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Documenting Lightning from Space with Optical and Radio-Frequency Sensors

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With the upcoming launch of the Lightning Imager (LI) on the Meteosat Third Generation (MTG) satellite, it is important to review what space-based optical sensors detect and how their perspective on lightning physics differs from RF instrumentation. Perhaps the most significant difference is how the signals propagate to the sensor. Unlike RF sensors, optical sensors do not directly sense lightning processes but instead measure the resultant cloud illumination. The clouds surrounding the lightning channels scatter and absorb the optical signals generated by the flash, thus modifying their appearance from orbit. This is primarily a concern for instrument performance, but it is also an opportunity to extract additional information about the lightning source and the cloud medium that the signals traverse from the spatial radiance data recorded by the lightning imager.

This study analyzes the pixel, cluster, and gridded products generated by the space-based lightning instruments that came before LI – particularly the Geostationary Lightning Mapper (GLM) on NOAA's GOES satellites and the optical and RF payloads on the Fast On-orbit Recording of Transient Events (FORTE). We use these platforms to compare RF and optical detections from the same flashes and examine what on-orbit data can reveal about lightning physics and thundercloud illumination. We then demonstrate how this information can be utilized in broader applications to characterize lightning sources, make inferences about the structure and dynamics of the parent thunderstorm, and monitor detection performance – including with the future LI data.

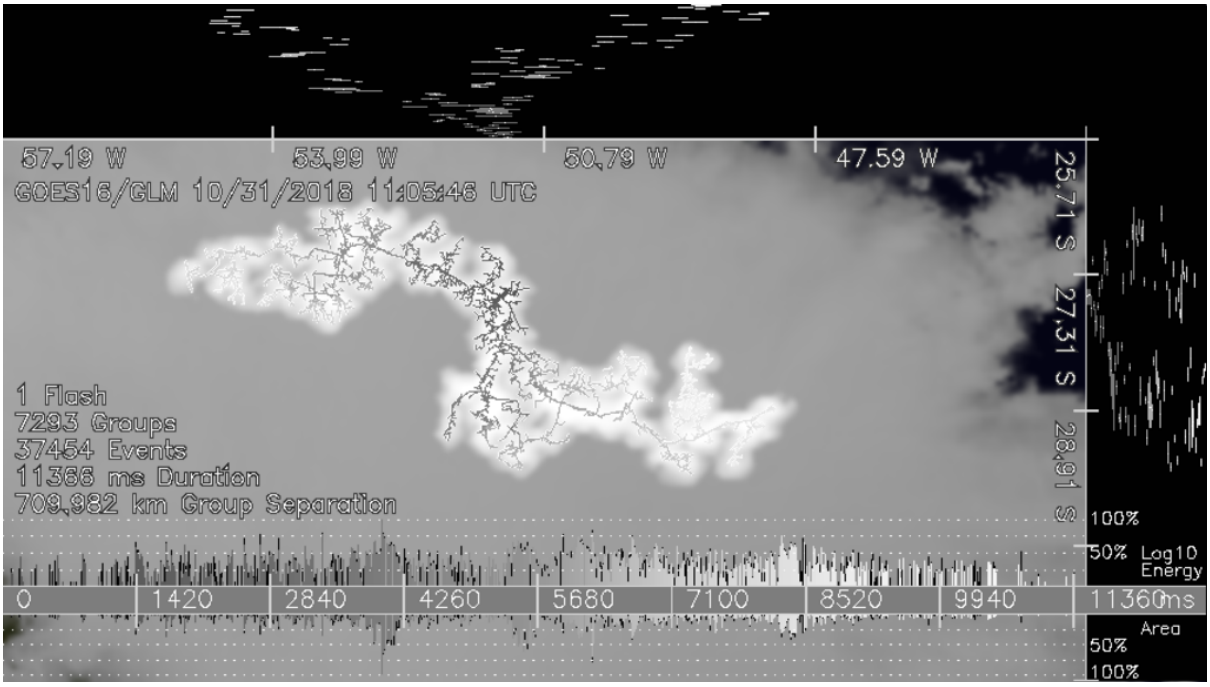

Figure 1. GLM observations of a 709-km lightning "megaflash" that occurred over southern Brazil on 10/31/2018. Lines in the central map panel show the incremental lateral development of the flash, while the upper and right panels show the positions and latitude / longitude extents of individual optical pulses over time. The bottom time series shows pulse energy (above the axis) and the geographical extent of the cloud illumination (below the axis) over the flash duration. This flash has been accepted as a new world record for flash extent by the World Meteorological Organization (WMO).

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