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Impact of Transient Luminous Events on the Atmospheric Chemistry

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Editorial Note

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EDITORIAL NOTE

During the last 30 years after the discovery in 1989 of various types of upper atmospheric electric discharges (so-called Transient Luminous Events) caused by lightning in the troposphere, atmospheric electricity was intensively studied. Despite a large number of studies that have yielded valuable new insights into how lightning creates a zoo of transient electrical discharges from the upper troposphere to the mesosphere, there is still a lack of understanding about how all forms of TLEs, including those that occur within thunderclouds, contribute to the chemistry of the atmosphere at both the local and global levels. Although the global chemical impact of elves and halos is almost insignificant, the large scale chemical impact of sprites, blue jets and blue starters, and impulsive cloud corona discharges can be non–negligible in terms of their potentially measurable contribution to essential greenhouse gases such as ozone and nitrous oxide, according to this study (N2O). Being the third most strong. A new age in atmospheric electricity is just emerging in which dedicated scientific space missions (ISS-LIS, ASIM) together with geostationary lightning sensors (since 2016) and new micro-scale and TLE parameterizations will hopefully help to begin clarifying the full role of TLEs in atmospheric chemistry circulation models in general atmospheric chemistry. Thirty years ago (in July 1990), Franz et al. (1990) revealed the discovery of the so-called sprites that had originally been reported the year before (1989) to the international scientific community as two transient luminous columns of light over a major thunderstorm over the midwestern United States. Several nonscientific (eyewitness) reports had reported on light over flashes prior to 1989.

Why did sprites occur in the mesosphere and in the stratosphere in the blue jets? How have they been produced? What was the essence of sprites and blue jets in global atmospheric chemistry, and what was their chemical influence? What other kinds of TLEs would there be? These questions began to be answered one by one, in order of increasing complexity. A number of unknowns, however, remain, particularly with regard to the transient quasi-electrostatic electric field induced by electric charges in thunderclouds should be greater than the conventional local air breakdown electric field (Ek), which is proportional to air density. Sprites will begin to develop at altitudes of 75 to 85 km, where the electric field can be maintained against the quick relaxation time typical of the highly conducting upper atmosphere. Since TLEs were discovered in 1989, a variety of space, balloon, aircraft, and ground-based instruments have been developed and used to observe them. In the context of infrasound, TLEs emit light, radio and acoustic signal flashes. In the last 30 years, all these various forms of signatures have been used to detect and recognise all kinds of TLEs.