Demonstration of the 2D MAX-DOAS instrument: comparison with HSRL, MFRSR and in-situ aerosol optical properties during TCAP

The two Column Aerosol Project (TCAP) investigated uncertainties in the aerosol direct effect in the northern hemisphere mid-latitudes. The DOE Atmospheric Radiation Measurement (ARM) Mobile Facility (AMF) and Mobile Aerosol Observing System (MAOS) provided opportunities for 1) atmospheric radiation closure studies, and 2) test retrievals of aerosol optical properties in the presence and absence of clouds. The University of Colorado deployed an innovative instrument, the 2D scanning ground Multi Axis Differential Optical Absorption Spectroscopy (2D-GMAX-DOAS) instrument to access column and profile information about aerosol optical properties and trace gases in the lower atmosphere.

Ground based deployment
- The 2D-GMAX-DOAS (B) and Cavity Enhanced (CE-) DOAS (C) instruments were deployed at the AMF site (A) from 1 Jul – 13 Aug 2012.

Ground based super site

2D-GMAX-DOAS

<table>
<thead>
<tr>
<th>2D-GMAX-DOAS</th>
<th>CE-DOAS</th>
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<tbody>
<tr>
<td>EA: 1°, 3°, 6°, 10°, 20°, 30°, 45° and zenith</td>
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<tr>
<td>View: North-South</td>
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<tr>
<td>Azimuth: 5, 10, 15, 180° (both sides)</td>
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<tr>
<td>3 spectrometers, 300-631 nm, 0.4-0.6nm FWHM</td>
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<tr>
<td>Acton-PIXIS spectrometer, 390-490nm, 0.5nm FWHM</td>
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<tr>
<td>Species: NO₂, CHOCHO, O₃, HCHO, IC, Raman</td>
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<tr>
<td>Scattering Probability (RSP)</td>
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</table>

Data analysis

Spectra were analyzed with the DOAS method in order to obtain differential Slant Column Densities (dSCD) in the visible and UV (D) spectral region.

Conclusions and Outlook

- 2D-GMAX-DOAS provides effective means to measure profiles of trace gases and aerosol optical properties simultaneously (no need for radiation calibration).
- NO₂ layers aloft are observed to be often decoupled from the surface.
- Aerosol extinction profiles and AOD agree well with HSRL and MFRSR.
- The MAX-DOAS technique is extended to aerosol microphysical properties.

Acknowledgments

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Aerosol extinction profile

Sun normalized radiances are modeled by a Monte Carlo Radiative Transfer Model (McArtim) and a Levenberg-Marquardt non-linear inversion is used to retrieve extinction profiles. (modified based on Prados Ramon et al., 2010, ACP)

Aerosol Microphysical properties

Extinction profiles: HSRL comparison

We compare retrievals of aerosol extinction profiles (360, 450, and 560 nm) with the High Spectra Resolution Lidar (HSRL, 355 and 532nm).

AOD: comparison with MFRSR and HSRL

The integrated extinction profile below 4km is compared with the AOD retrieved from the NOAA Multi Filter Rotating Shadowband Radiometer (MFRSR 450 and 560 nm) and HSRL (355 and 532nm).

NO₂ trace gas profile

Trace gas profile retrieved by a linear inversion using Optimal Estimation.