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Influence of D and E atmospheric layers on the propagation of radio waves and satellite signals

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INTRODUCTION. This report examines the possibilities of using distortion of GPS signals during periods of increased solar activity as a working tool for studies of quantum optical properties of their propagation medium. The possibility of the upper atmosphere parameters reconstruction and assessments of positioning errors by using simultaneously of GPS signal and infrared radiation (IR) are discussed. For this goal we consider properties of the incoherent UHF radiation spectrum of the atmosphere D layer Rydberg states in the range 0.8-8.0 GHz for different levels of geomagnetic disturbances. The possibility of such assessments undertaking is connected with the fact that near the frequencies of 1.44 GHz and 5 GHz the power flux of UHF radiation does not depend on the electron temperature, and the dependence of the propagation delay of GPS signal is proportional to the population of Rydberg states near these typical frequencies and has a quadratic dependence on the UHF radiation frequency.

AIM. The basic aims of investigation reduce to determine a communication of time delay of signal GPS propagation with UHF and far-infrared (IR) radiation of Rydberg particles in atmospheric D and E layers

METHODS. Integral variant of the multichannel quantum defect (MQD) to describe the perturbation states of Rydberg particles by neutral gas medium

RESULTS. The development of complex theoretical models of the upper atmosphere is determined by the necessity to study the dynamic response of the atmosphere to external influences. Because of the rapid development of experimental studies, the range of phenomena and processes in the atmosphere and ionosphere modeling has been recently significantly expanded, and requirements for the physical interpretation accuracy have been substantially increased. The calculated intensities of incoherent UHF radiation for the excited medium in the 0.8-1.8 GHz range are presented in Fig. 1 and Fig. 2 as functions for quiet and disturbed ionosphere states. The behavior of radiation flux in the 0.8-1.8 GHz and 4.0-6.0 GHz ranges are shown in Fig. 3 and Fig.4.

CONCLUSIONS. The data presented in the review reveals that the first-priority task is the monitoring of IR radiation spectrum during geomagnetic perturbations in the range 15-60 micron wavelength. At that a value of the delay at the frequency about 5 GHz can be restored with a help of this spectrum. It has to be measured by the spectrum analyzer mounted on the satellite or GPS constellation. At the same time, using all the possible methods of the signal filtering for the frequency 1.57 GHz cannot eliminate the position error. This takes place due to the fact that the position of the minimum is unstable, and the delay volume is caused by a cascade of re-resonant GPS signal on the Rydberg states of quasi-molecules. Recovery of the using the power flux UHF radiation from the lower ionosphere is in principle impossible, because it is not coherent. Only simultaneously using of the UHF radiation theory and the measurable real-time data on the far infrared IR radiation will solve this problem. Wherein, the GPS system positioning errors can be used to determine the basic ionospheric parameters: the electron temperature and concentration, concentration of neutral component of the medium.

Figure 1

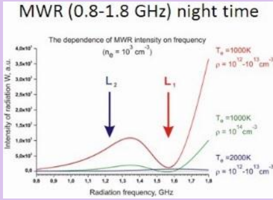

Figure 2

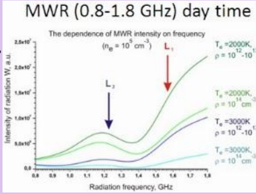

Figure 3

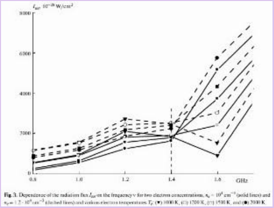

Figure 4