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SCIAMACHY tropospheric NO_2 over Switzerland: estimates of NO_x lifetimes and impact of the complex Alpine topography on the retrieval

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Abstract. This study evaluates NO_2 vertical tropospheric column densities (VTCs) retrieved from measurements of the Scanning Imaging Absorption Spectrometer for Atmospheric Chartography (SCIAMACHY) above Switzerland and the Alpine region. The close correlation between pixel averaged NO_x emission rates from a spatially and temporally highly resolved inventory and the NO_2 VTCs under anticyclonic meteorological conditions demonstrates the general ability of SCIAMACHY to detect sources of NO_x pollution in Switzerland. This correlation is further used to infer seasonal mean NO_x lifetimes carefully taking into account the influence of the strong diurnal cycle in NO_x emissions on these estimates. Lifetimes are estimated to 3.6 (±0.8) hours in summer and 13.1 (±3.8) hours in winter, the winter value being somewhat lower than previous estimates. A comparison between the 2003-2005 mean NO_2 VTC distribution over Switzerland and the corresponding 1996–2003 mean from the Global Ozone Monitoring Experiment (GOME) illustrates the much better capability of SCIAMACHY to resolve regional scale pollution features. However, the comparison of seasonal averages over the Swiss Plateau with GOME and ground based in situ observations indicates that SCIAMACHY exhibits a too weak seasonal cycle with comparatively high values in summer and low values in winter. A problem likely contributing to the reduced values in winter (not reported in earlier literature) is the use of inaccurate satellite pixel surface pressures derived from a coarse resolution global model in the retrieval. The marked topography in the Alpine region can lead to deviations of several hundred meters between the model assumed and the real pixel-averaged surface height. A sensitivity study based on selected clear sky SCIAMACHY NO_2 VTCs over the Swiss Plateau and two fixed a priori NO_2 profile shapes indicates that inaccurate pixel surface pressures affect retrieved NO_2 columns over complex terrain by up to 40%. For retrievals in the UV-visible spectral

range with a decreasing sensitivity towards the earth's surface, this effect is of major importance when the NO_2 resides close to the ground, a situation most frequently observed during winter.

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