GENERATION OF LARGE-AMPLITUDE ULF WAVES BY IONOSPHERIC HEATING

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This paper focuses on using ionospheric heating to generate and control ULF waves propagating into the magnetosphere. Our interest in upward propagating waves is motivated by their ability to modify the distribution of charged particles in the magnetosphere. Although the classical one-fluid MHD, shear Alfven wave is magnetically and hydrodynamically incompressible, at least two physical mechanisms involving Alfven waves are known to modify the distribution of charged particles in the magnetosphere. First, Alfven waves with a small perpendicular wavelength have a component of the electric field parallel to the ambient magnetic field. This electric field can accelerate electrons along the magnetic field lines and causing them to precipitate into the ionosphere. Second, shear Alfven waves can couple nonlinearly to slow, ion-acoustic MHD waves. The slow waves move ions along the magnetic field lines and redistribute plasma density in the magnetosphere.

We report on ground magnetic observations performed during the ionospheric heating experiments at the High Frequency Active Auroral Research Program (HAARP) facility in Alaska on February and May 2012. The experiments were aimed at generation of large-amplitude ULF electromagnetic waves by triggering and facilitating development of the ionospheric feedback instability (IFI). During the experiments ground-based magnetometers in Alaska detected large-amplitude ULF waves. The frequencies of these waves closely matched frequencies predicted by simulations of IFI for these particular geophysical conditions. These observations support the hypothesis that large-amplitude ULF waves and the ionospheric feedback instability are closely connected phenomena.