Upward Leader Currents Measured at the KSC Industrial Area Tower

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Abstract

The Industrial Area Tower (IAT) at the Kennedy Space Center (KSC) is located in a region with flat ground experiencing lightning flash density in the range of 8 to 12 flashes/sq. km/year. A lightning current measurement system was installed on this 91.5-m tall, grounded-guy-wire-supported tower and became operational on August 1, 2018. This relatively low-height (low enhancement) tower was selected in order to observe lightning attachment that exhibits the characteristics of natural cloud-to-ground lightning including short upward connecting and unconnected leaders in response to nearby downward leaders, natural first stroke onsets with slow-front and fast-transition characteristics, and natural first-stroke current waveforms. The measurement system consists of a shunt and a Rogowski coil near the base of a 6.2-m tall mast and Franklin rod installed at the top of the tower. Current from the base of the Franklin rod is brought by a down-conductor to the current measurement box at the tower top that contains the shunt and Rogowski coil. The current is measured in four separate channels, three from the shunt, and one from the Rogowski coil followed by an integrator, resulting in broadband current measurements in the range of 1 A to 200 kA. Data in all channels are transmitted via fiber optic links from the tower-top to its base where they are digitized using a 12-bit oscilloscope at a rate of 25 MHz (sampling interval of 40 ns). The record-length is 2 seconds with a 750-ms pre-trigger. All data are GPS timestamped to allow correlation with other datasets. Since the commencement of measurements at the tower, two downward negative flashes have attached to the tower. Additionally, currents from at least two unconnected upward leaders due to lightning in the close proximity of the tower have been recorded.

A high-speed video camera recorded the attachment of the upward and downward leaders in the flash that occurred on July 26, 2019. We have also examined the return-stroke current waveform of the negative cloud-to-ground flash that occurred on August 9, 2018 and will discuss characteristics of the slow front and fast transition components of the return stroke risetime. We were able to resolve upward-leader currents of a few amperes or less. Both the connected and unconnected leaders consisted of the “typical” faster modulations observed in such current waveforms overlaid on a slower “background” current thought to be produced by an upward-propagating positive leader. We will show up-to-date results and compare the current characteristics of unconnected and connecting upward leaders.

Topic Areas

Lightning Physics, Characteristics and Measurements

Submission Format

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