Characteristics of extremely bright TGFs and short TGFs from RHESSI
Intended for Energetic Radiation from Thunderstorms and Lightning

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Deeper analysis of gamma-ray data from the *Reuven Ramaty High Energy Solar Spectroscopic Imager (RHESSI)* satellite continues to reveal new populations of terrestrial gamma-ray flashes (TGFs). Following the publication of the original *RHESSI* TGF catalog (Grefenstette et al. 2009, JGR 114, A02314), Gjesteland et al. (2012, GRL 39, L05102) performed an improved analysis and more than doubled the number of TGFs detected and available for analysis. Both searches emphasized a time scale of 1 ms. We will report the study of a third analysis of the *RHESSI* database intended to find a wider range of durations if they are present, as well as both brighter and fainter events than those that appeared in the first catalog. We find two very interesting new populations:

Short events, with durations of approximately 100 us or less. Such events were previously reported in *Fermi* data, and, like the *Fermi* events, these show a greater correlation with sferic data from the WorldWide Lightning Location Network (WWLLN) than "ordinary" TGFs (Connaughton et al. 2013, JGR 118, 2313). We find that the short TGFs have a significantly different geographical distribution from the original RHESSI catalog, tending to favor oceanic regions rather than coastal or inland storms. Since a number of these events are in the northwest Atlantic, we will present a search for associated sferic data from the Duke University sensors, with particular emphasis on a search for things that might explain the oceanic tendency, such as an association with cloud-to-ground/cloud-to-ocean flashes of exceptionally high peak current. This could produce a global map similar to that of elves.

Extremely bright events, well over 10 times brighter than typical *RHESSI* TGFs, with some possibly 100 times brighter or more. These events overload the RHESSI detectors and are therefore difficult to recognize, with most having been missed by previous algorithms. We will present the meteorological context of several of these events, show their global distribution, and discuss efforts to estimate their true luminosity. The existence of these extremely bright events has implications for the design of future TGF instrumentation, for radiation risks to airline passengers and crew and the pilots of research aircraft, and for the role of TGFs in discharging thunderstorms.