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Deployment of ARM Aerial Facility Scanning Mobility Particle Sizer Field Campaign Report

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ARM

CLIMATE RESEARCH FACILITY

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Executive Summary

Atmospheric aerosols influence global climate by scattering and absorbing sunlight (direct effects) and by changing the microphysical structure, lifetime, and coverage of clouds (indirect effects). While it is widely accepted that aerosol indirect effects cool the Earth-atmosphere system by increasing cloud reflectivity and coverage, the magnitudes of the indirect effects are poorly quantified. One key aerosol property for understanding aerosol indirect effects is the ability of aerosol particles to form cloud droplets at atmospheric relevant supersaturations—i.e., cloud condensation Nuclei (CCN) activity. For particles consisting of typical atmospheric inorganic compounds, their CCN activity is well understood and can be effectively predicted using Köhler theory based on physicochemical properties of the solute, such as its mass, molar volume, and activity coefficient. However, atmospheric aerosols often consist of hundreds of organic species, which can contribute ~20-90% to the total fine aerosol mass. Depending on their properties, organic species can significantly influence the ability of aerosol particles to act as CCN and form cloud droplets. This project focuses on the CCN activity of secondary organic aerosol (SOA) compounds formed from key biogenic volatile organic compounds (VOCs) under representative conditions, and the relationship between the hygroscopicity and composition of organic aerosols.

The U.S. Department of Energy (DOE) Atmospheric Radiation Measurement (ARM) Climate Research Facility Aerial Facility (AAF) scanning mobility particles sizer (SMPS) was deployed during a ~ 2-week intensive measurement campaign, taking place February 10-February 23, 2016 at the Pacific Northwest National Laboratory (PNNL) Environmental Simulation Chamber. The SMPS was operated with a CCN counter (CCNc). Aerosol particles were first classified by the differential mobility analyzer inside the SMPS; the classified aerosol will then be simultaneously characterized by a condensation particle counter (CPC) (part of the SMPS) and the CCNc.

Acronyms and Abbreviations

AAF	ARM Aerial Facility
ARM	Atmospheric Radiation Monitoring Climate Research Facility
ASR	Atmospheric Systems Research
BNL	Brookhaven National Laboratory
BVOC	biogenic volatile organic carbon
CCN	cloud condensation nuclei
CCNc	CCN counter
CPC	condensation particle counter
DMA	differential mobility analyzer
DOE	U.S. Department of Energy
POA	primary organic aerosol
SMPS	scanning mobility particle sizer
SOA	secondary organic aerosol
VOC	volatile organic carbon

Contents

1.0 Background

Atmospheric aerosols influence global climate by scattering and absorbing sunlight (direct effects) and by changing the microphysical structure, lifetime, and coverage of clouds (indirect effects). While it is widely accepted that aerosol indirect effects act to cool the Earth-atmosphere system by increasing cloud reflectivity and coverage, the magnitudes of the indirect effects are poorly quantified. One key aerosol property for understanding aerosol indirect effects is the ability of aerosol particles to form cloud droplets at atmospheric relevant supersaturations (i.e., CCN activity). For particles consisting of typical atmospheric inorganic compounds, their CCN activity is well understood and can be effectively predicted using Köhler theory based on physicochemical properties of the solute, such as its mass, molar volume, and activity coefficient. However, atmospheric aerosols often consist of hundreds of organic species, which can contribute ~20-90% to the total fine aerosol mass. Depending on their properties, organic species can significantly influence the ability of aerosol particles to act as CCN and form cloud droplets. This project focuses on the CCN activity of SOA compounds formed from key biogenic VOCs under representative conditions, and the relationship between the hygroscopicity and composition of organic aerosols.

The AAF SMPS was deployed during a ~ 2 week intensive measurement campaign, taking place February 10-February 23, 2016 at the PNNL Environmental Simulation Chamber. The SMPS was operated with a CCNc. Aerosol particles were first classified by the differential mobility analyzer inside the SMPS, the classified aerosol will be then simultaneously characterized by a CPC (part of the SMPS) and the CCNc.

The principle investigator of this deployment is Jian Wang from Brookhaven National Laboratory (BNL). Co-investigator is Dr. Fan Mei from PNNL.

2.0 Notable Events or Highlights

The deployment of the AAF went smoothly. No unusual observations were made.

3.0 Results

The deployments of the AAF SMPS provided aerosol size spectrum from 40 to 250 nm, a size range in which CCN activity is strongly influenced by particle composition. The aerosol size spectrum data are now available from the ARM Data Center.

4.0 Publications

4.1 Journal Articles/Manuscripts

Data analysis is still ongoing. A manuscript describing the results from this deployment is planned.


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