

BROADBAND VLF MEASUREMENT OF D REGION IONOSPHERIC PERTURBATIONS CAUSED BY FAST DISCHARGING LIGHTNING-EMP

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The first experimental evidence of the impulsive direct coupling of energy released by lightning discharge to the lower ionosphere was reported in the form of early/fast perturbation on sub-ionospherically propagating very low frequency (VLF) signals. Since then, based on modeling and measurements, different mechanisms have been advanced to explain the fast sub-ionospheric VLF perturbations such as the ionization and heating associated with elves or electrical breakdown associated with sprites and halos. By comparing the broadband VLF spectra (3-25 kHz) of lightning discharges that occurred immediately (≤ 15 s) after an intense lightning discharge (≥ 60 kA) with the spectra of lightning discharges that were not preceded by an intense lightning discharge within approximately 60 seconds, we detect D region disturbances caused by these intense lightning flashes not only in the U.S. East Coast but also in the U.S. High Plains. The detailed electron density changes caused by the disturbances are measured by analyzing the broadband VLF propagation changes, and the perturbed electron density profiles from both regions are found to be consistent with those created by lightning-EMP when compared with theoretical predictions. In one case, the ionospheric perturbation occurred at the same time as an elve detected over the U.S. East Coast by the ISUAL satellite. This finding confirms that we are measuring lightning-EMP associated VLF perturbations. The elve-associated electron density profile is also found to be consistent with theoretical predictions. The characteristics of the lightning responsible for these perturbations has been investigated by comparing the intense causative lightning strokes to the intense non-causative lightning strokes, and it is found that the magnitude of VLF spheric spectrum of the intense causative lightning discharge is a reliable indicator of the measured perturbation strength. Our results suggest that many broadband detectable sub-ionospheric VLF perturbations are created by intense fast-discharging lightning-EMP, which can produce elves in the case of particularly intense discharges.

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2. H - Waves in Plasma
3. (a) S-H/G2
4. C - Contributed Paper
5. No special instructions