DENSITY STRUCTURES PRODUCED BY NONLINEAR ULF ELECTROMAGNETIC WAVES IN THE MAGNETOSPHERIC PLASMA

Streltsov, A.V.[1 2], Lotko, W.[1], Ganguli, G.[2]
, Rudakov, L.I.[3], Mithaiwala, M.[4]
[1]Dartmouth College, Hanover, NH 03755, USA
[2]Naval Research Laboratory, Washington, DC 20375, USA
[3]Icarus Research Inc., Bethesda, MD 20824, USA
[4]NRC-NRL Postdoc, Washington, DC 20375, USA

Results from a numerical study of the nonlinear interaction between ultra-low-frequency shear Alfvén waves, slow MHD waves, and the high-latitude auroral ionosphere are presented. The goal of this study is to investigate the role of magnetic field-aligned currents carried by shear Alfvén waves in the formation and spatiotemporal development of density structures in the low-altitude auroral magnetosphere and the ionosphere. Interest in this problem is motivated by ground-based radar and satellite observations of field-aligned ion flows and density cavities, extended along the ambient magnetic field and localized across it, in conjunction with discrete auroral arcs and intense field-aligned currents. The study is based on a reduced, two-fluid MHD model describing shear Alfvén and slow MHD waves in the cold, low-altitude magnetospheric plasma. Coupling between these two MHD modes occurs due to (a) the finite plasma compressibility, and (b) the nonlinear $\mathbf{j}\times\mathbf{B}$ term in the ion momentum equation. Another important nonlinear effect included in the model is active ionospheric boundary conditions (ionospheric feedback mechanism). Numerical simulations of the model equations have been performed in a two-dimensional, axisymmetric, dipole geometry of the ambient magnetic field with realistic parameters of the ambient field and the background plasma. Simulations show that ULF Alfvén waves generated in the equatorial magnetosphere or in the plasma sheet boundary layers carry significant amount of the electromagnetic power to the low-altitude magnetosphere and indeed modify plasma density there. This variation of the plasma density feedbacks on the dynamics of the waves. Simulations also show that another important physical effect responsible for formation of intense electromagnetic and plasma structures in the ionosphere and low-altitude magnetosphere is the ionospheric feedback mechanism.

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1. (a)
Anatoly Streltsov
Thayer School of Engineering
Dartmouth College
Hanover, NH
03755 USA
streltsov@dartmouth.ed
   (b) 603-646-2723
   (c) 603-646-3856
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