

What Are the Differences Between Sprite-producing and Non-sprite-producing Lightning?

Steven A. Cummer*, Wenyi Hu, Electrical and Computer Engineering Department, Duke University, Durham, NC 27708, USA (email: cummer@ee.duke.edu)

Walter A. Lyons, Thomas E. Nelson, FMA Research, Inc., Fort Collins, CO 80254, USA

Ongoing measurements have shown that the relationship between lightning and sprites is be complicated. To be sure, lightning discharges with large charge moment changes, which create relatively strong electric fields at mesospheric altitudes, do preferentially generate sprites. However, it is known experimentally that exceptionally few sprites are created by negative cloud-to-ground (CG) lightning, despite measurements showing similar occurrence rates between large +CG and -CG lightning in many circumstances [e.g., Huang et al., JGR, 1999]. This polarity asymmetry is not well-understood. Moreover, a preliminary analysis of charge moment changes in many North American sprite-producing discharges during the summer of 2000 has indicated that similar discharges sometimes do and sometimes do not make sprites [Hu and Cummer, GRL, 2002], suggesting at a minimum some day-to-day variability in the ability of lightning to generate sprites. We will present a systematic study of the lightning in individual thunderstorms to determine the differences between lightning that does and does not generate sprites. Local video and remote extremely low frequency (ELF) magnetic field measurements were made during the Severe Thunderstorm Electrification and Precipitation Study (STEPS) in the summer of 2000. These measurements are a relatively complete set of sprite occurrences and lightning charge moment changes spanning many days and individual storms. Specific issues that will be addressed include a comparison in individual storms of charge moment changes in positive cloud-to-ground (CG) lightning that did and did not generate sprites, and a determination of the distribution and limits of charge moment changes in negative CG lightning throughout the entire campaign period. An improved understanding of why some lightning discharges do generate sprites and others do not should expand our knowledge of sprites processes and their global implications.