FEEDBACK-UNSTABLE ULF WAVES IN THE IONOSPHERIC ALFVEN RESONATOR DETECTED BY THE MICA FLIGHT

A.D. Weigel[1], A.V. Streltsov[1], K. Lynch[2], P. Horak[2], P. Fernandes[2], R. Miceli[3], D. Hampton[4], R. Mitchell[5], M. Samara[5]
[1]Embry-Riddle Aeronautical University, Daytona Beach, FL, USA; [2]Dartmouth College, Hanover, NH, USA; [3]Cornell University, Cornell, NY, USA; [4]University of Alaska Fairbanks, Fairbanks, AK, USA; [5]Southwest Research Institute, San Antonio, TX, USA.

Localized packages of intense ultra-low-frequency (ULF) electromagnetic waves have been persistently detected by satellites at different altitudes on the magnetic field lines mapped to the auroral ionosphere. The origin of these waves still remains one of the most interesting unanswered questions of modern geophysics. Some studies suggest that these waves are generated in the equatorial magnetosphere in the process called magnetic field line resonance, which involve mode conversion between fast and shear ULF waves. Other studies suggest that these waves can be produced by the phase mixing of shear waves propagating toward the ionosphere from a distant tail. We investigate the hypothesis that these waves are the result of nonlinear coupling between the ionosphere and the magnetosphere inside the so-called ionospheric Alfvén resonator, formed by the conducting bottom of the ionosphere and a strong gradient of the Alfvén velocity at the altitude ~0.5-1.0 R_E. The resonator is driven by the ionospheric feedback instability fed by the electric field in the ionsophere. The mathematical model of ULF waves driven by the ionospheric instability is based on he reduced two-fluid MHD equations. These equations are implemented numerically in the dipole magnetic field geometry. The ionospheric feedback mechanism is incorporated in the model via boundary conditions.

This numerical mode is used to simulate results of observation performed by the Magnetosphere-Ionosphere Coupling in the Alfvén Resonator (MICA) sounding rocket, launched into the polar ionosphere on February 18, 2012 from Ft. Yukon, Alaska. The main objective of this experiment was to investigate the role of the active ionospheric feedback in the development of large-amplitude, small-scale electromagnetic waves and density depletions in the low-altitude (<400 km) auroral ionosphere. The results of simulations reproduce the main features of the intense, localized electromagnetic waves detected by MICA on the edges of the discrete auroral arc observed during the flight with the ground optical cameras. The main conclusion from this numerical study is that the ionospheric feedback instability indeed is the main mechanism responsible for the generation of small-scale intense, ULF waves at low altitudes in the vicinity of discrete auroral arcs.