Scales of Perturbations in the Middle Atmosphere: Investigating the Relevance of Repeated Small Scale Perturbations

Enrico Arnone, (e.arnone@ion.le.ac.uk)
Department of Physics and Astronomy, University of Leicester, Leicester, U.K.

Neil Arnold,
Department of Physics and Astronomy, University of Leicester, Leicester, U.K.

and

Bianca M. Dinelli,
ISAC - CNR, Bologna, Italy

There is a growing body of evidence to suggest that the middle atmosphere can have an important role in influencing tropospheric processes, and thus possibly impacting on climate. Mainly because of the stratospheric peak in the ozone concentration, the middle atmosphere is significantly influenced by the solar input, and thus represents an important connection between the Sun and the Earth's atmosphere.

In previous work, we have shown how changes in ozone induced by solar variability alter temperature and transport in the middle atmosphere, somewhat affecting the net heating to the troposphere. Furthermore, we investigated solar proton events (SPEs), such as the large SPE of October 2003, to understand the sensitivity of the atmospheric system to perturbations at different scale.

Phenomena such as sprites are of much smaller magnitude but there is increasing evidence of their repeated appearance during thunderstorms. In this work, we investigate whether it is possible to scale down the magnitude of the perturbations introduced in middle-atmospheric models, studying the impact of a global distribution of sprite-like events. For this reason, global lightning observations can be used as first approximation of sprite events.

We use a mechanistic 3-dimensional model of the middle atmosphere and simulate the perturbations in ozone using spatial locations and magnitudes observed by satellites instruments (such as MIPAS for the SPE events and LIS for the global lightning distribution).

Because of the increasing interest in understanding the possible impact on climate of small-scale natural processes (such as sprites), we present model results for short and long term perturbations, discussing whether time-dependence and location of the perturbations may increase the impact of lower magnitude events.