32nd URSI GASS, Montreal, 19–26 August 2017

Repeatability of Lightning Induced Ionospheric Disturbances in VLF Remote Sensing

Morris B. Cohen [(1)], Nikhil Pailoor [(1)] and Mark A. Golkowski [(2)]
(1) School of Electrical and Computer Engineering, Georgia Institute of Technology, Atlanta, Georgia, USA.
(2) Department of Electrical Engineering, University of Colorado Denver, USA.

1 Extended Abstract

Very Low Frequency (VLF) remote sensing is a well-employed technique to diagnose the impact of lightning on the D-region ionosphere, both from direct heating and ionization, and from lightning-induced electron precipitation events from the radiation belts.

One of the challenges is that previous observations of VLF perturbations have shown little consistency with each successive observation exhibiting new features. This is no doubt caused by the fact that the transmitter-receiver geometry, lightning properties, and ionospheric condition before the event, all impact the VLF scattering, making full repeatability of any given observations rare. This makes it very difficult, based on case studies which observe only a small number of cases, to infer the scattering pattern of VLF events, and therefore, to infer what happened to the ionosphere.

Our aim is to quantify repeatability by looking at a large database of lightning-induced ionospheric disturbances, taken over several years of recordings, beginning at Stanford University and then continuing on at Georgia Tech, utilizing the amplitude and phase of VLF transmitter signals. We utilize an automatic extraction algorithm to find, identify, and characterize VLF perturbations on a massive scale, using lightning geolocation data as a starting point (NLDN and GLD360). From there, we can investigate how the VLF perturbations change as a function of the parameters of the event, like lightning peak current, scattering angle, and other parameters. The identification of a "canonical" lightning-induced disturbance as a function of geometry and lightning parameters, provides a method of identifying the causative mechanisms and being able to accurately simulate and reproduce any lightning-induced ionospheric disturbance.