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On the production of terrestrial gamma-ray flashes in the streamer coronae ahead of a lightning leader

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We investigate the origin of terrestrial gamma-ray flashes (TGFs), bursts of MeV photons emitted from thunderstorms. We model the acceleration of electrons and the subsequent production of energetic TGF photons in the electric fields of two encountering streamer coronae, initiated in the vicinity of a negative leader tip and of the positively charged region in a cloud [1]. Applying a particle Monte Carlo code, we first initiate thermal electrons in the electric field of the leader tip and subsequently turn on the streamer coronae to simulate the acceleration of electrons from thermal energies to energies of several tens of MeV. We find that the electrons between these two streamer coronae accelerate up to relativistic energies, allowing for the generation of TGF photons, whilst the electric field of only one streamer corona ahead of the lightning leader is not sufficient to energize electrons significantly. We present the spatial and energy distribution of electrons and TGF photons as well as the duration of these relativistic beams and confront simulation results with the measurements in the optical, UV and gamma-ray bands of the Atmosphere-Space Interactions Monitor (ASIM) [2], mounted on the ISS and dedicated to observe lightning and associated TGFs [3].

References

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