Transient Luminosity along Negative Stepped Leaders in Lightning

Maribeth Stolzenburg (1), Thomas Marshall (1), Sumedhe Karunarathne (1), Nadeeka Karunarathna (1), and Richard Orville (2)

(1) University of Mississippi, Department of Physics and Astronomy, University MS, United States (mstolzen@phy.olemiss.edu), (2) Department of Atmospheric Sciences, Texas A&M University, College Station, TX, USA

We present observations of abandoned stepped leader branches that briefly reconnect to the main stepped leader trunk or another active branch during the negative stepped leader advance in natural cloud-to-ground lightning strokes. The transient luminous features described, termed sparks, are common, bright and fast based on high-speed video data with 20 us image interval. Sparks typically reach maximum visible extent of a few hundred meters or less and peak intensity of one to three times that of their parent leader within 40 us. Most sparks connect to a parent leader within their first 20 us and are visible for less than 120 us. Generally, there are several milliseconds (average 3.3 ms) before the spark during which its branch is visibly abandoned, i.e. apparently neither propagating nor connected to the active stepped leader system. There is a tendency for sparks to occur late in the stepped leader advance, averaging 900 us before the return stroke for 90 sparks in 14 strokes. Sparks occur at altitudes at least as high as the visible stepped leader top (about 3000 m in these data), but they have not been observed below 500 m altitude. Parent leaders typically get brighter below the connection point after the spark, and in some cases their speed of advance increases. Nearby time-correlated electric field change data show a distinct spark signature characterized by a relatively large bipolar pulse, followed by a slower decrease over 40-100 us, ending with another relatively large pulse.