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Modeling Thunderstorm Ground Enhancements and Gamma-ray Glows

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Energetic radiation from thunderstorms is currently being measured by ground-based particle detectors worldwide, e.g. Torri et al., JGR, 107, 2002; Khaerdinov et al., Atmospheric Research, 76, 2005; Chilingarian et al., Phys. Rev. D, 82, 2010; and Tsuchiya et al., JGR, 116, 2011. Additionally, long bursts of radiation lasting more than one second (gamma-ray glows), have been observed from aircraft and balloons, e.g. McCarthy and Parks, GRL, 12, 1985; Eack et al., GRL, 27, 2000; Smith et al., JGR, 116, 2011; and Kelley et al., Nature Communications, 6, 2015. The Relativistic Runaway Electron Avalanche (RREA) model explains that the observed particle fluxes are due to electron acceleration and consequent gamma-ray emission in the large-scale atmospheric electric fields [Dwyer, GRL, 30, 2003].

Since the primary RREA electrons rapidly attenuate in the atmosphere, most of the information on the nature of the electric field inside the thundercloud can come from detection of the emitted gamma rays. In this work, we use the Relativistic Runaway Electron Avalanche Model (REAM) developed by Dwyer, GRL, 30, 2003, to model various layouts of the electric field configuration and study the predicted photon spectra. The comparison of the electron avalanche length calculated with REAM and with that of the model developed by Celestin and Pasko, JGR, 116, 2011, is also discussed.