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Accounting for the effect of horizontal gradients in limb measurements of scattered sunlight

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Abstract. Limb measurements provided by the SCanning Imaging Absorption spectrometer for Atmospheric CHartographY (SCIAMACHY) on the ENVISAT satellite allow retrieving stratospheric profiles of various trace gases on a global scale, among them BrO for the first time. For limb observations in the UV/VIS spectral region the instrument measures scattered light with a complex distribution of light paths: the light is measured at different tangent heights and can be scattered or absorbed in the atmosphere or reflected by the ground. By means of spectroscopy and radiative transfer modelling these measurements can be inverted to retrieve the vertical distribution of stratospheric trace gases.

The fully spherical 3-D Monte Carlo radiative transfer model "Tracy-II" is applied in this study. The Monte Carlo method benefits from conceptual simplicity and allows realizing the concept of full spherical geometry of the atmosphere and also its 3-D properties, which is important for a realistic description of the limb geometry. Furthermore it allows accounting for horizontal gradients in the distribution of trace gases.

In this study the effect of horizontally inhomogeneous distributions of trace gases along flight/viewing direction on the retrieval of profiles is investigated. We introduce a tomographic method to correct for this effect by combining consecutive limb scanning sequences and utilizing the overlap in their measurement sensitivity regions. It is found that if horizontal inhomogenity is not properly accounted for, typical errors of 20% for NO_2 and up to 50% for OClO around the altitude of the profile peak can arise for measurements close to the Arctic polar vortex boundary in boreal winter.

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