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Comparison of box-air-mass-factors and radiances for Multiple-Axis Differential Optical Absorption Spectroscopy (MAX-DOAS) geometries calculated from different UV/visible radiative transfer models

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Abstract. The results of a comparison exercise of radiative transfer models (RTM) of various international research groups for Multiple AXis Differential Optical Absorption Spectroscopy (MAX-DOAS) viewing geometry are presented. Besides the assessment of the agreement between the different models, a second focus of the comparison was the systematic investigation of the sensitivity of the MAX-DOAS technique under various viewing geometries and aerosol conditions. In contrast to previous comparison exercises, box-air-mass-factors (box-AMFs) for different atmospheric height layers were modelled, which describe the sensitivity of the measurements as a function of altitude. In addition, radiances were calculated allowing the identification of potential errors, which might be overlooked if only AMFs are compared. Accurate modelling of radiances is also a prerequisite for the correct interpretation of satellite observations, for which the received radiance can strongly vary across the large ground pixels, and might be also important for the retrieval of aerosol properties as a future application of MAX-DOAS. The comparison exercises included different wavelengths and atmospheric scenarios (with and without aerosols). The strong and systematic influence of aerosol scattering indicates that from MAX-DOAS observations also information on atmospheric aerosols can be retrieved. During the various iterations of the exercises, the results from all models showed a substantial convergence, and the final data sets agreed for most cases within about 5%. Larger deviations were found for cases with low atmospheric optical depth, for which the photon path lengths along the line of sight of the instrument can become very large. The differences occurred between models including full spherical geometry and those using only plane parallel approximation indicating that the correct treatment of the Earth's sphericity becomes indispensable. The modelled box-AMFs constitute an universal data base for the calculation of arbitrary (total) AMFs by simple convolution with a given trace gas concentration profile. Together with the modelled radiances and the specified settings for the various exercises, they can serve as test cases for future RTM developments.

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