Effect of the Intermediate and Magnetic Field on the Relativistic Runaway Electron Avalanche (RREA) and Terrestrial Gamma-ray Flashes (TGFs)

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In this project, we studied how water content and the magnetic field affect the Relativistic Runaway Electron Avalanche (RREA) and Terrestrial Gamma-ray Flashes (TGFs) using a simulation toolkit known as Geant4. Previous researches have found that TGFs were more likely to be detected around the geomagnetic equator, where geomagnetic fields and thunderstorms cloud electric fields are perpendicular to each other. Moreover, they studied RREA by assuming that the air is dry, which is different from the real process where the RREA process occurs in the cloud condensed with water content. From our results, we found that water content affects the characteristic length of the RREA process and TGFs only when a weak electric field is present. Meanwhile, the alignment of the magnetic field with the electric field has a minor influence on the RREA process and TGFs. However, the magnetic field affects the symmetry of photon showers over short time intervals. These findings contribute to a deeper understanding of a phenomenon known as TGFs, which occur during lightning events and result in the release of gamma rays if high-energy electrons enter a region of highly intense electric field in the thundercloud. TGFs stem from the RREA process, wherein relativistic electrons within a cloud undergo multiplication. The high-energy seeds, secondary cosmic electrons generated by the collision between cosmic rays and molecules in Earth's atmosphere, initiate the process. Then electrons mainly generated the X-rays and gamma rays by a phenomenon termed Bremsstrahlung.

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