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# Are non-linearity effects of absorption important for MAX-DOAS observations?

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For scattered light observations the absorption optical depth depends non-linearly on the trace gas concentrations if their absorption is strong. This is the case because the Beer-Lambert law is generally not applicable for scattered light measurements due to many (i.e. more than one) light paths contributing to the measurement. While in many cases a linear approximation can be made, for scenarios with strong absorption non-linear effects cannot always be neglected. This is especially the case for observation geometries with spatially extended and diffuse light paths, especially in satellite limb geometry but also for nadir measurements as well.
Fortunately the effects of non-linear effects can be quantified by means of expanding the radiative transfer equation in a Taylor series with respect to the trace gas absorption coefficients. Herewith if necessary (1) the higher order absorption structures can be described as separate fit parameters in the DOAS fit and (2) the algorithm constraints of retrievals of VCDs and profiles can be improved by considering higher order sensitivity parameters.
In this study we investigate the contribution of the higher order absorption structures for MAX-DOAS observation geometry for different atmospheric and ground properties (cloud and aerosol effects, trace gas amount, albedo) and geometry (different Sun and viewing angles).