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2D Tomography for SCIAMACHY Limb Measurements of Scattered Sunlight

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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.
We use a two step method for the retrieval in the UV/VIS spectral region: First, Differential Optical Absorption Spectroscopy (DOAS) is applied on the spectra, yielding slant column densities (SCDs) of the respective trace gases. Second, the SCDs are converted into vertical concentration profiles applying radiative transfer modeling.
An important point is the necessity of accounting for horizontal gradients of number densities of considered species in the retrieval algorithm. This is of special interest in Polar Regions, where photochemistry can highly vary along the long absorption paths. We investigate the influence of horizontal gradients by applying 3-dimensional radiative transfer modeling.
We introduce a tomographic method to correct for the effect of horizontal gradients by combining consecutive limb scanning sequences and utilizing the overlap in their measurement sensitivity regions. For the Arctic polar region it is found that, if the horizontal inhomogenity is not properly accounted for, typical errors of 20% for NO2 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.
We also study the improvement for midlatitudes and tropics, if the tomographic retrieval is performed for special “limb-only” orbits. The impact of the horizontal distance between consecutive limb scanning sequences on the quality of tomographic approach is investigated.