LIGHTNING-INDUCED HEATING OF THE LOWER IONOSPHERE

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Abstract Submission Form

2004 National Radio Science Meeting

Abstract: gerken25049

Date Received: September 24, 2004

One of the most fascinating developments in near earth space science in the last decade is the detection of upper atmospheric lightning-related electrical discharges commonly known as "sprites", "elves", and "blue jets". While much recent work has focused on studying the impact of lightning on the D-region of the ionosphere and below, little is known about the effects in the higher ionospheric regions. Cornell University has launched four rockets over thunderstorms from Wallops Island (Kelley et al., *Geophys. Res. Lett.*, **24**, 1111, 1997; Kelley et al., *Geophys. Res. Lett.*, **17**, 2221, 1990; Siefring and Kelley, *J. Geophys. Res.*, **96**, 17,813, 1991; Baker et al., *J. Spacecraft and Rockets*, **33**, 92, 1996). One of the most intriguing, and as yet not understood, features observed in these launches is the parallel electric field accompanying each strike. One of the Cornell rocket experiments, named "Thunderstorm II", was carried out at the Wallops Island Flight Facility in July 1988. It involved the simultaneous launch over a thunderstorm of two high-flying rockets (apogees over 300 km) with electric field and particle detectors. Parallel electric field pulses accompanying nearly every detected lightning strike were observed during this flight. A second Cornell rocket experiment, "Thunderstorm III", was launched from Wallops Island Flight Facility in September 1995 to further study electromagnetic pulses above thunderstorms. Complete waveform information was obtained for this sounding rocket using a specially designed 4-M sample/sec triggered burst memory (Baker et al., *J. Spacecraft and Rockets*, **33**, 92, 1996). This rocket launch produced the first ionospheric observations of the spectrum of lightning-induced electromagnetic waves from ELF through MF bands. These data were obtained on a near vertical path over a very active thunderstorm cell using a double-probe electric field sensor. The payload was magnetically aligned so the two detectors perpendicular to B saw a dispersed circularly polarized whistler mode wave. Similar to data obtained by the Thunderstorm II experiment, parallel electric field components observed during Thunderstorm III took the form of pulses lasting several ms and the features were similar for each strike. The average value of these fields was found to be $\sim$1.5 mV/m during 13 s of the upleg of the rocket flight. Using the thermal balance equation with this data set, it is determined that the electron temperature should be greatly enhanced within a few seconds. Modeling of the height distributed 630 nm oxygen airglow emission shows the lightning strikes should produce airglow enhancements which may be detectable from the ground, depending on the efficiency of the molecular nitrogen vibrational barrier.

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2. G - Ionospheric Radio and Propagation
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4. C - Contributed Paper, Program chair: Steve Cummer, Elizabeth Gerken
5. Ionospheric Effects of Lightning