One TGF and two elves produced by the same thunderstorm system

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On February 8, 2019 the Atmosphere-Space Interaction Monitor (ASIM) passed a thunderstorm system north east of Puerto Rico and observed a TGF and an Elve from the same lightning stroke at the very beginning of a lightning flash. A second Elve was observed 456 ms later but without any signature of a TGF about 300 km south-east of the first Elve.

The strokes associated with the two Elve events were detected by WWLLN and Vaisala, which allows for an absolute timing accuracy of the ASIM measurements of at least 100 us. Images of the lighting strokes support the source locations for the Elves and TGF.

Both the rise time of the UV pulse by ASIM MMIA photometer and radio measurements from Puerto Rico indicate that the first stroke was an intracloud positive while the latter was a cloud-to-ground stroke. The UV emissions from the Elves preceded the optical emissions in 777 nm by

50 us and 90 us, respectively. This can partly be explained by the scattering of 777 nm within the cloud.

Current moments derived from radio measurements at Puerto Rico and Duke University indicate a fast (30 us) and large (200 kA) current pulse emitting an electromagnetic wave that produces an Elve and a slow (1-2 ms) current producing the optical signals.

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