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Estimated Number of Avalanche Electrons in a Downward TGF during Winter Thunderstorms

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Terrestrial gamma-ray flashes (TGFs) are sub-millisecond intense emissions coinciding with lightning discharges. Recent ground-based observations in Japan have demonstrated that downward TGFs take place in winter thunderstorms and trigger photonuclear reactions. However, nearby downward TGFs are so intense that it had been difficult to measure gamma-ray flux hampered by saturation of typical scintillation detectors. During winterdunderstorms on November 11th, 2017, we detected a downward TGF with scintillation detectors and ionization chambers. Time history of gamma-ray signals is compared with waveforms of a broardband low-frequency radio measurement. A radiation dose distribution recorded by nine ionization chambers and our Monte Carlo simulations suggest that the downward TGF took place at the 1500 m altitude, and produced 10^{18}-10^{19} avalanche electrons above 1 MeV. This number of avalanche eletcrons is the same order of magnitude as those in typical TGFs observed from space.