Using WWLLN to Find Weaker TGFs in the Fermi GBM Data

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Terrestrial gamma-ray flashes are currently detected with the Fermi Gamma-ray Burst Monitor (GBM) in two ways: the flight software monitors the data in orbit and detects brighter TGFs, and an offline search scans individual photon data at higher temporal resolution to detect weaker TGFs. The resulting sample of more than 3000 TGFs has been released as the GBM TGF catalog: `http://fermi.gsfc.nasa.gov/ssc/data/access/gbm/tgf/`. The offline search applies several thresholds to ensure that a cluster of gamma-rays is statistically significant and is a TGF rather than a cosmic ray, e.g., it requires four photons in each of the two GBM BGO detectors. Are there weaker TGFs in the GBM data?

As done by other researchers with RHESSI data, we test for excess GBM gamma-rays proximate to sferics detected by the World Wide Lightning Location Network. We check the number of gamma-rays within ± 100 μs of WWLLN sferics, after correcting for light travel time to Fermi. Background is obtained from the number of gamma-rays at a large offset to sferics. There is strong evidence (chance $P < 5 \times 10^{-5}$) for an excess of gamma-rays starting with five gamma-rays total in the BGO detectors. However, a specific cluster of five gamma-rays cannot be reliably identified as a TGF because there is a larger number of chance associations. From nine or more gamma-rays, the number of chance associations is negligible and these clusters can be identified as TGFs. The clusters identified as TGFs tend to be located with respect to the spacecraft so that the "four photons in each BGO detector" requirement is difficult to satisfy. Many are at large offsets from the spacecraft and are spectrally soft. These do not appear to be intrinsically different from the TGFs found with the standard offline search. Research is in progress to characterize the fainter TGFs (five to eight gamma-rays) that cannot be separated from the background.