U.S. DEPARTMENT OF ENERGY | Office of Science

DOE/SC-ARM-15-080

Observations and Modeling of the Green Ocean Amazon 2014/15: Transmission Electron Microscopy Analysis of Aerosol Particles Field Campaign Report

P Buseck

March 2016

ARM CLIMATE RESEARCH FACILITY

DISCLAIMER

DOE/SC-ARM-15-080

Observations and Modeling of the Green Ocean Amazon 2014/15: Transmission Electron Microscopy Analysis of Aerosol Particles Field Campaign Report

P Buseck, Arizona State University
Principal Investigator

March 2016

Work supported by the U.S. Department of Energy,
Office of Science, Office of Biological and Environmental Research

Executive Summary

During two Intensive Operational Periods (IOP), we collected samples at 3-hour intervals for transmission electron microscopy analysis. The resulting transmission electron microscopy images and compositions were analyzed for the samples of interest. Further analysis will be done especially for the plume of interest.

We found solid spherical organic particles from rebounded samples collected with Professor Scot Martin's group (Harvard University). Approximately 30% of the rebounded particles at 95% relative humidity were spherical organic particles. Their sources and formation process are not known, but such spherical particles could be solid and will have heterogeneous chemical reactions.

We observed many organic particles that are internally mixed with inorganic elements such as potassium and nitrogen. They are either homogeneously mixed or have inorganic cores with organic aerosol coatings.

Samples collected from the Manaus, Brazil, pollution plume included many nano-size soot particles mixed with organic material and sulfate. Aerosol particles from clean periods included organic aerosol particles, sulfate, sea salt, dust, and primary biogenic aerosol particles. There was more dust, primary biogenic aerosol, and tar balls in samples taken during IOP1 than those taken during IOP2. Many dust particles were found between March 2 and 3.

Acronyms and Abbreviations

IOP	Intensive Operational Period
TEM	transmission electron microscopy

Contents

1.0 Background

Atmospheric samples collected from the Amazon Basin, a major source of natural continental aerosols impacted seasonally by biomass burning and urban emissions, are important indicators of atmospheric reactions and their effects on climate and health. We used transmission electron microscopy (TEM) to determine the spatially resolved compositions, sizes, morphologies, mixing states (i.e., aggregated, coated, embedded), and reactions to changes in relative humidity of aerosol particles of natural and anthropogenic origin.

Specific goals of this campaign are described below:

- Determine the compositions, sizes, shapes, mixing states, and phases of different particle types such as nano-size soot, tar balls, mineral dust, and organic particles as well as coarse particles such as fragments of plants and insects, pollen grains, algae, fern spores, and fungal spores in Amazonia and near Manaus, Brazil
- Develop new TEM methods for characterizing the organic material on or within individual particles to obtain compositional details and properties of primary and secondary biogenic organic particles
- Apply those results to explain micro-chemical processes between reactive gases (e.g., biogenic volatile organic compounds, sulfur dioxide, and nitrogen oxides) and particles during particle growth
- Compare monitoring-mode measurements, as well as those from fast-throughput techniques such as aerosol mass spectroscopy, with detailed TEM particle measurements.

Most of the TEM samples were collected from the T3 site at Manacapuru, Amazonia, Brazil. Samples were collected from both Intensive Operational Periods (IOPs)—i.e., from February 16 to March 27, 2014, and from September 1 to October 10, 2014—at the Mobile Aerosol Observing System-Aerosol container with help from Art Sedlacek (Brookhaven National Laboratory) and Professor Scot Martin's group (Harvard University). We also collected samples at the ZF2 site during the campaign with help from P. Artaxo's group (University of São Paulo).

2.0 Notable Events or Highlights

1. We found solid spherical organic particles from rebounded samples collected with Professor Martin's group (Harvard University). Approximately 30% of rebounded particles at 95% relative humidity were spherical organic particles. Their sources and formation process are not known, but such spherical particles could be solid and will have heterogeneous chemical reactions.
2. We observed many organic particles that are internally mixed with inorganic elements such as potassium and nitrogen. They are either homogeneously mixed or have inorganic cores with organic aerosol coatings.
3. Samples collected from the Manaus pollution plume included many nano-size soot particles mixed with organic material and sulfate. Aerosol particles from clean periods included organic aerosol particles, sulfate, sea salt, dust, and primary biogenic aerosol particles. More dust, primary biogenic aerosol, and tar balls were present in IOP1 samples than in IOP2 samples. Many dust particles were found between March 2 and 3 during IOP1.

3.0 Lessons Learned

No lessons learned are reported.

4.0 Results

We collected TEM samples at 3-hour intervals during both IOPs. The TEM images and compositions were analyzed for the samples of interest. The major results are listed in Section 2.0. Further analysis will be done, especially for the plume of interest.

5.0 Meeting Abstracts/Presentations/Posters

Adachi, K, Z Gong, AP Bateman, ST Martin, GG Cirino, P Artaxo, AJ Sedlacek III, and PR Buseck. 2014. "Single-particle analyses of compositions, morphology, and viscosity of aerosol particles collected during GoAmazon2014." Abstract A23A-3192, American Geophysical Union Fall Meeting, San Francisco, California.

Adachi, K, Z Gong, AP Bateman, S Martin, GG Cirino da Silva, P Artaxo, A Sedlacek, and PR Buseck. 2014. "Appearance and bouncing behavior of aerosol particles collected during GoAmazon 2014: An early look." Presented at the 13th iCACGP/IGAC Science Conference on Atmospheric Chemistry, Natal, Brazil.

Adachi, K. 2014. "Mixing states of aerosol particles from various environments: Transmission electron microscopy analysis." International Aerosol Conference, Busan, South Korea.

www.arm.gov

U.S. DEPARTMENT OF
ENERGY

Office of Science