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Satellite Ring effect observations of aerosol properties

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The Ring effect describes the so-called 'filling-in' of solar Fraunhofer lines in the spectra of scattered sun light compared to direct sun light observations. It was first observed by Shefov (1959) and Grainger and Ring (1962). Observations of the Ring effect can be used to investigate details of the atmospheric radiative transfer. The filling-in of Fraunhofer lines depends in particular on the presence and properties of clouds and aerosols. Several algorithms for cloud properties from Ring effect observations were developed in recent years and successfully applied to observations from TOMS, GOME, and OMI satellite instruments. In this study we extend the application of satellite Ring effect observations to the retrieval of information on tropospheric aerosols. In contrast to observations of absorptions of the oxygen molecule O2 or dimer O4, the Ring effect shows only a rather weak dependence on surface albedo. Thus the presence of aerosols usually leads to a decrease of the Ring effect (depending on layer height), because aerosols shield possible Raman scattering events inside and below the aerosol layer. We present a case study for Beijing, for which we find that with increasing aerosol optical depth (determined from sun photometers on the ground) the Ring effect in satellite observations systematically decreases. Also a dependence on aerosol layer altitude is found. This finding is in agreement with radiative transfer simulations. The dependence of the Ring effect on the aerosol layer height offers the interesting possibility to determine aerosol profile information from passive UV/vis satellite instruments. This might be of special importance for future satellite missions with small ground pixels, because of the smaller probability of cloud contamination.