MEASUREMENTS OF LIGHTNING ASSOCIATED WITH TRANSIENT LUMINOUS EVENTS AND TERRESTRIAL GAMMA RAY FLASHES

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Two ongoing satellite missions are providing a unique opportunity to study lightning-associated phenomena over wider geographic regions than previously possible. We first discuss measurements of lightning associated with sprites, halos, and elves recorded by the ISUAL instrument on ROCSAT-2. Much of what is known about the characteristics of lightning that produces transient luminous events (TLEs) in the mesosphere comes from measurements made over many years in the U.S. High Plains. Some measurements in other regions suggest that these characteristics may be different in different geographic regions. For example, the MEIDEX space shuttle experiment recorded video observations of a number of sprites and elves that occurred with a surprising lack of extremely low frequency (ELF) transients [*Price et al.*, GRL, 2004] that are typically associated with large cloud to ground lightning strokes. The ISUAL instrument on ROCSAT-2 is steadily recording TLEs over much of the globe and offers a unique opportunity to systematically investigate with a reasonably large database whether TLEs are produced by the same kind of lightning independent of location. Two sets of magnetic field sensors spanning the entire <1 Hz to 30 kHz frequency range have been operating at Duke University continuously since March 2004 and thus cover the initial months of ISUAL operations. Focusing primarily on TLEs observed in the Americas and Africa, which are close enough to the sensors that direct VLF signals are usually detectable from large lightning strokes, we estimate and analyze lightning parameters such as charge moment change, peak current moment, and current moment rise time in an effort to determine whether the TLE-lightning relationship is geographically variable. In particular, these parameters will be compared to those derived for U.S. High Plains TLEs from magnetic field observations using the same set of sensors.

We also report ground-based measurements of the very low frequency (VLF, 3–30 kHz) and lower frequency radio signals radiated by lightning associated with recent terrestrial gamma ray flash (TGF) observations from the RHESSI satellite. Through detailed modeling, the lightning charge transfer (specifically, the lightning charge moment change) required to generate the observed TGFs has been estimated to be around 5000 C km [*Lehtinen et al.*, JGR, 2001], which is near the charge moment change in bigger sprite-associated lightning strokes. However, this quantity has not yet been measured in TGF-associated lightning; in fact, the entire TGF-lightning relationship has been analyzed for few events, and little is known with any certainty. We quantify the lightning-TGF relationship in detail and attempt to constrain the possible source mechanisms. Specifically, we address three issues: the correlation of TGFs with individual lightning strokes, the implications of detailed event timing analysis, and the charge moment change and related high altitude electric field profile produced by the observed lightning strokes.