Horizontal Structural Functions in Troposphere for Radio Waves Refractivity Index by Use of Ground Set of GPS-GLONASS Receivers

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Abstract— In this paper we show results of troposphere fluctuation analysis and its influence on radiowaves refractive index variations. For comparison of inhomogeneous impurities structure we used electromagnetic waves refraction index data which don't depend on impurity but depend on atmospheric parameters only. Our main object of investigation is a mesoscale process in troposphere. We can estimate space structure of atmospheric parameters, using the data from network based on Global Navigation Satellite System receivers. We used structure function to estimate characteristics of impurities and refraction index fluctuation. Function shows the contribution of the processes of the defined scale in the total variance of the fluctuations. The received structure functions demonstrate increasing with distance between stations. The results show a significant effect on electromagnetic wave refraction index caused by the mesoscale troposphere process.

1. INTRODUCTION

Investigation of inhomogeneities and their connection with the movement of air masses in the atmosphere is one of the most difficult modern scientific problems. So far is slightly investigated their influence, in the radar measurements and satellite navigation. Our main object of investigation is a mesoscale process in troposphere ant their influence on radio waves. These processes have size from 1 km up to 1000 km and time scale about few hours. Mesoscale processes are less investigated than smaller or larger processes. One of main reason is that, this task requires system with good temporal and spatial resolution. At present, with the modern development Global Navigation Satellite System (GNSSS) there is opportunuity to use their signals for remote sensing of the troposphere. Using the data from network based on Global Navigation System receivers, we can estimate space structure of atmospheric parameters, and calculate influence of mesoscale processes and other irregularities on the propagation of radio waves in the troposphere.

In this paper we show results of troposphere fluctuation analysis and its influence on radio waves refractive index variations. For comparison of inhomogeneous impurities structure we used electromagnetic waves refraction index data which don't depend on impurity but depend on atmospheric parameters only.

2. MEASUREMENT METHODS

Since the route between the satellite and receiver radio waves are affected by the atmosphere, the radio signal comes on the receiver with delay. If we calculated its spatial and temporal variations, we can estimate the quantitative characteristics of the atmospheric processes [1, 2].

The distance between satellite and receiver measured by carrier phase can be represented as the sum of the true distance between satellite and receiver, ionosphere and troposphere delays of the signal, measured errors, including errors due receiver and satellite clock drift. Atmospheric correction, which characterizes the delay of radio waves as compared to propagation in vacuum, is defined as the integral of the refractive index of the path passed by radio wave in the atmosphere [1–3].

Main parameter in remote sensing of troposphere is zenith troposphere delay (ZTD), equal to the difference of the optical and geometric path signals of satellite navigation systems in a neutral atmosphere in the zenith direction. ZTD is measured in units of length.

Investigation of the effect of inhomogeneities on radio waves propagation of are most commonly used two methods — the method of spectral and structural features. When measuring the spectra should be borne in mind that the measured signal is a superposition of the inhomogeneities influence in absolutely all sizes, and the use of structural features in the measured signal is not taken into account the influence of inhomogeneities in less than a certain size. For satellite radio paths — most suitable ground-based receiver is the second method — the structure functions. Structure function is a basic characteristic of process with random increments. Physically, structure function