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High-Energy Particle Showers Observed at Ground Level in Coincidence With Downward Lightning Leaders at the Telescope Array Observatory

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Terrestrial Gamma Ray Flashes (TGFs) detected by satellite observations have been shown to be generated by upward propagating negative leaders at altitudes of about 10 to 12 km MSL, and have durations ranging between a few hundred microseconds and a few milliseconds. The Telescope Array Cosmic Ray observatory, designed to observe air showers induced by ultra high energy cosmic rays, includes a surface scintillator detector (SD) covering approximately 750 square kilometers on a 1.2 km grid. Following the observation of anomalous SD triggers correlated with local lightning activity, a Lightning Mapping Array (LMA) and slow electric field antenna were installed at the TA site in order to characterize the lightning associated with these anomalous triggers. In this talk, we present evidence that the anomalous triggers are produced during the initial breakdown phase of fast, downward propagating, negative leaders above the detectors which produced the triggers. The durations of the high energy radiation are a few hundred microseconds, similar to satellite observations of TGFs. The triggers were produced within a few hundred microseconds of the initiation of the leaders, when the leaders were at an altitude of about 3 to 4 km MSL. The TA scintillation detectors are not optimized for gamma ray detection, however we present the results of simulations demonstrating that the fluxes observed are consistent with this picture. We conclude that the anomalous triggers observed by TA are clearly due to high energy radiation produced by the fast downward propagating negative leaders, and are probably downwarddirected TGFs.

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