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Lightning/Ionosphere Interactions and Experimental Observations

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Extended Abstract

Powerful lightning discharges can significantly impact the electrical properties of the overlying ionosphere (at ~60-100 km altitude). The resulting ionospheric disturbances manifest as so-called early VLF scattering events, wherein subionospherically propagating VLF radio waves exhibit significant changes in amplitude and phase at a receiver as a function of time. *Kotovsky and Moore* (2015) presented experimental observations to identify a wide variety of early VLF scattering events, exhibiting slow, intermediate, and fast event onsets as well as regular and slow event recoveries. The development of models which can reproduce the observed properties of early VLF scattering events gives us insight into the important electron and ion dynamics of middles atmosphere, under both ambient and disturbed conditions. The knowledge gained will also aid us in predicting the response of the lower ionosphere to a variety of other ionizing phenomena, including solar flares, proton injection events, lightning-induced precipitation, and high-altitude nuclear explosions.

Kotovsky and Moore (2016a,b) presented theoretical numerical analysis of electric field heating of the ionosphere (0-dimensional) for a wide variety of cases. Recent work implements a cylindrically-symmetric dynamic model of lightning-ionosphere interactions, wherein the atmospheric chemistry delineated by *Kotovsky and Moore* (2016a,b) is simultaneously solved with an electrodynamic solution of Maxwell's equations (using FDTD).

In this presentation, we demonstrate the successful modeling of VLF scattering during regular-recovery and long-recovery early VLF scattering events using the new model; we investigate VLF scattering onset durations in particular; and we study the effect of the ionospheric nonlinearities on the propagation of the VLF sferic, both into space and back to the ground.

References

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