Studying Terrestrial Gamma-ray Flashes with Fermi Gamma-ray Burst Monitor and Lightning Locating Systems

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The Fermi Gamma-ray Burst Monitor (GBM) provides an unprecedentedly large Terrestrial Gamma-ray Flash (TGF) dataset comprised of more than 4000 such events [*Roberts et al., JGR*, *123, 4381, 2018*]. The two-dimensional geolocation of a TGF is obtained by correlating the time-of-occurrence of the TGF with the associated radio frequency (RF) emission reported by a lightning locating system (LLS). The precise geolocation of TGFs enables us to perform detailed spectral analysis and hence study TGF production mechanisms by fitting the data with various models. The GBM has observed tens of events with sufficiently-high detected photon counts, which are suitable for the individual spectral analysis. Additionally, the RF emissions themselves can give insights into TGF production mechanisms and the characteristics of storms, which produce TGFs. We analyzed TGFs detected by the Fermi-GBM in conjunction with data from the U.S. National Lightning Detection Network (NLDN) and the Global Lightning Dataset (GLD360). For TGFs occurring within the coverage region of the NLDN, we examine the peak currents reported by the NLDN for 61 pulses that occurred within 5 ms of the start-time of TGFs. Further, using data from the GLD360, we examined the estimated peak currents of RF pulses occurring almost simultaneously with GBM TGFs occurring worldwide. The Fermi-GBM reported 3870 TGFs during the 2013-2017, of which 2198 TGFs occurred within 3.5 ms of 2273 GLD360-reported RF pulses. For 1825 RF pulses (about 80%) whose start-times were after the respective TGF's start-time, the time-intervals ranged from 1 μs to 3.5 ms with the median being 91 μs.