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Quantification of lightning-produced NO_x over the Pyrenees by using different TROPOMI-NO_2 research products

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Lightning discharges are one of the main sources of atmospheric NO_x, contributing about 10% of NO_x emissions globally and playing an important role for the concentration of ozone and other chemical species in the upper troposphere. Lightning produces between 2-8 Tg N per year globally (100-400 mol NO_x per flash). Reducing the uncertainty of the NO_x production by lightning and understanding the factors that influence this production is still a challenge.

The TROPOspheric Monitoring Instrument (TROPOMI) is orbiting the Earth from a near-polar, sun-synchronous orbit since October 2017. TROPOMI is equipped with four spectrometers that provide information about the chemical composition of the troposphere with unprecedented horizontal spatial resolutions of 3.5 x 7 km before 6 August 2019 and 3.5 x 5.5 km after that date. In this work, we combine the DLR-NO_2 research product, the DLR cloud operational product and the TROPOMI v2.1_test NO_2 product to estimate the production of NO_x per flash (LNO_x). The v2.1_test NO_2 product contains more useful data pixels than the official offline v1.x data product, because of better treatment of saturation of the TROPOMI measurements (which occurs frequently over high bright clouds that are often linked with LNOx) and the use of an improved version of the FRESCO cloud algorithm.

We for the first time ever use these chemical measurements from TROPOMI combined with lightning radio measurements provided by the EUropean Cooperation for LIghtning Detection (EUCLID) and the Earth Network Total Lightning Network (ENTLN), together with lightning optical measurements provided by the space-based Lightning Imaging Sensor (LIS) to estimate the Detection Effiency (DE) of EUCLID and ENTLN. In addition, we use the ECHAM5/MESSy Atmospheric Chemistry (EMAC) simulations to calculate the air mass factor employed to convert tropospheric slant column of measured NO_2 to vertical column LNO_x and the winds provided by reanalysis data

to eliminate the influence of upwind storms in the estimation of the background NO_x. Concentration.

We focus our analysis on different remote regions, where the background concentration of NO is relatively low. In particular, we focus our analysis on 11 thunderstorm cases taking place near the Pyrenees, where intense thunderstorms are frequent and the DE of EUCLID and ENTLN is relatively high and homogeneous. According to our preliminary results from a single case using the DLR-NO_2 research product, we get about 400 mol NO_x per flash when we estimate the background using NO_x from CARIBIC flights and about 200-600 mol per flash when we estimate the background using TROPOMI measurements from non-flashing pixels.