Retrieving Vertical Ozone Profiles from Measurements of Spectral Global Irradiance

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The Umkehr method for retrieving vertical ozone profiles is routinely being applied to measurements from Dobson and Brewer instruments. Typical implementation is based on ratios of zenith-sky radiances at two wavelengths in the UV, one strongly and one weakly attenuated by ozone. Here we explore a variant of the method using measurements of spectral global irradiance, i.e., the irradiance received by a horizontal "cosine" collector from both direct Sun and sky (zenith to horizon). The method can potentially make existing long-term datasets of global irradiance available to Umkehr retrievals. This is particularly interesting for locations where no zenith-sky observations have been performed.

The retrieval method is based on the optimal estimation approach (Gauss-Newton method). The state vector is the average ozone concentration divided into eleven layers with a uniform layer-height of 5 km. Forward modeling is performed with the pseudospherical Discrete Ordinate Radiative Transfer (DISORT) solver of the UVSPEC/libRadtran model, which takes multiple scattering into account. The method was tested using measurements of spectral global irradiance performed with a high-resolution (0.6 nm) spectroradiometer at Summit Greenland (72.5° N). The measurement vector consists of ratios of measurements at 310 and 340 nm for eleven solar zenith angles (SZAs) between 60° and 92°. Results were validated using ozone profiles measured with balloon sondes at Summit by NOAA/GMD.

Figure 1 compares these retrievals with sonde measurements. In general, Umkehr profiles agree well with the sonde data, but cannot resolve the fine structure in the ozone distribution. Total ozone columns calculated from the retrieved profiles agree to within 1.5-4.9% with measurements of the Ozone Monitoring instrument (OMI). These initial results are very promising, but rigorous error analysis and validation are pending. The method will be further improved by optimizing the wavelengths, SZAs and number of layers used in retrieval, the *a priori* profile and associated covariance matrix, and the forward model implementation (e.g., aerosol treatment, modeling speed).

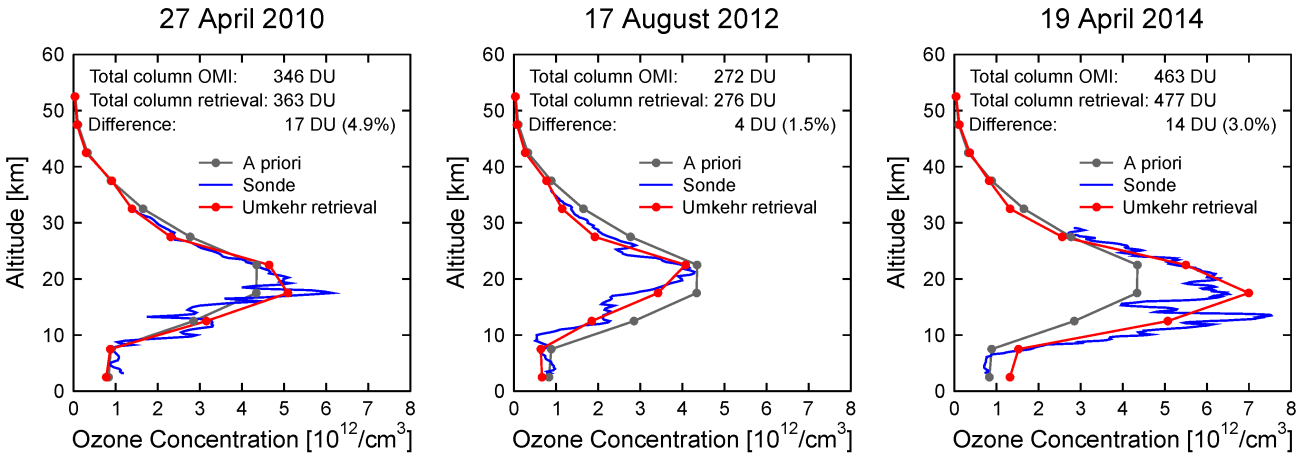

Figure 1. Comparison of ozone profiles retrieved from measurements of spectral global irradiance (red) with profiles measured by balloon sondes (blue) on three days at Summit, Greenland. The *a priori* profile used by the Umkehr method is the median of over 200 sonde profiles measured at Summit that were extended above the balloons' burst altitude using the AFGL atmospheric constituent profile for subarctic summer.