Breakout Session Report
ARM/ASR User and PI Meeting
March 16-20, 2015

Session Title: Absorbing Aerosol
Session Date: Monday, March 16, 2015
Session Time: 3:30–5:50 p.m.
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Description

Understanding the sources and distributions of absorbing aerosol is critical for adequate predictions of aerosol radiative forcing. Primary absorbing aerosols—from dust, biomass burning, and fuel combustion—are difficult to discriminate with the most common measurement techniques. This session covered potential novel approaches to improving observations of absorbing aerosol and for identifying and quantifying the sources and magnitude of these aerosol.

Main Discussion

The absorbing aerosol focus area within the Aerosol Life Cycle Working Group (ALWG) has been an informal, but regular, breakout over the past few years. Absorbing aerosol is a highly relevant and timely topic in climate science, and participation in the breakouts over the past few years reveal a very deep interest and involvement in this subject within the ASR science team. However, a more formal and directed effort has not evolved naturally. This is most likely due to the very broad range of research topics that fit under the general descriptor of absorbing aerosol and also because of overlap in the existing, more formal ALWG efforts of aerosol mixing state and secondary organic aerosol. The objective of the absorbing aerosol group at this meeting was to define a more concrete path forward that would serve ASR science goals and complement the work already being done in the ALWG by other focus groups.

Among the objectives of the existing focus groups in the ALWG is to bring what is known about aerosols at the particle scale to climate models. The necessary link between these two disparate scales is bulk aerosol chemical, physical, and optical properties that dictate radiative forcing. Currently, the foremost challenge in characterizing these bulk properties is the distribution of absorption and accuracy with which we can measure it. Thus, the overarching objective of the absorbing aerosol group will be to improve measured and modeled bulk, vertically-distributed aerosol optical, chemical, and microphysical properties, and to provide information in a way that it is effectively related to aerosol process studies at the particle and larger scale as well as model parameterizations.

Three topics that have been consistently discussed by the group over the past few years were presented as a way to move forward under this overarching objective. These were 1) aerosol absorption measurement development, 2) discrimination of black carbon (BC), brown carbon (BrC), and dust in their contributions to bulk column absorption, and 3) the use of ARM campaigns as model testbed to improve process representation that controls aerosol absorption.

Rich Ferrare, National Aeronautics and Space Administration (NASA) Langley Research Center, gave an overview of efforts in measurement development involving a proof-of-concept deployment proposed at Southern Great Plains for a multi-wavelength high resolution lidar system (HSRL). A ground-based HSRL (University of Wisconsin) would be deployed alongside the ARM Raman lidar to test the NASA Langley developed retrieval algorithm for vertically-resolved particle effective radius and index of refraction, and retrieved scattering, absorption and derived single-scattering albedo using Mie theory. The

group was very interested in this new approach as the lack of knowledge of absorption vertical profiles is an obstacle to process understanding and model representation of aerosol spatio-temporal distributions.

Art Sedlacek, Brookhaven National Laboratory, provided a thought provoking overview of the current methods the community has in hand to discriminate absorbing aerosol types and asked how we might think outside the box to produce new and more informative methods. He showed that our current methods do not provide unique solutions, but adding information from existing or new measurements might allow for better solutions.

Key Findings

An interesting discussion arose regarding the second topic—discrimination of BC, BrC, and dust—and why such a strict discrimination between these aerosol types was desired. The point was made that there is a continuum of compositions and coating thicknesses that determine absorption and somewhat arbitrary lines are being forced in order to fit into existing model frameworks. Much more detailed information is available from measurements so perhaps we should be looking at the problem with respect to how aerosol 'types' are represented in models. Another interesting aspect of this discussion was concerning the use of Mie theory to guide our expectations of what optical properties are produced by particular aerosol compositions and morphologies. It was suggested by Chis Cappa, University of California, Davis, that we consider whether our theory is appropriate for this applications.

Decisions

Since very little time is available at the spring principal investigator meeting for the working groups to meet, specific decisions on a path forward were not made. Rather, attendees were asked to make known their interest in participating in any of these sub-areas. The bulk of the post-meeting interest was in a concerted effort to make a field inter-comparison campaign a reality and a small group is currently working on plan for a proposal.

Needs

Many of the needs that came through in discussion were measurement needs, indicating the importance in this research area of improving our ability to measure aerosol absorption and the relevant controlling properties:

- In situ measurements with higher spectral range and resolution
- Better characterization of super-micron particles and their role in light extinction and absorption
- Coincident single particle and bulk aerosol property measurements (such as in the Two-Column Aerosol Project) to provide a link between detailed particle scale information and radiative properties observable by satellite and represented by climate models
- Laboratory measurements to characterize refractive indices of different absorbing aerosol types and at different stages in their evolution.

Future Plans

The leaders of the group plan to pursue directed activities in each of the sub-topics outlined here. The first step will be to gauge interest within the ALWG and build teams to work within each area. Identifying

leaders and a structure for discussion at the next meeting that will commence activity in each of these areas will be the first steps before the group comes together again in discussion.