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Investigation of the optical and instrumental artifacts in the Brewer Umkehr ozone profile retrieval.

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Umkehr measurements are taken by Brewer (or Dobson) spectrophotometers by pointing at the zenith and recording photon counts from diffuse skylight while the sun rises or sets. Scattered UV radiation is measured at the same spectral channels that are used for total ozone direct sun measurements and then again by turning the diffraction grating to select longer wavelengths in the UV solar spectrum. The log-intensity ratio at two wavelengths (single wavelength pair), one from a short and one from a long spectral channel, is calculated as a function of the solar zenith angle to estimate the Umkehr effect. The Brewer Umkehr retrieval algorithm for ozone profiles was developed several years ago and its quality is similar to the Dobson Umkehr retrieval. However, Umkehr measurements keep the Brewer busy for a relevant part of the daily measurement schedule, and some stations are not interested in Umkehr data collection. Another problem comes from the diurnal changes in stratospheric ozone over an extended period of time, which impacts the quality of the ozone retrieval. The multi-spectral retrieval was proposed to reduce time of the data collection. The code was developed, however it was found that the instrumental sensitivity to polarized light is not trivial for simulation due to non-ideal polarization filters used in the instrument and/or polarization effects on the grating. We investigate the above mentioned limitations by means of the radiative transfer simulations of the observed multi-spectral Umkehr measurements in the Brewer Mk III (double) and MKIV (single) instruments. The impact of non-elastic scattering in the Rayleigh scattering atmosphere and ozone absorption in the UV spectrum is assessed for errors in the ozone profile retrieval. The dependence of the effective ozone temperature on the UV spectral absorption is also investigated. The results of the investigation could be of practical relevance for all Brewer users and could notably be implemented in the framework of the recently started European Brewer Network (EUBREWNET)