Coupling Between the Internal Atmospheric Waves and Tilted Sporadic E-Layers in the Earth’s Ionosphere

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Introduction:
We have used the radio occultation (RO) satellite data for studying the ionosphere of the Earth. A method for deriving the parameters of ionospheric structures is based on an analysis of the RO signal variations in the phase path and intensity. This method allows one to estimate the spatial displacement of a plasma layer with respect to the ray perigee, and to determine the layer inclination and height correction values [1, 2]. In this work, we focus on the case study of inclined sporadic (E s) E-layers in the high-latitude ionosphere based on available CHAMP (Challenging Minisatellite Payload/Global Positioning System) RO data. Assuming that the internal gravity waves (IGWs) with the phase-fronts parallel to the ionization layer surfaces are responsible for the tilt angles of sporadic plasma layers, we have developed a new technique for determining the parameters of IGWs linked with the inclined E s-structures [3]. A small-scale internal wave may be modulating initially horizontal E s-layer in height and causing a direction of the plasma density gradient to be rotated and aligned with that of the wave propagation vector \( \mathbf{k} \). We have shown that the magnitudes of intrinsic frequency and period can be directly determined based on the values of Brunt-Väisälä frequency and angle between the local vertical and wave propagation vector, only. It was found that the analyzed internal waves have the intrinsic periods from 35 to 46 min and intrinsic vertical phase speeds from 1.4 to 2.0 m/s. These values correspond to a period of 30 min in the ground-based frame and downward wind speed of 2.0 m/s at a height of 100 km found for a model of the Polar cap Sporadic-E layers [4]. The developed technique extends capabilities of the RO method for studying the atmospheres and ionospheres of the Earth and planets. The results of determination of the intrinsic wave frequency and period, vertical and horizontal wavelengths, intrinsic vertical and horizontal phase speeds, angle between the local vertical and wave propagation vector, and other characteristics of IGWs under study are presented and discussed.

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References: