NONLINEAR EVOLUTION OF PLANETARY-SCALE ELECTROMAGNETIC WAVES IN E-REGION OF THE IONOSPHERE FOR A SPHERICAL EARTH MODEL

G.D.Aburjania*, G.V.Jandieri **, A.G.Khantadze***

* Vekua Institute of Applied
Mathematics, Tbilisi State University,
2 University str., 380043 Tbilisi, Georgia
** Department of physics, Georgian Technical University,
77 Kostava str., 380075 Tbilisi, Georgia
*** Chair of Meteorology and
Hydrology, Tbilisi State University,
1 Chavchavadze av., 380028 Tbilisi, Georgia
(Received: 23.04.01; revised: 12.10.01)

Abstract

Physical mechanism of generation of slow and fast planetary waves of electromagnetic type in dissipative $E-$ region of the ionosphere is suggested. The waves are caused by a constantly acting factor - a latitude variation of geomagnetic field. It is shown that slow waves are generated by the dynamo field in the ionosphere and fast waves - by vortical electric field. Slow electromagnetic wave is analogous to the Rossby planetary wave, fast one is a new mode of proper oscillation of $E-$layer. Linear waves propagate both to the east and west directions in dynamo region of the ionosphere along parallel against a background of the mean zonal flow.

Nonlinear theory of fast and slow planetary electromagnetic waves in $E-$ region of the ionosphere is developed for the first time in this paper. It was established that these perturbations are self-localized in the form of nonlinear solitary vortical structures in dynamo-region of the ionosphere and they move to the east (slow) and west (fast) directions against a background of the mean zonal flow. Nonlinear structure consists of a couple of cyclone-anticyclone type vortices, which rotate in the opposite directions and transfer trapped particles of the medium. Energy and enstrophy of large-scale vortices attenuate weakly and are long-lived. Vortical structures generate magnetic fields greater by an order of magnitude than the corresponding linear waves. The features and parameters of the theoretically investigated electromagnetic wave structures are in conformity with the features and parameters of the experimentally observed large-scale ultralow frequent wave perturbations in the ionosphere.

Key words and phrases: Planetary waves, Nonlinear vortex, Geomagnetic field, Ionosphere.

AMS subject classification: 76W05; 76E30; 76X05.