Seeking Sprite Signatures in MIPAS/ENVISAT Measurements of Middle Atmosphere NO_2

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Sprites and other transient luminous events have been suggested to impact atmospheric chemistry, in particular through production of NO_x. Recent ion-chemistry modelling estimated sprites to locally perturb atmospheric NO_x by a few tens of percent. From these estimates, together with consideration of chemical and dynamical timescales, and of the occurrence rate of sprites, it can be concluded that the global chemical impact of sprites is negligible. Nevertheless, it appears that sprite-induced chemical changes can be locally significant and detectable.

Satellite observations of NO_2 from the MIPAS/ENVISAT spectrometer were analysed in coincidence with regions of high likelihood of sprite occurrence in order to find evidence of sprite perturbations. Given the paucity of available sprite observations, intense tropospheric thunderstorms were used as a proxy of sprite activity and a one-to-one correlation between these active regions and night time NO_2 was performed for the period August to December 2003. MIPAS NO_2 data were retrieved with the 2-dimensional GMTR algorithm thus enhancing the sensitivity to small changes. Intense thunderstorms were localised through the WWLLN lightning detection network that had higher efficiency towards the Maritime Continent during the coincidence period.

The analysis showed a statistically significant enhancement of night time NO_2 of about 10% at 52 km height in coincidence with intense thunderstorm activity (and thus high likelihood of sprite occurrence) over the 5° to 10°N and 15° to 20°N latitude bands. The region 5°S to 5°N showed no significant change, while other regions had too few coincidences to be meaningful. An overall distribution of these perturbations showed the enhancement to weaken below 52 km height and increase around 60 km. The use of first order backward trajectories to account for atmospheric winds led to consistent results. Although at the very limit of the sensitivity of our analysis, Monte Carlo simulations showed that these results could be found by chance only in 1 out of 100 simulations.