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Estimating the NO_x produced by lightning from GOME and NLDN data: a case study in the Gulf of Mexico

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Abstract. Nitrogen oxides (NO_x NO+NO_2) play an important role in tropospheric chemistry, in particular in catalytic ozone production. Lightning provides a natural source of nitrogen oxides, dominating the production in the tropical upper troposphere, with strong impact on tropospheric ozone and the atmosphere's oxidizing capacity. Recent estimates of lightning produced NO_x (LNO_x) are of the order of 5 Tg [N] per year with still high uncertainties in the range of one order of magnitude.

The Global Ozone Monitoring Experiment (GOME) on board the ESA-satellite ERS-2 allows the retrieval of tropospheric column densities of NO_2 on a global scale. Here we present the GOME NO_2 measurement directly over a large convective system over the Gulf of Mexico. Simultaneously, cloud-to-ground (CG) flashes are counted by the U.S. National Lightning Detection Network (NLDN™), and extrapolated to include intra-cloud (IC)+CG flashes based on a climatological IC:CG ratio derived from NASA's space-based lightning sensors. A series of 14 GOME pixels shows largely enhanced column densities over thick and high clouds, coinciding with strong lightning activity. The enhancements can not be explained by transport of anthropogenic NO_x and must be due to fresh production of LNO_x. A quantitative analysis, accounting in particular for the visibility of LNO_x from satellite, yields a LNO_x production of 90 (32-240) moles of NO_x, or 1.3 (0.4-3.4) kg [N], per flash. If simply extrapolated, this corresponds to a global LNO_x production of 1.7 (0.6-4.7)Tg [N]/yr.

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