Remote Sensing of the Lower Ionosphere by use of GPS Signals

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Sporadic, irregular layers in the lower ionosphere previously have been studied by ionosonds and geophysical rockets. Appearance of sporadic E_S - structures is connected with various causes: space weather effects, electric fields, precipitation of energetic particles from radiation belts, transfer of long-lived ions under influence of planetary waves and magnetic field in the area of wind shear. The radio occultation (RO) remote sensing is a new kind of bistatic radar for investigation of the solar activity effects on the ionosphere and on the radio communication conditions in the near Earth space. The RO radar presented new possibilities for studying sporadic formations using the satellite-to-satellite paths. The influence of these layers on the amplitude and phase of the RO signal has been studied in a number of works, with aim to introduce classification, to analyze the mechanism of formation of plasma layers in near-Earth space. In this report, the relationship between the variation of the amplitude and phase of the radio signal generated due to the effects of plasma formations is analyzed, and a classification of the morphological features of sporadic structures in the lower ionosphere is introduced. A method for determination of the altitude profiles of electron density gradients based on the relationships between variations of the amplitude and phase of radio waves caused by ionospheric sporadic structures is described. The amplitude variations of the RO signal may be described by the magnitude of the S4 scintillation. A new S4 scintillation index is introduced which is based on the phase acceleration variations. This index may have a general significance, and, in particular, can be important for the trans-ionospheric satellite-to-satellite and satellite-to-Earth links. The dependence of the phase and amplitude scintillation indexes on the solar activity during period 2002-2012 is analysed and their connection with space weather effects is established. This work was partially supported by the Program 22 of the Presidium of RAS and grant of the Russian Fund of Basic Researches № 13-02-00526-a.