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Two-Column Aerosol Project (TCAP): Ground-Based Radiation and Aerosol Validation Using the NOAA Mobile SURFRAD Station
Field Campaign Report

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ARM CLIMATE RESEARCH FACILITY

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Acronyms and Abbreviations

AERONET	Aerosol Robotic Network
AMF	ARM Mobile Facility
AOD	aerosol optical depth
ARM	Atmospheric Radiation Measurement Climate Research Facility
DARF	direct aerosol radiative forcing
DOE	U.S. Department of Energy
GOES-R	Geostationary Operational Environmental Satellite R-Series
MFR	Multi-Filter Radiometer
MFRSR	Multi-Filter Rotating Shadowband Radiometer
NOAA	National Oceanic and Atmospheric Administration
PNNL	Pacific Northwest National Laboratory
TCAP	Two-Column Aerosol Project

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1.0 Background

The National Oceanic and Atmospheric Administration (NOAA) is preparing for the launch of the Geostationary Operational Environmental Satellite R-Series (GOES-R) satellite in 2015. This satellite will feature higher time (5-minute versus 30-minute sampling) and spatial resolution (0.5 km vs 1 km in the visible channel) than current GOES instruments provide. NOAA's National Environmental Satellite Data and Information Service has funded the Global Monitoring Division at the Earth System Research Laboratory to provide ground-based validation data for many of the new and old products the new GOES instruments will retrieve specifically related to radiation at the surface and aerosol and its extensive and intensive properties in the column. The Two-Column Aerosol Project (TCAP) had an emphasis on aerosol; therefore, we asked to be involved in this campaign to de-bug our new instrumentation and to provide a new capability that the U.S. Department of Energy (DOE) Atmospheric Radiation Measurement (ARM) Climate Research Facility's Mobile Facilities (AMF) did not possess, namely surface albedo measurement out to 1625 nm. This gave us a chance to test remote operation of our new multi-filter rotating shadowband radiometer/multi-filter radiometer (MFRSR/MFR) combination. We did not deploy standard broadband shortwave and longwave radiation instrumentation because ARM does this as part of every AMF deployment. As it turned out, the ARM standard MFRSR had issues, and we were able to provide the aerosol column data for the first 2 months of the campaign covering the summer flight phase of the deployment. Using these data, we were able to work with personnel at Pacific Northwest National Laboratory (PNNL) to retrieve not only aerosol optical depth (AOD), but single scattering albedo and asymmetry parameter, as well.

The data obtained from the MFRSR/MFR combination can be found at the web site http://www.arm.gov/campaigns/amf2012tcap. Click on *Michalsky* under "Guest Ground-Based Data" for access to the AOD and surface albedo data. These MFRSR data are at wavelengths near 415, 500, 673, 870, and, for the first time at a ground station, 1625 nm. The purpose in changing from the standard 615-nm filter to one at 1625 nm was to improve the retrieval of the large-mode-size distribution of aerosols. This also should allow a better estimate of the spectral albedo over more of the solar wavelengths because there is now a measurement in the middle of the near-infrared region. This was a changed to ARM albedo measurements as suggested in the study by McFarlane et al. (2011).

The AODs were obtained every 20 seconds between June 28 and September 6, 2012, with some outages primarily resulting from instrument and communications problems. Nevertheless, an interesting data set was obtained.

Kassianov et al. (2013) studied the diurnal variability of AOD, single-scattering albedo, and asymmetry parameter at the Cape Cod site and found it to be as variable in AOD as some urban and/or industrial sites as determined in other studies. The main question addressed in their paper was whether a daily averaged AOD was sufficient for determining the average direct aerosol radiative forcing (DARF) with these strong diurnal changes present. They found that the effect on DARF was negligible as long as modest temporal sampling captured the changes. This suggested that, at a minimum, both morning and afternoon sampling by satellites or ground instruments is needed to obtain an approximately correct DARF.

Another significant finding in this study concerned the intensive properties of single-scattering albedo and asymmetry parameter. Although the AOD could vary by as much as 300% during the day (Figure 1) and had a diurnal change that averaged 30% during the study period, the variability in single scattering albedo and asymmetry parameter were modest. The standard deviation over 29 days was only 3% in asymmetry parameter and 1% in single-scattering albedo, while it was over 60% in AOD.

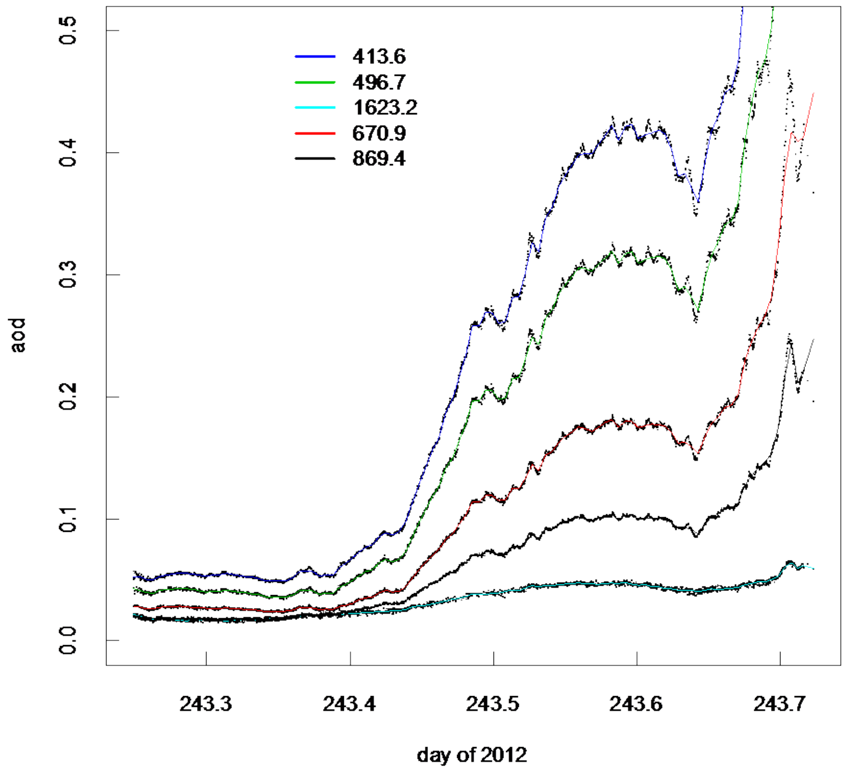

Figure 1. Aerosol optical depth at TCAP on Cape Cod on August 30, 2012. The 496.7-nm AOD (in green) is around 0.05 in the morning and increases to 0.3, and higher, in the afternoon.

Rainer Volkamer led a University of Colorado team that also used the data to compare their AOD retrievals based on a differential optical absorption spectroscopy to the MFRSR, to the Aerosol Robotic Network (AERONET), and to the High Spectral Resolution Lidar. Ivan Ortega and colleagues presented these comparisons in a poster at the American Geophysical Union (Ortega et al., 2012).

2.0 Lessons Learned

Most of the data losses were associated with communications issues and power failures that plagued this experiment, especially in the early stages. The narrow communications bandwidth would not allow time for the data set to be completely downloaded before it was terminated. As a result, we had to restart the transfer of data, but even more data needed to be transferred the second time. Fortunately, Carlos Sousa and Vaughn Ivans came to our rescue by hand-downloading the data from our instruments directly to a computer. Power failures caused some data loss, but this issue was minor compared to the communications issues discussed above. At the beginning of the experiment, the site manager decided to relocate our MFRSR after the system had been set up and we had gone for home for the day. Turning the power off before the data download was completed resulted in the loss of data that had been collected over several days.

This problem with communications led us to establish our own independent data acquisition and communications system using broadband cellular service to remotely control our systems and acquire our data.

3.0 Future Analysis

More analyses of these data are expected. For example, single-scattering albedo and asymmetry parameters also are retrieved by AERONET when conditions permit. The greatest confidence in these data is achieved when the AOD exceeds 0.4. We would like to compare results for these conditions, but also for conditions when AODs are less, to see when the retrievals depart from each other. Of course this can be done when AERONET and MFRSRs are collocated.

4.0 References

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