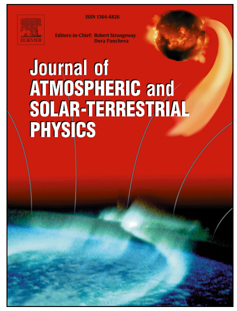

Peculiarities of acoustic-gravity waves in inhomogeneous flows of the polar thermosphere

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Peculiarities of acoustic-gravity waves in inhomogeneous flows of the polar thermosphere

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Abstract

The peculiarities of acoustic-gravity waves propagating in inhomogeneous polar thermosphere flows have been investigated. It is shown that a spectrum filtration and a change in amplitudes of acoustic-gravity waves occur in the region of polar thermosphere circulation. As a result, the waves with horizontal lengths of 500–700 km and periods of ∼10 min are predominated in satellite observations. We have shown that such spectral properties correspond to the waves which are blocked in the counter flow. The amplitudes of the blocked waves are greatly enhanced due to their interaction with the non-uniform flow. A ground-based observer registers these waves with periods from 30 minutes to more than 1 hour, depending on the flow velocity. Taking in to account the interaction of the waves with the flows we can explain the discrepancy between the results of satellite and ground-based observations of acoustic-gravity wave in the polar regions.

Keywords: Acoustic-gravity waves, thermosphere, inhomogeneous flows

1. Introduction

In this paper, the observed properties of acoustic-gravity waves (AGWs) in the polar thermosphere are shown to be caused mainly by their interaction with horizontally inhomogeneous flows. The investigation was based on observations of Dynamic Explorer 2 (DE2) satellite that clearly indicate the wind control of AGWs propagation in the polar region (Fedorenko and Kryuchkov, 2013; Fedorenko et al., 2015).

Acoustic-gravity waves in the Earth's atmosphere have been studied theoretically and experimentally for more than 60 years. AGWs effectively transfer the energy and the momentum between different atmospheric altitude levels and, thus, they play an important role in the dynamics and in the energy balance of the atmosphere. These waves can be generated by various sources (both natural and anthropogenic ones) which are accompanied by a significant inflow of energy into the atmosphere. The charged particle precipitations and auroral currents are usually considered as the most probable sources of AGWs in the high-latitude upper atmosphere (Crowley et al., 1987; Williams et al., 1992). AGWs at ionospheric altitudes can be observed by ground-based techniques in the form of traveling ionospheric disturbances (TIDs) (Hines, 1960). The high-latitude sources are associated mainly with large-scale TIDs having periods of ∼1 hr and more (Hunsucker, 1982). The frequency of occurrence of large-scale TIDs correlates with the auroral electrojet variations (Hajkovicz, 1991). In particular, the statistical investigations based on the GPS network have shown that the frequency of the occurrence of the large-scale TID increases with K_p -index, but a significant part of the disturbances (∼28%) is also observed in magnetically quiet days (Tsugawa and Saito, 2004).

In the framework of the linear theory of AGW, the basic results on early experimental and theoretical studies are presented in classical monographs (Hines, 1960; Hines, 1974; Yeh and Liu, 1974; Francis, 1975). Under the propagation of AGWs in the atmosphere "from below", their amplitudes increase exponentially with decreasing background

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