Geophysical Research Abstracts
Vol. 13, EGU2011-11778, 2011
EGU General Assembly 2011

Climate-chemistry model sensitivity to sprite-induced chemical perturbations

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Over the last two decades visible and high energy emissions have been observed to be produced in the atmosphere above thunderstorms, including the so called transient luminous events (TLEs) occurring in a variety of forms between thunderstorm tops and the lower ionosphere. These phenomena may locally impact the Earth's atmosphere through ion-neutral chemistry reactions leading to additional chemical sources which are as yet not included in the present picture of atmospheric chemistry and climate. Particular emphasis has been given to sprites, with models and observations suggesting a capability of perturbing atmospheric nitrogen oxides at a local level, as it is known to occur for tropospheric lightning and laboratory air discharges. Dedicated ion-neutral chemistry modelling of sprite predict up to hundreds of percent enhancement of nitrogen oxides to be produced within individual sprite streamers at about 70 km altitude. Satellite observations found a 10 percent enhancement of nitrogen oxides in regions of high likelihood of sprite occurrence, although no signature of a global impact has been found. Can then sprite chemistry be of any relevance for the global atmosphere with transport affecting our ability of observing their perturbations? In this paper we study the climate-chemistry sensitivity of the Whole Atmosphere Community Climate Model (WACCM) to sprite-like perturbations. Due to the large uncertainties affecting the available knowledge of sprite chemistry and of their atmospheric impact, a realistic simulation of the global impact of sprites on a climate-chemistry model is to date unfeasible. We therefore take a top-down approach to estimate what magnitude sprite-perturbations should have to become significant as compared to other relevant atmospheric processes and study the sensitivity of the model response within the given uncertainties. Preliminary results from this modelling effort are presented within the current framework of constraints available from observations.