



VLF sferics associated with TGFs

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Terrestrial gamma ray flashes (TGFs) are produced by the runaway electron beams inside the thunderclouds by bremsstrahlung. Numerous satellite observations of the TGFs cannot provide a definite answer about the details of the generation processes of TGFs. There exist two TGF production models. According to one a TGF is produced during the upward negative IC leader propagation. Another one supposes that relativistic runaway electron avalanches (RREAs) producing TGFs can develop in strong thundercloud electric fields without involving a leader discharge mechanism. One of the most promising observation instruments to investigate the TGF production is LF radio waves emitted by the RREAs or RREA generated secondary currents. Detection and analyses of the radio waveforms from these currents provide new possibilities to better understanding of TGF generation mechanisms.

In this work we analyze RHESSI TGF data detected between 2004 and 2011 in association with the VLF waveforms recorded by the VLF magnetic field receiver deployed at the Duke University. Pairs of associated TGF-VLF events identified in combination with the World Wide Lightning Location Network (WWLLN) catalogue which provides independent lightning locations and timings. Selection criteria retrieved only the pairs with WWLLN-RHESSI nadir distances less than 500 km and time difference between the TGF start time and VLF sferic start time (recalculated to a WWLLN provided location) less than 150 μ s, which is based on the RHESSI-WWLLN-Duke combined timing accuracy. In total 15 events within these limits were identified. These events support the possibility of detection of VLF radio waveforms produced by RREAs or RREA associated secondary currents.

Further search in the RHESSI data and Duke recordings without having WWLLN confirmed locations revealed about a hundred TGF-VLF associated pairs. These are also simultaneous within 150 μ s and less than 500 km from nadir point. In this work we compare the distribution of WWLLN-RHESSI-Duke events with the distribution of RHESSI-Duke events. This comparison supports that the radio signals are simultaneous with the TGF production.