Low Frequency Electromagnetic Radiation from Sprite Streamers

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Sprites are mesospheric discharges that carry significant electrical currents and produce electromagnetic radiation observed typically in the extremely low (ELF) to very low (VLF) frequency bands [*Cummer et al.,* 1998]. Recently, Low-Frequency (LF) radio observations of sprite-producing lightning discharges have shown the existence of consecutive broadband pulses exhibiting EM radiation that spans in the LF range, and it has been suggested that this LF radiation may stem from non-luminous relativistic electron beams above thunderstorms [*Fullekrug et al.,* 2010]. In this letter, we present the first theoretical estimates of the electromagnetic radiation produced by individual sprite streamers using simulation results from a plasma fluid model. It is demonstrated that the spectral content of the radiation produced by sprite streamers is a function of the air density N and the lightning-induced quasi-static ambient electric field E in the regions of space where the sprite streamers are propagating. We demonstrate that the exponential growth of the current in sprite streamers at 75 km would be preferentially associated with electromagnetic radiation in the frequency range from 0 and up to $\sim$3 kHz, whereas the growth of the streamer current at 40 km could produce radiation with frequencies up to $\sim$300 kHz, consistently with the scaling of atmospheric air density [*Kosar et al.,* 2012]. We further conjecture that the periodic branching of streamers may lead to a radiation spectrum enhancement in the VLF to low frequency (LF) range. The present study shows that sprite streamers could be responsible for at least part of the LF radiation associated with sprite-producing lightning discharges and detected recently by *Fullekrug et al.* [2010].