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The First Terrestrial Electron Beam Observed by The Atmosphere-Space Interactions Monitor (ASIM)

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Terrestrial Gamma-ray Flashes (TGFs) are short (< 2 ms) flashes of high energy (< 30 MeV) photons, produced by thunderstorms, between 10 and 15 km altitude (at least for TGFs detectable from space). They deposit a large amount of energy into the atmosphere and the ionosphere, since a large fraction (typically > 98%) of the initial source of high energy photons is absorbed before reaching space. When interacting with the atmosphere, the photons can produce a large quantity of electrons (through Compton scattering and pair production) and positrons (through pair production), but only a small fraction is able to escape the atmosphere [1,2].
The surviving electrons and positrons are then bounded to Earth's magnetic field lines and can travel large distances inside the ionosphere and the magnetosphere. They have an effect on the radiation belts that is yet to be quantified. This phenomenon is called a Terrestrial Electron Beam (TEB).

In this presentation, we report the first TEB detected by the Atmosphere-Space Interactions Monitor (ASIM). This event happened on September 16th, 2018. The ASIM-MXGS detector recorded an unusually long TGF (> 4 ms), with a softer spectrum than what is typically recorded for TGF events. Further modeling using the MCPEP code [3] permitted to estimate a likely geographical position of the TGF producing the TEB, where we could find a WWLLN match within a very short time interval (<15 ms), corresponding to the parent lightning. Imaging from a GOES-R satellite shows that the source TGF was generated close to an overshooting top of a thunderstorm. Further modeling, using Geant4 simulation of the ASIM mass model, confirms that MXGS most likely detected bremsstrahlung photons generated by relativistic electrons interacting with material surrounding the detector.

References:

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