Formation and Propagation of Negative Streamers in Sprites

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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; Liu and Pasko, JGR, 109, A04301, 2004]. Our previous modeling work on sprite streamers mainly focused on studies of the formation and propagation of positive streamers and their associated optical emissions [Liu and Pasko, GRL, 32, L05104, 2005, Liu et al., GRL, 33, L01101, 2006, Liu and Pasko, GRL, 34, L16103]. Recent high-speed observations indicate that upward propagating negative streamers appear later than the downward negative streamers and they also originate from a lower altitude from pre-existing sprite structures [Stanley et al., 1999; Cummer et al., 2006; McHarg et al., GRL, 34, L06804, 2007; Stenbaek-Nieslen et al., GRL, 34, L11105, 2007]. Stenbaek-Nieslen et al. [2007] also point out that simultaneous development of downward and upward streamers is rarely observed.

In this talk, we report simulation results on negative streamers at sprite altitudes and compare the results with those obtained previously for positive streamers. The most distinct differences include much higher stability field and lower maximum field in the streamer head for negative streamers. Utilizing the results from a recent study [Hu et al., JGR, 112, D13115, 2007] on dynamics of electric field established at the sprite altitude by lightning discharges, we will discuss an explanation of the observed occurrence sequence of positive and negative streamers, including the lower originating altitudes of negative streamers in sprite events.