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Characteristics of Subionospheric VLF Signal Propagation during Energetic Electron Injections

R. Ghaffari* (1), C. M. Cully (1), D. L. Turner (2) and G. D. Reeves (3,4)
(1) University of Calgary, Canada
(2) Aerospace Corporation, El Segundo, USA
(3) Los Alamos National Laboratory, USA
(4) The New Mexico Consortium, USA

1. Extended Abstract

The space around the Earth is filled with fast moving particles trapped in our magnetic field, forming two ”belts” separated by a ”slot” region. In particular, the outer radiation belt (located 3.5–8 Earth radii from the Earth’s center) is highly dynamic. This high dynamism is due to large and rapid changes in the fluxes in the particles, caused by the acceleration and loss of energetic radiation belt electrons during and after geomagnetic storms. One of the major routes for the loss of these electrons is into the atmosphere in a process termed ”precipitation”. This precipitation alters the ionization rate over a wide altitude range. Changes in D-Region ionization caused by energetic particle precipitation are monitored by the Array for Broadband Observations of VLF/ELF Emissions (ABOVE) - a network of VLF receivers deployed across Western Canada. The observed amplitudes and phases of subionospheric VLF signals from distant artificial transmitters depend sensitively on the free electron population created by precipitation of energetic charged particles. So precipitation affects subionospheric VLF signal propagation, influencing the amplitude and phase of the received signal in ground based instruments.

We characterize energetic electron injections (a sharp increase of energetic particle flux in the near-Earth tail) from sub-storms based on Van Allen Probes (RBSP-Radiation Belt Storm Probes) data. We measure the change in flux and focus on injections which penetrate to L-shell lower than four in our energy range of interest (100-500 keV electrons). Then we analyze data from the ground based VLF instrument array ABOVE to determine the correlation of amplitudes and phases of VLF signals with losses from Van Allen Probes. We use the ABOVE data to constrain when, where and how much precipitation occurs during the injections.