# Ground-Truth Instrumentation and Data to Evaluate MERLIN's Tall Structure Detection Efficiency

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## Abstract

The 45th Weather Squadron utilizes the Mesoscale Eastern Range Lightning Information Network (MERLIN) to provide high-fidelity lightning reports to space launch providers at the Kennedy Space Center (KSC) and Cape Canaveral Air Force Station (CCAFS). MERLIN is a lightning detection/location network comprised of 10 Vaisala TLS-200 sensors located in and around KSC and CCAFS. A prior study conducted by Scientific Lightning Solutions, LLC (SLS) found that the MERLIN detection efficiency (DE) for a dataset of 45 cloud-to-ground return strokes to tall structures and large catenary wire systems (84.4%) was lower than the DE for a dataset of 276 strokes attaching to ground (93.5%). The results of the study were presented at ILDC 2016. Anecdotal evidence suggests that the MERLIN DE for strokes to tall structures may, in fact, be as low as 75%. Note the performance of MERLIN for strikes to tall structures (launch pads, vehicle/payload assembly buildings, etc.) at KSC/CCAFS is of critical importance to assess the risk of induced current damage in the electronics of satellite payloads, space launch vehicles, and test equipment from nearby strong strokes. A network of SLS' Jupiter Transient Monitoring Systems (TMS) and Jupiter Optical Lightning Surveillance (OLS) Systems have been deployed during Fall 2019 at KSC and CCAFS to provide ground-truth data to determine if the apparent MERLIN DE difference for strokes attaching to tall structures/catenary wire systems versus ground is statistically significantly lower. If the DE difference for strokes to tall structures and ground is found to be statistically significant, the 45th WS will utilize the collected data to try to improve MERLIN's DE for strokes to tall structures without degrading MERLIN's overall performance elsewhere.

To capture a statistically significant dataset of ground truth lightning events in a reasonable amount of time, SLS has installed seven Jupiter OLS systems to monitor active launch pads LC-37, LC-40, LC-41, LC-39A, and LC-39B in addition to the VAB area. Blue Origin's LC-36 will also be monitored after the launch pad lightning protection towers are erected. The proposed Jupiter OLS systems will also view several tall assembly/integration buildings and weather/communication towers that are frequently struck by lightning. Jupiter OLS provides 100% detection efficiency for lightning events occurring in close proximity to the monitored target, including both direct strikes to the target and nearby strikes to open ground.

SLS has also deployed eight Jupiter TMS that will be used as an eight-station time-of-arrival (TOA) network. The Jupiter TMS network timing accuracy is of the order of 15 ns RMS, which provides both unprecedented strike location accuracy and the ability to precisely correlate detected events with both Jupiter OLS high-speed video recordings and MERLIN lightning strike reports. Note that a similar TOA network was used to provide ground-truth data during the initial MERLIN performance evaluation in 2015/2016. Three years of data collection will likely be needed to obtain a large enough sample size for reliable results. This paper describes in detail the instrumentation being used and the deployment to provide the required ground-truth data to determine the MERLIN DE to tall structures.

## Topic Areas

Lightning Detection Systems Technology and Performance

## Submission Format

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