Determining the Impact of Tropospheric Aerosol Particles on Climate and Air Quality using Shipboard Observations

Scientific Questions

PMEL’s Atmospheric Chemistry Program addresses NOAA’s mission to understand and predict changes in Earth’s environment to meet our Nation’s economic, social and environmental needs. Our research is driven by two main scientific questions:

• How do aerosols evolve as they are transported away from the source region and what impact does this evolution have on the remote atmosphere?

• How do tropospheric aerosol particles that are produced within or transported to a particular region affect regional air quality and aerosol radiative forcing of climate?

Research Strategy

We are addressing these questions with shipboard observations of aerosol properties around the world. These measurements provide our customers (air quality and climate modelers) with web based data sets of aerosol properties which allows for the parameterization of key aerosol processes in air quality and climate models and the reduction of model uncertainties.

Recent Accomplishments

Comparison of regional aerosol properties to constrain climate models

As part of the Climate Change Science Program (CCSP), measurements made during intensive field campaigns were used to constrain radiative transfer calculations of direct climate forcing. The resulting top of the atmosphere direct climate forcings were on average, 37.7% larger than those obtained using “a priori” optical properties (Bates et al., 2005).

Development of aerosol parameterizations for use in air quality and climate models

In situ measurements that determine the role of aerosol properties in particle activation are needed to improve estimates of cloud droplet formation by global climate models. The measurements made during GAWCCS showed that both composition and size are required for accurate estimates of cloud condensation nuclei (CCN) concentrations. Including the HOA (organic) mass fraction in models can increase the accuracy of estimates of CCN by more than 50% over the assumption of a fixed global mean organic aerosol concentration (Quinn et al., 2008).

Future Directions

We will continue bi-annual air quality/climate cruises to investigate aerosol distributions, properties, and processes in new regions around the globe. The 2010 experiment will take place off the coast of California in conjunction NOAA/ESRL/CSD and NOAA aircraft. We will be working with the California Air Resources Board and the California Energy Commission to assess regional air quality and climate. The data we collect will be made available through our web-based data server.

Linkages to NOAA’s Strategic and Research Plans

NOAA Strategic Plan - Performance Objectives

- Describe and understand the state of the climate system through integrated observations, analysis and data stewardship.

NOAA Research Area and Milestones

Document and understand changes in climate forcings and feedbacks, thereby reducing uncertainty in climate projections.

- Execute field missions to understand the transport and properties of absorbing aerosols and their precursors to the Arctic polar region as part of the International Polar Year. [Participated in ICARUS onboard RV Froude]
- Initiate cloud/aerosol interaction field study. [Performed in air aerosol and cloud condensation nuclei measurements during GAWCCS and IDEA-07]
- Reduce uncertainty in model simulations of the influence of aerosols on climate. [See Recent Accomplishments]

Provide information to air quality decision makers and improve NOAA’s national air quality forecast capability.

- Conduct field campaign to characterize wintertime particulate matter formation and growth. [Participated in ICARUS onboard RV Froude]
- Conduct field campaign in California to characterize drivers of poor air quality: 2010 and shipboard component of CalNex2010 – see Future Directions

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