

Modeling of formation processes of the upper atmospheric lightning discharge

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The upper atmospheric discharges called sprites are known to be one of large-scale phenomena induced by lightning, occurring at stratosphere-mesosphere region above active thunderstorms (Sentman et al., 1995GRL). Recent high-speed imager observations indicate that, during their optical lifetime of 1-100 ms, they form a tree-like structure through propagation, branching, and collision of streamers (Gerken and Inan, 2002JGR; Moudry et al., 2003JASTP; Cummer et al., 2006GRL). From spectral observations, streamer is known to propagate with a high electric field of its tip where electrons are accelerated to get energy of 10 eV and drive a variety of atomic-molecular processes. We have investigated on the initiation condition of sprites and its relationship with lightning parameters, e.g. current moment, and atomic processes in the lightning-induced field (Hiraki and Fukunishi, 2006JGR; Hiraki, 2010JGR). Several morphologies of sprites, focusing column and carrot shapes in this study, remain to be understood on the dynamics and the criterion of lightning parameters to control the shapes. We now construct the fluid dynamical model of cooperative motion of streamers with atomic-molecular processes to understand these structure formation processes. We present the first results in this talk.

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