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Influence of sprite streamers in the mesospheric chemical and thermal balance

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We present new results to contribute to the fundamental understanding of the chemistry of non-equilibrium plasmas produced by nighttime sprite streamers in the mesosphere and their influence on the chemical composition and thermal evolution of the upper atmosphere. This contribution describes the kinetic model used and the time evolution of the concentration of many important species for the sprite and its afterglow through an upgrade of previous TLE kinetic models [1], [2].

A one-dimensional self-consistent model has been developed to study the chemical and thermal effects of a single sprite streamer in the Earth mesosphere. We have used sprite streamer profiles with three different driving current durations (5 ms, 50 ms and 100 ms) between 50 and 80 km of altitude and considering a kinetic scheme of air with 20 chemical species.

Our model predicts strong increases in practically all the concentrations of the species studied at the moment of the streamer head passage. Moreover, their densities remain high during the streamer afterglow phase. The electron concentration can reach values of up to 10^8 cm^{-3} in the three cases analyzed. The model also predicts an important enhancement, of several orders of magnitude above ambient values, of nitrogen oxides (NO_x and N_2O) and the considered metastables species (N_2(A), O_2(a), O_2(b)). Metastables are capable of storing energy for relatively long time (hundreds of seconds).

On the other hand, we found that the 4.26 μm IR emission brightness of CO_2 can exceed in 4 orders of magnitude the threshold of visibility (1 MR) at low altitudes ($<$ 65 km) for the cases of intermediate (50 ms) and long (100 ms) driving currents. These results suggest the possibility of detecting sprite IR emissions from space with the appropriate instrumentation. Moreover, according to our model, the Meinel emission brightness of N_2^+ could also reach the threshold of visibility below 50 km.

Finally, we found that the thermal impact of sprites in the Earth mesosphere is proportional to the driving current duration. This produces variations of more than 40 K (in the extreme case of a 100 ms driving current) at low altitudes ($<$ 55 km) and at about 10 seconds after the streamer head.

[1] Gordillo-Vazquez, F. J., Air plasma kinetics under the influence of sprites, J. Phys. D, 41(23), 234016, doi:10.1088/0022-3727/41/23/234016, 2008.

[2] Parra-Rojas, F. C., A. Luque, and F. J. Gordillo-Vazquez, Chemical and electrical impact of

lightning on the Earth mesosphere: The case of sprite halos, J. Geophys. Res., 118, 1–25, doi:10.1002/jgra.50449, 2013a.