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Elves Caused by In-Cloud Discharge Processes Producing Terrestrial Gamma-Ray Flashes

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Recent studies of the optical emissions associated with terrestrial gamma-ray flashes (TGFs) near source regions [Dwyer et al., GRL, 40, 2013] or immediately above thunderclouds [Xu et al., AGU Fall Meeting Abstract, 2016] have found that although their intensity is weak, they may be detectable with high-speed optical instruments. In addition, they can be differentiated from those from other atmospheric electrical discharges such as lightning and streamers, because they have distinct spectral properties.

In this talk, we investigate optical phenomena at lower ionospheric altitudes caused by the in-cloud (IC) discharge processes producing TGFs. It has recently been found that a special class of IC discharges (energetic in-cloud pulses, EIPs) with high peak currents greater than 150 kA is tied to the production of TGFs [Cummer et al., GRL, 41, 2014; Lyu et al., GRL, 42, 2015; Lyu et al., GRL, 43, 2016]. In particular, one of the observed TGFs is produced by an in-cloud discharge event resulting in a current moment of 542 kA km, which would have been reported as a >500 kA peak current event if NLDN detectors were not saturated [Cummer et al., 2014]. EIPs are expected to produce bright optical emissions in the lower ionosphere, similar to elves typically produced by cloud-to-ground (CG) lightning discharges with high peak currents. We will present modeling results of the elves produced by EIPs and discuss the similarities and differences between them and those produced by CGs.