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# Chemistry of sprite discharges through ion-neutral reactions

Y. Hiraki[1], Y. Kasai[2], and H. Fukunishi[3]
[1]Solar-Terrestrial Environment Lab, Nagoya University, Nagoya, Japan
[2]National Institute of Information and Communications Technology (NICT), Koganei, Tokyo, Japan
[3]Department of Geophysics, Tohoku University, Sendai, Miyagi, Japan

Abstract. We estimate the concentration changes, caused by streamer discharge in sprites, of ozone and related minor species as odd nitrogen ($NO_x$) and hydrogen ($HO_x$) families in the upper stratosphere and mesosphere. The streamer has an intense electric field and high electron density at its head, where a large number of chemically-radical ions and atoms are produced through electron impact on neutral molecules. After its propagation, densities of minor species can be perturbed through ion-neutral chemical reactions initiated by the relaxation of these radical products. We evaluate the production rates of ions and atoms using an electron kinetics model and by assuming that the electric field and electron density are in the head region. We calculate the density variations mainly for $NO_x$, $O_x$, and $HO_x$ species using a one-dimensional model of the neutral and ion composition of the middle atmosphere, including the effect of the sprite streamer. Results at the nighttime condition show that the densities of NO, $O_3$, H, and OH increase suddenly through reactions triggered by the first atomic nitrogen and oxygen product, and electrons just after streamer initiation. It is shown that NO and $NO_2$ still remain for 1 h by a certain order of increase with their source-sink balance, predominantly around 60 km; for other species, increases in $O_3$, OH, $HO_2$, and $H_2O_2$ still remain in the range of 40–70 km. From this affirmative result of long-time behavior previously not presented, we emphasize that sprites would have the power to impact local chemistry at night. We also discuss the consistency with previous theoretical and observational studies, along with future suggestions.

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