Further Comparison of Sprite Streamer Modeling Results with ISUAL Spectrophotometric Measurements

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Abstract

Streamer discharge theory has been applied to explain the filamentary structures observed in sprites [e.g., Pasko et al., GRL, 25, 2123, 1998; Stanley et al., GRL, 26, 3201, 1999; Gerken et al., GRL, 27, 2637, 2000]. We have recently developed a two-dimensional model for studies of dynamics of positive and negative streamers for a wide range of air pressures under the influence of external electric fields of various strength [Liu and Pasko, JGR, 109, A04301, 2004]. This model has been successfully applied to investigate the streamer characteristics including their associated optical emissions [Liu and Pasko, GRL, 32, L05104, 2005; Liu et al., GRL, 33, L01101, 2006; Liu and Pasko, GRL, 34, L16103, 2007].

The recent successful launch of the ISUAL instruments on FORMOSAT-2 satellite [Chern et al., JASTP, 65, 647, 2003] provides new opportunities for studies of sprite spatial, temporal and spectral properties from a global point of view. Utilizing the scientific data provided by the ISUAL instruments, important new knowledge has been obtained for various high-altitude discharges, including the energetics of electrons in sprites and the information of the driving field [e.g., Kuo et al., GRL, 32, L19103, 2005; Liu et al., 2006], and ionization effects of elves on the lower ionosphere and their detailed morphologies [e.g., Mende et al., JGR, 110, A11312, 2005; Kuo et al., JGR, 112, A11312, 2007].

For the work reported in [Liu et al., 2006], we conducted a single case study by comparing modeling results of a positive streamer with ISUAL spectrophotometric data of a sprite event. Three intensity ratios of the second positive band system of N_2 to N_2 LBH band system, the first negative band system of N_2^+, and the first positive band system of N_2 are obtained separately from the modeling and from the measurements, and they agree very well (within a factor of 2) at the initial stage of sprite development (within 1 ms after the sprite initiation) [Liu et al., 2006]. In this talk, we report our comparison results of more case studies including analysis of the intensity ratios obtained from simulation results of a negative streamer. We will also discuss the implications of the most recent high-speed video observations of sprites [Cummer et al., 33, L04104, 2006; McHarg et al., GRL, 34, L06804, 2007; Stenbaek-Nieslen et al., GRL, 34, L11105, 2007] to our comparison results.