Aerosol property retrievals from UV-MFRSR irradiance measurements during MCMA-2003

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Introduction

- Instrumentation and data
- MCMA-2003 field campaign
- Research objectives
- Retrieval technique
- Results and comparisons
- Future plans

The UV-MFRSR instrument

- Ultraviolet multi-filter rotating shadowband radiometer by Yankee Environmental Systems
- Measures total horizontal, direct normal, and diffuse horizontal solar irradiance every 20 seconds (averaged over 3 minutes)
- 7 independent filters with passbands centered at 300, 305, 311, 317, 325, 332, and 368 nm

Image provided by USDA UV-B Monitoring and Research Program

The MCMA-2003 field campaign

- Air pollution measurement and modeling campaign in the Mexico City Metropolitan Area (MCMA)
- International team of 30 scientists, post-docs, and students led by Mario and Luisa Molina of MIT
- Timeframe of 5 weeks from April to May 2003 during the period of maximum photochemical activity
- Immobile instruments located at Centro Nacional de Investigación y Capacitación Ambiental (CENICA)
Research objectives

- Retrieve the total column ozone for each day
- Retrieve aerosol optical depths and single-scattering albedos from cloud-free measurements
- Provide a multi-parameter retrieval package for the USDA UV-B Monitoring and Research Program network

Retrieval technique

- Screen measurements for clouds according to Long and Ackerman (2000)
- Implement estimation theory framework (Rodgers, 2000) in which Bayesian probabilities are represented by vectors and matrices; linearization is based on small perturbations in forward model inputs
- Centerpiece is the Tropospheric Ultraviolet (TUV) radiative transfer model (Madronich/NCAR) using an 8-stream DISORT radiative transfer algorithm

Retrieval results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Column O3</td>
<td>298.1 DU</td>
<td>361.1 DU</td>
</tr>
<tr>
<td>Aerosol AOD</td>
<td>0.0158</td>
<td>1.2180</td>
</tr>
<tr>
<td>368 nm AOD</td>
<td>0.0034</td>
<td>1.0630</td>
</tr>
<tr>
<td>332 nm AOD</td>
<td>0.0134</td>
<td>0.8230</td>
</tr>
<tr>
<td>325 nm AOD</td>
<td>0.0264</td>
<td>0.6064</td>
</tr>
<tr>
<td>317 nm AOD</td>
<td>0.0475</td>
<td>0.8414</td>
</tr>
<tr>
<td>311 nm AOD</td>
<td>0.0804</td>
<td>0.8310</td>
</tr>
<tr>
<td>305 nm AOD</td>
<td>0.1254</td>
<td>0.7664</td>
</tr>
<tr>
<td>300 nm AOD</td>
<td>0.2624</td>
<td>0.9167</td>
</tr>
<tr>
<td>368 nm SSA</td>
<td>0.0194</td>
<td>0.0310</td>
</tr>
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Aerosol optical depth

- Estimation theory retrievals compared to Langley regression used by NREL UV-B Lab (McArthur et al., 2003)
Single-scattering albedo

- Estimation theory retrievals compared to direct-to-diffuse irradiance ratio technique used by NREL UV-B Lab

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<tr>
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<th>325 nm</th>
<th>332 nm</th>
<th>368 nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min daily RMS diff.</td>
<td>0.013</td>
<td>0.012</td>
<td>0.008</td>
<td>0.006</td>
<td>0.008</td>
<td>0.004</td>
</tr>
<tr>
<td>Max daily RMS diff.</td>
<td>0.102</td>
<td>0.071</td>
<td>0.060</td>
<td>0.056</td>
<td>0.053</td>
<td>0.045</td>
</tr>
</tbody>
</table>

Measurement simulations

- Measurements were simulated by TUV using retrieval results as inputs, both from estimation theory and combined results of independent methods, then compared to observations
- Direct-normal irradiance – better agreement in all passbands when using estimation theory inputs

Measurement simulations

- Measurements were simulated by TUV using retrieval results as inputs, both from estimation theory and combined results of independent methods, then compared to observations
- Diffuse-horizontal irradiance – similar or better agreement when using estimation theory inputs, except at 325 nm

Conclusion and future plans

- UV-MFRSR measured solar irradiance at MCMA-2003
- Screened measurements for cloud coverage
- Developed estimation theory retrieval technique
- Retrieval results compared favorably to independent methods
- Accuracy of simulations improved over independent methods
- Improve upon implementation shortcomings
- Apply across UV-B Research and Monitoring Program network
- Provide ground validation for satellite measurements
- Develop climatology of aerosol properties and/or ozone for future research
References


