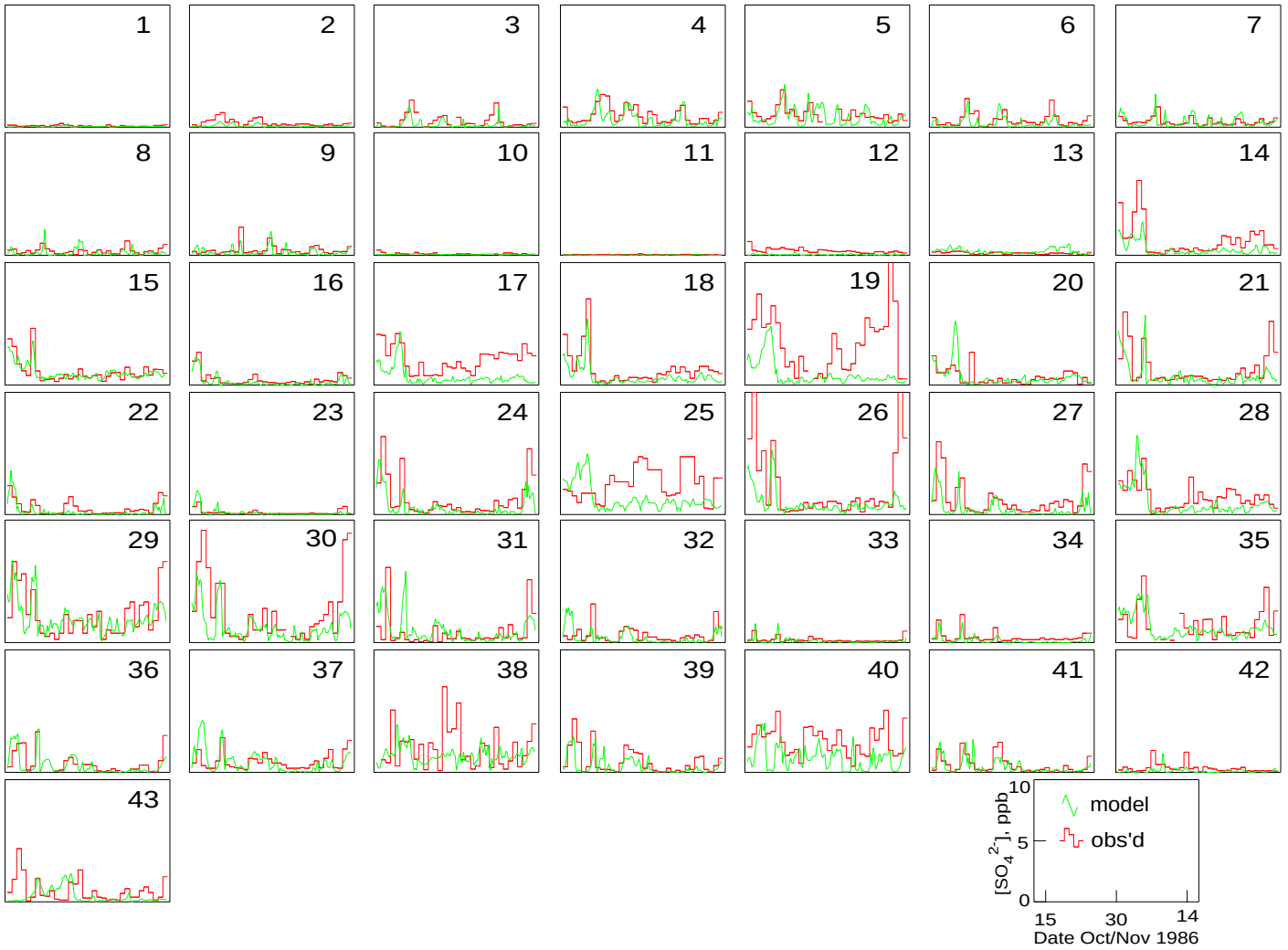
Newly built high-efficiency single-particle mass spectrometer was first deployed in field measurements in summer 2000.

Modeling the Evolution of Aerosol Loading and Properties



Note evolution of aerosol loading and properties with time.

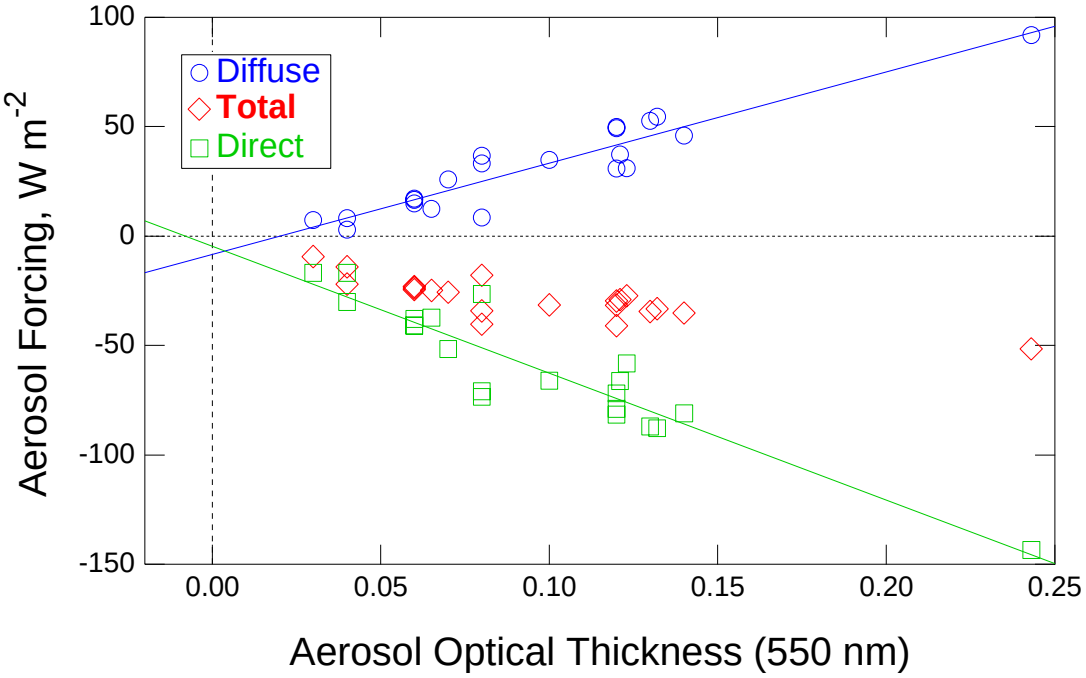
Model Evaluation



Driving the model by observation-derived meteorological data allows model evaluation by comparison with observation.

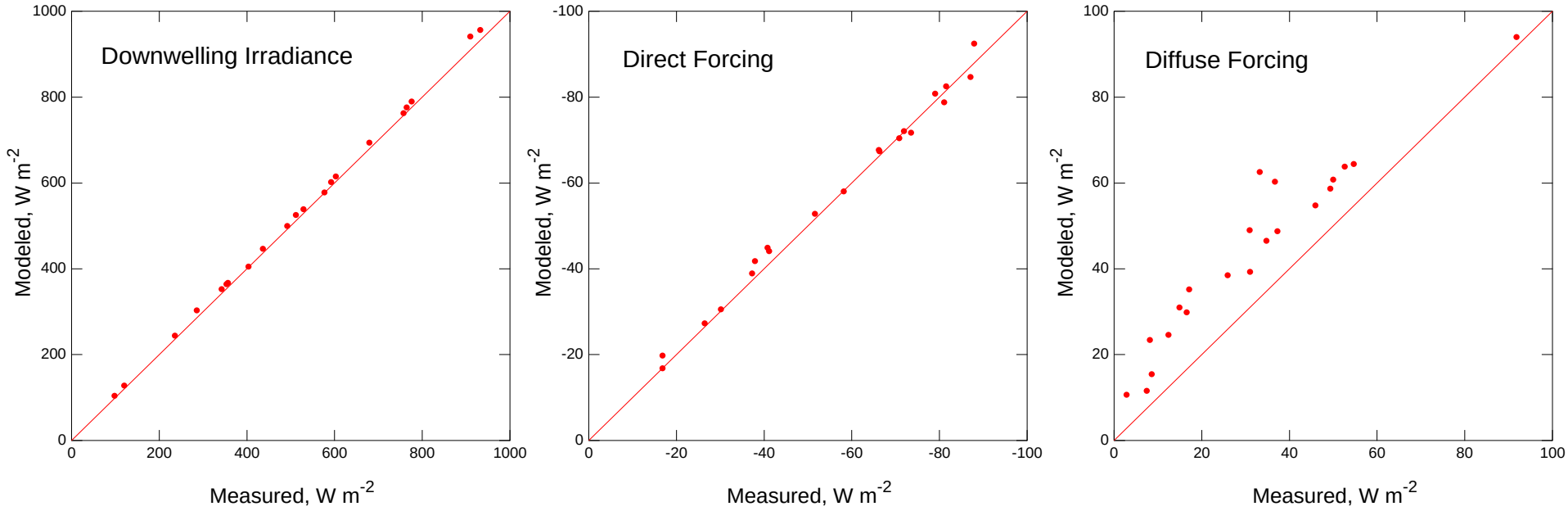
Direct Measurement of Aerosol Forcing of Surface Irradiance

Measurements under cloud-free skies at DOE Atmospheric Radiation Measurement Site in North Central Oklahoma:



- Aerosol scattering **decreases direct** irradiance, **increases diffuse** irradiance.
- Aerosols **decrease total surface irradiance (direct + diffuse)**.

Comparison with Radiation Transfer Model



Systematic discrepancy in diffuse forcing suggests atmospheric absorption not accounted for in present atmospheric models.

Looking to the Future...

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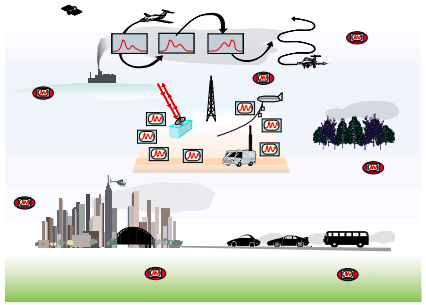
DOE/SC-0034

Tropospheric Aerosol Program

Tropospheric Aerosol Program



Program Plan

March 2001

U. S. Department of Energy
Office of Science
Office of Biological and Environmental Research
Environmental Sciences Division