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Estimates of lightning NO_x production from GOME satellite observations

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Abstract. Tropospheric NO₂ column retrievals from the Global Ozone Monitoring Experiment (GOME) satellite spectrometer are used to quantify the source strength and 3-D distribution of lightning produced nitrogen oxides (NO_x=NO+NO₂). A sharp increase of NO₂ is observed at convective cloud tops with increasing cloud top height, consistent with a power-law behaviour with power 5±2. Convective production of clouds with the same cloud height are found to produce NO₂ with a ratio 1.6/1 for continents compared to oceans. This relation between cloud properties and NO₂ is used to construct a 10:30 local time global lightning NO₂ production map for 1997. An extensive statistical comparison is conducted to investigate the capability of the TM3 chemistry transport model to reproduce observed patterns of lightning NO₂ in time and space. This comparison uses the averaging kernel to relate modelled profiles of NO₂ to observed NO₂ columns. It exploits a masking scheme to minimise the interference of other NO_x sources on the observed total columns. Simulations are performed with two lightning parameterizations, one relating convective precipitation (CP scheme) to lightning flash distributions, and the other relating the fifth power of the cloud top height (H5 scheme) to lightning distributions. The satellite-retrieved NO₂ fields show significant correlations with the simulated lightning contribution to the NO₂ concentrations for both parameterizations. Over tropical continents modelled lightning NO₂ shows remarkable quantitative agreement with observations. Over the oceans however, the two model lightning parameterizations overestimate the retrieved NO₂ attributed to lightning. Possible explanations for these overestimations are discussed. The ratio between satellite-retrieved NO₂ and modelled lightning NO₂ is used to rescale the original modelled lightning NO_x production. Eight estimates of the lightning NO_x production in 1997 are obtained from spatial and temporal correlation methods, from cloud-free and cloud-covered observations, and from two different lightning parameterizations. Accounting for a wide variety of random and possible systematic errors, we estimate the global NO_x production from lightning to be in the range 1.1–6.4 Tg N in 1997.

[Final Revised Paper](#) (PDF, 936 KB) [Discussion Paper](#) (ACPD)

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