OBSERVATIONAL STUDIES OF ATMOSPHERIC AEROSOLS IN THE LOWER TROPOSPHERE USING MULTIPLE SENSORS

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1. Problem Addressed

Aerosols play an important role in the radiative forcing of the climate system. However, the diversity of aerosol species and their highly variable spatial and temporal distribution in the atmosphere make it difficult to understand the role aerosols play on the radiative forcing of the climate system. This has led the Intergovernmental Panel on Climate Change (IPCC) to state in the Fourth Assessment Report (FAR) that the radiative forcing associated with aerosols has a low level of scientific understanding [1].

Long term studies of aerosols are being carried out using various deployment strategies in an effort to better understand the role of aerosols on the radiative forcing of the climate system. These deployment strategies include networks of common instruments such as the Aerosol Robotic Network (AERONET) [2] that monitor aerosol optical properties over long periods of time from geographically diverse sites, multiple instrument deployments at field sites such as the Southern Great Plains cloud and radiation test bed site operated by the Atmospheric Radiation Measurement program [3], and multi-investigator field campaigns such as the Aerosol Characterization Experiment (ACE) [4]. Because of the spatial and temporal variations of atmospheric aerosols, small-scale, long-term studies of atmospheric aerosols from a variety of locations can complement these larger field campaigns. Researchers at Montana State University are developing and deploying multiple remote sensing and in-situ instruments for characterizing atmospheric aerosols in the lower troposphere for long term studies of atmospheric aerosols.

In this presentation, a brief overview of the instruments developed at Montana State University will be presented. Coordinated data used to characterize the atmospheric aerosols collected in August and September of 2009 at Montana State University in Bozeman, Montana (45.66 N, 111.04 W, elevation 1530 m) using the multiple instruments will also be presented.

2. Methods

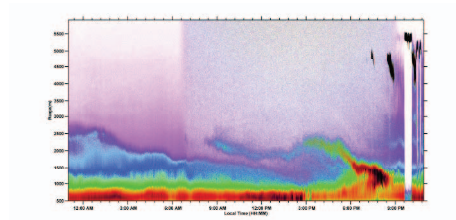

Figure 1 The range corrected returns.

Researchers at Montana State University are developing and deploying multiple remote sensing and in-situ instruments for characterizing atmospheric aerosols in the lower troposphere. Instruments developed and currently deployed include a two color lidar [5] and micro-pulse differential absorption lidar (DIAL) [6]. Other instruments deployed include a solar radiometer as part of the NASA run AERONET program [2], a ground-based nephelometer, and a ground-based particle counter. Instruments currently under development include a high spectral resolution lidar.

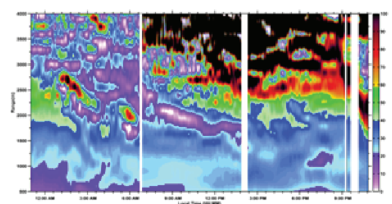

Figure 2 The relative humidity as a function of range and time.

The data products from the instruments currently deployed at Montana State University allow the atmospheric aerosol optical and microphysical properties to be characterized. The data products for the water vapor DIAL instrument include the return signal as a function of range for both the on-line and off-line wavelengths, shown in figure 1, water vapor number density profiles, and relative humidity profiles, shown in figure 2. The data products for the two color lidar instrument include the return signal at both the 532 nm and 1064 nm wavelengths as a function of range, vertical profiles of the aerosol backscatter and extinction at both wavelengths, and the aerosol optical depth for each wavelength. A plot of the aerosol backscatter at 532 nm is shown in figure 3. The data products from the Cimel solar radiometer include the aerosol optical depth and the Angstrom exponents. The inversions applied to the almucantar scans completed by NASA through the AERONET program [2] provide the column integrated aerosol phase, the single scatter albedo, the complex index of refraction, and the aerosol size distribution for accumulation and coarse modes shown in

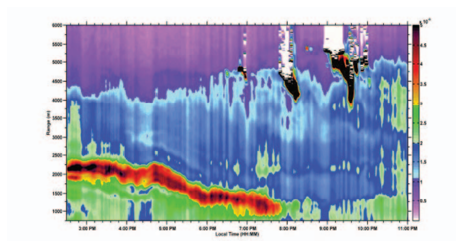

Figure 3 The aerosol backscatter at 532 nm measured using the two color lidar.

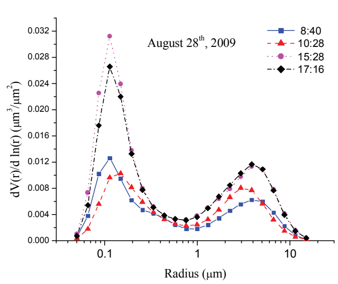

Figure 4 A plot of the bimodal lognormal size distribution.

figure 4. The data product for the ground based nephelometer provides measurements of the aerosol scattering extinction at 530 nm. The data product for the ground based particle counter provides measurements of the aerosol size distribution in the accumulation mode.

3. Conclusions

The ability to characterize atmospheric aerosols is enhanced by using multiple instruments. The use of multiple instruments minimizes the assumptions needed to infer aerosol optical properties. The ability to characterize aerosol optical properties as well as classify aerosols using aerosol models [7,8] is leading to a better understanding of the role of aerosols on the radiative forcing of the climate system.

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