

A Four-Year Fermi Large Area Telescope Survey of Terrestrial Gamma-ray Flashes

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The Fermi Large Area Telescope (LAT) regularly detects Terrestrial Gamma-ray Flashes (TGFs) as it performs its nominal mission to survey the astrophysical gamma-ray sky at energies from ~ 20 MeV to 300 GeV from low Earth orbit. Because of the LAT's flexible trigger logic, TGF emissions at and above 10 MeV are detected with high sensitivity despite their having arrived from outside the instrument's field of view. Because the LAT will not trigger on lower-energy gamma rays, and because it is more sensitive than any previous gamma-ray instrument above ~ 20 MeV, the LAT is capable of revealing a new population of high-energy TGFs that is distinct from those in the literature, which are dominated by emission near and below 1 MeV, should that population exist. A deep search of four years of LAT data reveals more than 300 TGFs with hard gamma-ray emission, many of which were independently detected by the Fermi Gamma-ray Burst Monitor (GBM). Bright TGFs can be imaged with good accuracy for comparison with low-frequency (LF) and very-low-frequency (VLF) radio geolocations. The geographic distribution of LAT-detected TGFs is consistent with that of historical TGFs and is generally related to the distribution of active thunderstorm regions. The diurnal variation of LAT-detected TGFs is also consistent with historical TGFs: they are most common in local afternoon and rare in local morning. LAT-detected TGFs rarely exceed 1 millisecond in duration. We conclude that this sample of high-energy gamma-ray flashes is compatible with the known population of TGFs, and we present here a summary of their spectral, temporal, diurnal, and geographic features.