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Relativistic Runaway Electron Avalanche Seeding Efficiency

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Relativistic runaway electron (RRE) avalanche breakdown occurs when the lower dynamic friction on relativistic electrons allows them to undergo avalanche multiplication while driven by smaller electric fields than those required for conventional breakdown. RRE avalanche has been suggested to be the driving physical mechanism for many processes, including lightning initiation, sprites, and terrestrial gamma-ray flashes (TGFs). The RRE avalanche has been studied extensively, but existing results typically assume a rudimentary source of seed relativistic electrons. In this paper, we focus on this seeding process and present detailed simulation results of various seeding conditions. The initial seed particle type, energy, and relative direction are varied, as are the ambient electric field and atmospheric density. Known results on the temporal and spatial distributions and flux and energy spectra of cosmic rays as well as other possible seed sources are incorporated. The seeding of RRE avalanche under quasi-electrostatic and electromagnetic pulse models (previously suggested for TGF and sprite production) are also included. The efficiency of seeding under these circumstances and the effects of seeding structure on RREA spatial and temporal structure are discussed.

Keywords: relativistic breakdown, tgf, sprite