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Application of GPS radio occultation method for observation of the internal waves in the atmosphere with global coverage

A.G. Pavelyev (1), Y.A. Liou (2), J. Wickert (3), A.A. Pavelyev (1), T. Schmidt (3), V.N. Gubenko (1)

(1) Institute of Radio Engineering and Electronics of Russian Academy of Sciences, (IRE RAS), Fryazino, Vvedenskogo sq. 1, 141190 Moscow region, Russia. E-mail pvlv@ms.ire.rssi.ru Fax: +7 095 203 8414
(2) Center for Space and Remote Sensing Research, National Central University, Chung-Li 320, Taiwan.
E-mail: yueian@csrsr.ncu.edu.tw. Tel: (03) 4227151 ext 7631. Fax: (03) 4254908.
(3) GeoForschungsZentrum Potsdam (GFZ-Potsdam), Telegrafenberg, 14473 Potsdam Germany.
E-mail: wickert@gfz-potsdam.de Phone: +49- 331-288-1168; Fax: +49-331-288-1169.

For studies of the internal waves (IW) as affecting the atmospheric circulation and temperature it is important to have the experimental data showing the phase and amplitude dependence of the IW on height with global coverage. We show that the radio occultation (RO) method, which employs high-precision global positioning system (GPS) signals, allows one to determine the vertical gradients of refractivity and monitor wave structures in the atmosphere on a global scale ranging from 10 to 40 km altitude interval. We show that the sensitivity of the RO amplitude data to the IW structures in the atmosphere with vertical periods from 0.8 to 4 km, exceeds one of the RO phase data by a factor of order 10. The sensitivity of the amplitude method is inversely proportional to the square of the IW vertical period, indicating high sensitivity to the IW structures with small vertical periods in the 0.8-4 km interval. As an example of this approach, analytical results of the Challenging Minisatellite Payload's (CHAMP) RO events are presented. We demonstrate that the amplitude variations can be considered as a radio-holographic image of the IW structures in the atmosphere. We show that the IW portrait, which consists of the altitude dependence of the IW

phase, amplitude and vertical spatial frequency, can be retrieved from the amplitude variations of the RO signal. If the IW is associated with propagation of the internal gravity wave (GW) then the GW dispersion and polarization relationships allow one to estimate the vertical profile of the horizontal wind perturbations, its gradient and the GW intrinsic phase speed. In general, when the IW origin and its type are not known, the height dependence of the vertical gradient of refractivity can be applied for monitoring the seasonal and geographical distributions of IW activities at different levels in the atmosphere with global coverage. The amplitude GPS occultation method reveals an asymmetry in distribution of the IW activity at the 12 km level in the atmosphere. The maximal IW activity occurs in the summer polar region. At the 14 – 16 km levels the IW activity is centered in the moderate latitudes both in the Northern and Southern Hemisphere. At 18 – 26 km levels, most of the IW energy is concentrated in the equatorial areas. The local seasonal dependencies are clear for some regions, e.g. Siberia at the height of 14 km in the winter, owns a low IW activity and a high IW activity in the summer. Therefore, the amplitude radio holographic method has a promise to be effective in investigating the climatology of the wave activity in the 10 – 40 km height intervals in the upper troposphere and stratosphere.