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Constraints on the Emission Cone of Terrestrial Gamma-ray Flashes by Spectral Analysis of Geolocated Events.

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The source lightning discharges associated with TGFs detected by the RHESSI satellite are determined from WWLLN data. 36 events occurring before 2006 are used in this analysis. Later events are not included because of radiation damage to the RHESSI instrument, which changed the energy response. The energy spectra are binned according to observation angle, i.e. the angle between the RHESSI nadir and the straight line to the source lightning. The result is a significant softening of the energy spectrum for TGFs detected at large ($> 40^\circ$) observation angles. The softening is due to Compton scattering which reduces the photon energies. It is also found that the highest photon energies in the distant TGFs are in order of 10 MeV indicating that they can not be scattered more than $\sim 15^\circ$. Based on these results TGFs seems to be produced in a nearly vertical electrical field which is consistent with the ambient field in thunder clouds and not around streamer/leader tips which imply highly divergent electrical fields.