Terrestrial gamma-ray flash electron observations by the SAMPEX satellite and their implications

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Terrestrial gamma-ray flashes (TGFs) are brief (≈ 1 ms), intense flashes of energetic gamma-rays detected by satellites above thunderstorms in coincidence with lightning. Such gamma-rays are predicted to be accompanied by energetic Compton electron emissions as a result of scattering of the photons in the upper atmosphere. These electrons have been suggested to explain several anomalous TGF observations by the Reuven Ramaty High Energy Solar Spectroscopic Imager (RHESSI) and the Burst And Transient Source Experiment on board the Compton Gamma-Ray Observatory (BATSE/CGRO) and additionally provide a new window for study of TGFs as they carry additional information about the source through their pitch angle and arrival time distributions and confinement by the geomagnetic field. We present results of simulations of electron and photon emissions and describe the implications of these results for inferences about the TGF source, including localization of the source region and constraint of the emission mechanism.

We also present new results of a search for these electron flashes in recent data from the Heavy Ion Large Telescope (HILT) on board the Solar, Anomalous, and Magnetospheric Particle Explorer (SAMPEX). Approximately 60 possible events are found in 11 years of data, with two especially interesting instances where a cluster of many possible electron flashes were observed within 1 minute of each other. Analysis of possible coincident lightning from radio observations with the Stanford very-low frequency (VLF) receiver network to provide evidence for coincident lightning is also included, together with meteorological context provided by various weather satellites.

These results are then analyzed in the context of their implications for TGF source altitude, photon emission directional distribution, and meteorology.