Report of a Second Terrestrial Gamma Ray Flash Induced by Rocket-and-Wire Triggered Lightning

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We report on the second observed terrestrial gamma ray flash (TGF) that was coincident with a triggered lightning flash, the first occurring on Aug. 15, 2003 [*Dwyer et al.,* 2004]. This TGF was observed on Aug. 15, 2014, by a ground-level network of gamma ray, electric field, Lightning Mapping Array (LMA), optical, and radar measurements at the International Center for Lightning Research and Testing (ICLRT) in north central Florida. Simultaneous gamma radiation and LMA data indicate that on Aug. 15, 2014, the upward positive leader of an altitude-triggered lightning flash induced relativistic runaway electron avalanches near its tip when it was at about 3.5 km altitude, resulting in the measured TGF. Channel luminosity and electric field data show that there was an Initial Continuous Current (ICC) pulse in the channel to ground during the time of the TGF. The 2014 event is very similar to the 2003 TGF which occurred during the initial stage of a classically-triggered lightning flash at the ICLRT. Modeling of the observed ICC pulse electric fields at close range in 2014 and direct measurement of the ICC in 2003 indicate that the ICC current pulses in both 2003

and 2014 had both a slow and fast component, and that the fast component was more or less coincident with the terrestrial gamma ray flash, suggesting that relativistic runaway electron avalanches at the tip of the upward positive leader induced at least part of the ICC pulse observed at ground. In 2003, the slow and fast current amplitudes were measured to be 3.7 kA and 5.9 kA above a steady background current of 1.3 kA, with pulse widths of 325 μs and 32 μs respectively. In 2014 the slow and fast current amplitudes were estimated from modeling to be 1.2 kA and 8 kA, with pulse widths of 100 μs and 25 μs. Our ICC pulse model reproduces moderately well the 2014 two-station close electric fields at the ICLRT as well as three independent electromagnetic field measurements made about 250 km away. Radar and LMA data suggests that there was negative charge in the region in which the UPL initiated the TGF.