Detailed Radio Observations of Lightning Processes Associated with Terrestrial Gamma Ray Flashes

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The discovery of terrestrial gamma ray flashes (TGFs) and modeling of gamma ray generation that followed has shown with near 100% certainty that the basic process of relativistic runaway breakdown is driven by thunderstorms and lightning on Earth. Determining what processes are responsible for creating the potential drop of tens of megavolts and also seeding the breakdown with high-energy electrons, and understanding the conditions under which those processes occur, has proven much more challenging.

Radio emissions are among the only observables that provide a view into the electrodynamics of the region of gamma ray production. It is generally agreed that most and perhaps all TGFs are produced during the early, upward leader stage of normal polarity IC lightning flashes. Recent observations [Cummer et al., Geophys. Res. Lett., 2011] have indicated that at least some TGFs are simultaneous with a distinct low frequency pulse that is likely produced by the electron acceleration process that also generates the TGF itself.

We will describe recent coordinated observations of lightning and terrestrial gamma ray flashes that provide new insight into the detailed processes that generate this thunderstorm-driven high-energy radiation. Our goals are to confirm the presence of this distinct TGF radio signature in a larger number of events, and to quantify the the current and charge motion before, during, and after the TGF on a range of time scales from several milliseconds to several microseconds. This effort employs TGF measurements from the GBM instrument on the Fermi satellite and multiple magnetic field sensors deployed at locations across the US.