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Dynamics of IGW and traveling ionospheric disturbances in regions with sharp gradients of the ionospheric parameters ☆

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Abstract

The dynamics of the 2D solitary nonlinear internal gravity waves (IGW), as well as traveling ionospheric disturbances (TID) of the electron density excited by them at heights of the ionosphere F-region, for conditions close to those of the F-layer assuming that the source of initial perturbation has the pulse character is studied analytically and numerically. On a level with general case the rather interesting applications when the sharp gradients of the ionospheric parameters are the functions of space coordinates and time, namely the IGW and TID dynamics in the frontal regions of the solar terminator and solar eclipse are considered. The results obtained describe the dynamical structure, evolution and transformation of the IGW and TID at heights of the ionosphere F-layer including its strongly heterogeneous regions.

Keywords: Internal gravity waves; Solitons; TID; Ionosphere; Solar terminator; Solar eclipse

1. Introduction

Structure and dynamics of internal gravity waves (IGW) and associated traveling ionospheric disturbances (TID) are extensively studied for more than forty years (Heisler, 1959; Hunsucker, 1982, 1987; Hocke and Schlegel, 1996). Despite extensive observations involving numerous various technics such as, e.g., vertical and slanted ionospheric as well as satellite sounding (Belashova et al., 1990) and recently developed imaging technique using multipoint GPS networks (Tsugawa et al., 2006), the associated theory is less developed.

To solve the wide range of problems associated with wave perturbations at the ionospheric F-layer heights, it is necessary to take into account essential factors such as the middle- and large-scale traveling ionospheric disturbances (TID). TID directly affect variability of the ionospheric parameters as well as those of the Earth's ionosphere waveguide. One of the most convenient approaches to these problems is to study TID dynamics in terms of the internal gravity waves (IGW) (Belashov and Vladimirov, 2005). Of special interest are the IGW solitons as traveling in the F-layer stable large-scale wave formations, caused by various reasons such as the isolated magnetic substorms, solar terminator and solar eclipse (Belashova and Belashov, 2006), seismo-volcanic processes, and high-power artificial explosions (Belashov and Vladimirov, 2005; Belashova and Belashov, 2006). Here we first investigate the dynamics of the solitary nonlinear IGW (as well as TID excited by them at the heights of

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