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RESEARCH ARTICLE

Retrievals of aerosol optical depth and total column ozone from Ultraviolet Multifilter Rotating Shadowband Radiometer measurements based on an optimal estimation technique

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Abstract A Bayesian optimal estimation (OE) retrieval technique was used to retreive aerosol optical depth (AOD), aerosol single scattering albedo (SSA), and an asymmetry factor (*g*) at seven ultraviolet wavelengths, along with total column ozone (TOC), from the measurements of the UltraViolet Multifilter Rotating Shadowband Radiometer (UV-MFRSR) deployed at the Southern Great Plains (SGP) site during March through November in 2009. The OE technique specifies appropriate error covariance matrices and optimizes a forward model (Tropospheric ultraviolet radiative transfer model, TUV), and thus provides a supplemental method for use across the network of the Department of Agriculture UV-B Monitoring and Research Program (USDA UVMRP) for the retrieval of aerosol properties and TOC with reasonable accuracy in the UV spectral range under various atmospheric conditions. In order to assess the accuracy of the OE technique, we compared the AOD retreivals from this method with those from Beer's Law and the AErosol RObotic Network (AERONET) AOD product. We also examine the OE retrieved TOC in comparison with the TOC from the U.S. Department of Agriculture UV-B Monitoring and Research Program (USDA UVMRP) and the Ozone Monitoring Instrument (OMI) satellite data. The scatterplots of the estimated AOD from the OE method agree well with those derived from Beer's law and the collocated AERONET AOD product, showing high values of correlation coefficients, generally 0.98 and 0.99, and large slopes, ranging from 0.95 to 1.0, as well as small offsets, less than 0.02 especially at 368 nm. The comparison of TOC retrievals also indicates the promising accuracy of the OE method in that the standard deviations of the difference between the OE derived TOC and other TOC products are about 5 to 6 Dobson Units (DU). Validation of the OE retrievals on these selected dates suggested that the OE technique has its merits and can serve as a supplemental tool in further analyzing UVMRP data.

Keywords optimal estimation, aerosol optical depth, total column ozone, Ultraviolet Multifilter Rotating Shadowband Radiometer (UV-MFRSR), Aerosol Robotic Network (AERONET), Tropospheric ultraviolet radiative transfer model (TUV)

1 Introduction

Ultraviolet (UV) radiation, invisible to the human eye, is part of the electromagnetic radiation emitted by the sun. Although UV radiation constitutes less than 7% of solar radiation in the vacuum that reaches the Earth's surface (Caldwell, 1971), it has great impact on human health (such as causing skin cancers and the diseases related to eyes and the immune system), and affects animals, marine organisms, and plants, as well as crop yields (Rötter and van de Geijn, 1999; Kakani et al., 2003; Gallagher and Lee, 2006). It also contributes to climate change and environmental stresses via regulating the emission rates of several atmospheric trace gases, including ozone, carbonyl sulfide, methane, methyl bromide, and dimethyl sulfide (Zepp et al., 2007). On the other hand, ozone is known as the most important UV radiation absorber in the atmosphere, and it can effectively reduce the UV radiation reaching the Earth's surface. As such, the decrease of ozone concentration in the atmosphere will inevitably lead to the increase of UV radiation at the terrestrial surface. Thus, absorption by the atmospheric ozone column is a primary factor for UV radiation extinction.

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