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Recent advances in the spectral retrievals of UV/VIS DOAS data

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The technique of Differential Optical Absorption Spectroscopy (DOAS) enables the detection of atmospheric traces gases with very small optical depth. The detection limit is determined by the residual RMS of the spectral analysis, which is constrained not only by photon statistics, but also by a number of additional effects and absorbers, which were previously ignored, falsely reported or not even detected.

We present an overview of recent progress made for the spectral analysis of spectra of scattered sunlight from 300-500nm:

1. Additionally to rotational Raman scattering or the so-called Ring-effect, the spectral signature of vibrational Raman scattering in air is found in the measurement data not only in the blue wavelength range, but also towards the UV.

2. We show systematic problems of current water vapour line lists in the blue spectral range. We show clear and unambiguous detection of water vapour absorption around 360nm based on the water vapour line list POKAZATEL from Polyansky et al 2017.

3. We demonstrate the need to consider the temperature dependence of the Ring effect also for ground-based observations. We present first results to use this information to improve cloud filter algorithms for MAX-DOAS data.

4. Different colors of measured spectra can lead to an apparent shift of the observed spectra relative to each other. This effect, which was coined ‘Tilt’ in previous publications (e.g. Sioris et al 2003), was empirically corrected for in spectral retrievals of satellite-born limb spectra. We give a formal derivation and show that this effect is also found in ground-based observations with optical depths of up to 2.5×10^{-3}, if not corrected for.

The consideration of these small effects, together with general improvements of the instrumental setup, can reduce the residual RMS to magnitudes of 10^{-4}. This enables not only the detection of very weak absorber, but might also reduce biases for stronger absorbers.