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Pavelyev Alexander, Zhang Kefei, Gubenko Vladimir, Fu Erjiang, Wang Chuan-Sheng, Liou Yuei-An , and Kuleshov Yuriy
(alxndr38@mail.ru)

Identification and radio vision of the vertical structure of the layers and wave activity in the atmosphere

Alexander Pavelyev, Vladimir Gubenko
Institute of Radio Engineering and Electronics, Russian Academy of Sciences, Fryazino, Russia
Kefei Zhang, Erjiang Fu and Chuan-Sheng Wang
School of Mathematical and Geospatial Sciences, RMIT University, Melbourne, Australia
Yuei-An Liou
Center for Space and Remote Sensing Research (CSRSR), National Central University, Jhongli, Taiwan
Yuriy Kuleshov
National Climate Centre, Bureau of Meteorology, Melbourne, Australia

From an analysis of the CHAMP (Challenging Minisatellite Payload, Germany) and the FORMOSAT-3/COSMIC (FORMOSA Satellite Constellation Observing Systems for Meteorology, Ionosphere, and Climate mission, USA -Taiwan) satellite data it follows that the second-order time derivative of the eikonal (eikonal acceleration) and the Doppler frequency shift are two most important parameters indispensable for the radio vision of layers in the atmosphere and the ionosphere. Measurements of the temporal evolution of the Doppler shift permit one to study the vertical structure of the atmosphere under the condition of its spherical symmetry. Analysis of the amplitude and phase of interrelated variations in the eikonal acceleration and radio-wave intensity permits one to detect and identify the layers in the atmosphere and ionosphere. Therefore the eikonal acceleration/intensity technique can be applied to separate the influence of layered structures from contributions of irregularities and turbulence in the atmosphere. In many cases the layered structures in the atmosphere indicate quasi-periodical altitude dependence that reveals their wave origin. The altitude profile of the vertical gradient of refractivity in the layered structures can be used to find the main characteristics of the internal wave activity with a global coverage. When the type of internal waves are not known, the height dependence of the vertical gradient of refractivity can be applied for monitoring the temporal and spatial distributions of wave activity at different levels in the atmosphere. In the case of the internal gravity waves one can measure their important parameters by use of the vertical profile of the refractivity: the intrinsic phase speed, the horizontal wind perturbations and, under some assumptions, the intrinsic frequency as functions of height in the atmosphere. Advantages of the eikonal acceleration/intensity technique are validated by means of analysis of the CHAMP and FORMOSAT-3/COSMIC RO data. Eikonal variations may be converted into refraction attenuation variations, which allows the integral absorption to be determined with the refraction effect on the radio-wave intensity cancelled out. This is necessary for measurements of the water-vapor density and gas minorities during multifrequency radio-occultation sounding along the satellite-to-satellite paths. The obtained results can be of common value for other remote-sounding paths, as well.