Geophysical Research Abstracts
Vol. 18, EGU2016-15528, 2016
EGU General Assembly 2016

Effects of the geomagnetic field on the beaming geometry of TGFs

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Terrestrial gamma-ray flashes (TGFs) are bursts of high-energy photons originating from the Earth's atmosphere in association with thunderstorm activity [e.g., Briggs et al., JGR, 118, 3805, 2013]. Although TGFs are believed to be produced inside thunderclouds (below 15 km altitude), the underlying physical mechanisms are still debated. Large-scale relativistic runaway electron avalanches (RREAs) along with relativistic feedback caused by positrons and photons have been proposed to occur in thunderclouds and to produce TGFs [e.g., Dwyer et al., Space Sci. Rev., 173, 133, 2012]. It has also been found that the production of thermal runaway electrons by stepping lightning leaders and their further acceleration could explain the TGF spectra and fluences for intracloud (IC) lightning electric potentials above ∼100 MV [Xu et al., GRL, 39, L08801, 2012; Celestin et al., JGR, 120, 2015]. In both scenarios, runaway electron avalanches take place and the related bremsstrahlung produces the TGF.

The impact of the geomagnetic field on RREAs has been seldom studied (with the notable exceptions of Lehtinen et al. [JGR, 104, 24699, 1999], Babich et al. [Geom. Aeron., 44, 243, 2004] and Cramer et al. [AGU Fall Meeting, abstract AE33A-0472, San Francisco, USA, 2015]), particularly in view of recent knowledge acquired about TGF sources properties. In this work, we study the effects of the geomagnetic field on the runaway electron beam geometry in large-scale RREAs and in the vicinity of lightning leaders and the corresponding impact on TGF observations using analytical and numerical means.