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A model study of the plasma chemistry of stratospheric Blue Jets

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Stratospheric Blue Jets (BJs) are upward propagating discharges in the altitude range 15–40 km above thunderstorms. They appear as conical bodies of blue light originating at the top of thunderclouds and proceed upward with velocities of the order of 100 km/s. Electric discharges in the atmosphere are known to have chemical effects. Of particular interest is the liberation of atomic oxygen and the formation of reactive nitrogen radicals.

We have used a numerical plasma chemistry model in order to simulate the chemical processes in stratospheric BJs. It was applied to BJ streamers in the altitude range 18-38 km. The model results show that there is a production of ozone from atomic oxygen liberated at the streamer tips. At the same time, significant amounts of nitric oxide are produced. Compared to earlier plasma chemistry simulations of BJ streamers, the production of NO and O_3 is by orders of magnitude larger. Additionally, the chemical processes in the leader part of a BJ have been simulated for the first time. In the leader channel, driven by high-temperature reactions, the concentration of N_2O and NO increases by several orders of magnitude, and there is a significant depletion of ozone. The model results might gain importance by the fact that the chemical perturbations in BJs are largest at altitudes of the stratospheric ozone layer.