



Ground Radio Measurements of a Fermi TGF associated with a Cloud-to-Ground Lightning Flash

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We report the ground-level radio frequency measurements of a Terrestrial Gamma-ray Flash (TGF) detected by Fermi Gamma-ray Burst Monitor, at the time of a negative cloud-to-ground (CG) lightning flash. The multisite measurements show that this CG-associated TGF occurred only 3 ms prior to a CG stroke of a high peak current 146 kA, and there appears a slow LF/VLF pulse simultaneous with the TGF gamma rays of a time difference within ± 3 μ s. According to Pu et al., 2019, this isolated slow pulse may be direct signal from the electron movement during the TGF production process. The slow pulse shows negative polarity discharge with downward-going negative charge and is estimated to initiate at 5.4~6.7 km altitude. The measurements indicate that this is likely a downward TGF triggered by an upward positive leader in a CG flash with its reverse positron gamma-rays (Bowers et al., 2018) detectable from the space. Compared with the observation of a normal IC-associated upward TGF, it should be more difficult to detect the gamma rays produced by a weaker reversed beam of TGF in the deeper atmosphere, which may explain the lack of report of CG-TGFs. Note that the unique waveform of CG-TGF allows for ground detection with only distant radio signals, we then perform a statistical analysis of VLF data to find whether the CG-TGF is just a coincidence or repeatable natural phenomenon. The result shows that this type of downward CG-TGF may occur at a rate of 0.008% of all CGs and represent a considerable amount ($>30,000$) per year over the entire Earth.

References

- [1] Pu, Y. J., S. A. Cummer, F. C. Lyu, M. Briggs, B. Mailyan, M. Stanbro, and O. Roberts (2019), Low Frequency Radio Pulses Produced by Terrestrial Gamma-Ray Flashes, *Geophys. Res. Lett.*, **46**(12), 6990-6997, doi:10.1029/2019gl082743.
- [2] Bowers, G. S., et al. (2018), A Terrestrial Gamma-Ray Flash inside the Eyewall of Hurricane Patricia, *J. Geophys. Res.*, **123**(10), 4977-4987, doi:10.1029/2017jd027771.