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Time Correlated High-Speed Video and Multi-frequency Electromagnetic Observations of Cloud-to-Ground Lightning

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On 28-29 July 2010, time correlated data of lightning flashes were obtained near Kennedy Space Center, Florida, with two high-speed video cameras, five flat-plate 'slow/fast' antennas, a seven-station LINET, and the nine-station LDAR2 system. Optical images were obtained at 54000 frames per s, with 18.1 us exposure, 20 um sensor size, and 8 mm focal length lens. Fast electric field changes were sampled at 1 MHz with a decay time constant of 1 s. The LINET system (deployed 15 June-15 August 2010) uses time-of-arrival of the magnetic field change at VLF/LF (5-200 kHz) to locate in-cloud and ground strokes of lightning flashes. The LDAR2 (or 4DLSS) lightning mapping system locates impulsive sources at VHF (60-66 MHz). The flashes observed were 25-45 km from the camera site and occurred at 1400-1600 Local Time.

Examination of the data for ten cloud-to-ground lightning flashes has revealed several intriguing features. Brief bursts of light, bright enough to be seen during daylight through intervening cloud, were observed to accompany "characteristic pulses" in the field change records during preliminary breakdown of two flashes. Leader stepping was observed to have a distinct character, both optically and electromagnetically, that can be used to determine when new channel development is occurring. Numerous attempted (or failed) dart leaders were seen in the flashes, but not all these failed leaders had accompanying K-changes, LDAR2 sources, or LINET detections. In the few milliseconds immediately following some return strokes, there is evidence for substantial new channel development and, in a few cases, brief return-stroke-like events occurred upward from the ground. Multiple ground connections were observed in five of the seven multi-stroke flashes. This presentation will describe the data from the various sensors during initiation and leader development before and during first and subsequent return strokes.