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Satellite observations and model simulations of tropospheric NO₂ columns over south-eastern Europe

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Abstract. Satellite observations of nitrogen dioxide (NO₂) tropospheric columns over south-eastern Europe are analyzed to study the characteristics of the spatial and temporal variability of pollution in the area. The interannual variability of the tropospheric NO₂ columns is presented over urban, rural and industrial locations based on measurements from four satellite instruments, GOME/ERS-2, SCIAMACHY/Envisat, OMI/Aura and GOME-2/MetOp spanning a period of over twelve years. The consistency between the different datasets over the area is investigated. Two operational algorithms for the retrieval of tropospheric NO₂ are considered, the one developed jointly by the Royal Netherlands Meteorological Institute and Belgian Institute for Space Astronomy and the one developed by the University of Bremen. The tropospheric NO₂ columns for the area under study have been simulated for the period 1996–2001 with the Comprehensive Air Quality Model (CAMx) and are compared with GOME measurements. Over urban and industrial locations the mean tropospheric NO₂ columns range between 3 and 7.0 × 10¹⁵ molecules/cm², showing a seasonal variability with a peak to peak amplitude of about 6.0 × 10¹⁵ molecules/cm², while the background values over rural sites are close to 1.1 × 10¹⁵ molecules/cm². Differences in the overpass time and spatial resolution of the different satellites, as well as differences in the algorithms, introduce significant differences in the estimated columns however the correlation between the different estimates is higher than 0.8. It is found that the model simulations reveal similar spatial patterns as the GOME observations, a result which is consistent with both algorithms. Although the model simulations show a mean bias of −0.1 × 10¹⁵ molecules/cm² under clean conditions, the modeled temporal correlation of 0.5 is poor in absence of biogenic and biomass burning emissions.

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