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Evaluation wavelength range mapping, a tool to optimize the evaluation window in differential absorption spectroscopy

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Optical remote sensing via Differential Optical Absorption Spectroscopy (DOAS) has become a standard technique to assess various trace gases in the atmosphere. Measurement instruments are usually classified into active instruments applying an artificial light source and passive instruments using natural light sources, e.g., scattered or direct sunlight. Platforms range from ground based to satellites and trace gases are studied in all kinds of different environments. Naturally, the evaluation of gathered spectra needs to be tuned to each specific case and trace gas of interest due to the wide range of measurement conditions, atmospheric compositions and instruments used. A well chosen evaluation wavelength range is crucial to the DOAS technique. It should be as large as possible and include the largest differential absorption features of the trace gas of interest in order to maximize sensitivity. However, the differential optical densities of other absorbers should be minimized in order to prevent interferences between different absorption cross sections. Furthermore, instrumental specific features and wavelength dependent radiative transfer effects may have malicious effects and lead to erroneous values. Usually a compromise needs to be found depending on the conditions at hand.

Evaluation wavelength range mapping is an easily applied tool to visualize wavelength depending evaluation features of DOAS and to find the optimal retrieval wavelength range. As an example, synthetic spectra are studied which simulate passive DOAS measurements of stratospheric bromine monoxide (BrO) by Zenith-DOAS and Multi-Axis DOAS (MAX-DOAS) measurements of BrO in volcanic plumes. The influence of the I_0-effect and the Ring-effect on the respective retrievals are demonstrated. However, due to the general nature of the tool it is applicable to any DOAS measurement and the technique also allows to study any other wavelength dependent influences on retrieved trace gas columns.