Geophysical Research Abstracts
Vol. 20, EGU2018-10908, 2018
EGU General Assembly 2018

Addressing non-linearity effects due to ozone absorption for MAX-DOAS UV observations of minor trace gases

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MAX – DOAS measurements has become a convenient and wide-spread method to measure different atmospheric trace gases and aerosols. One of the recent improvements includes the reduction of the integration time necessary to obtain good signal to noise ratio. Together with improvements of the analysis software this has made possible the usage of sequential Fraunhofer reference spectra which minimizes the effects caused by the stratospheric absorptions mainly for NO_2, O_3 and BrO. Especially during twilight these stratospheric absorption can become very large. The sequential reference improves the retrieval quality especially at shorter wavelengths where strong ozone absorption and largely increased Rayleigh scattering play an important role.
Even if a sequential reference is used still some effects have to be considered: first, for the different viewing angles the light paths (even in the stratosphere) are distributed differently. Thus the stratospheric absorptions in the measurement and the sequential reference are not exactly the same. Further complications might arise from the time difference between both measurements, especially at high SZA.
To further improve the fit quality, it is possible to account for the remaining interferences of the strongly absorbing ozone by including higher order ozone absorption terms in the DOAS fit. Although these terms are based on the expansion of the radiative transfer equation in a Taylor series with respect to the absorption, their impact has not yet been assessed by sensitivity studies in a quantitative manner for MAX-DOAS observations.
In this study we investigate the effect of including higher order ozone absorption terms in the spectral analysis of the UV interval 320-360 nm for the retrieval of HCHO (and BrO) by RTM and sensitivity studies.