Analysis of the probability fields of ionospheric parameters obtained from the probabilistic plasma-chemical model of the lower ionosphere

Bekker S.Z., Ryakhovskiy I.A.

Institute of geosphere dynamics of Russian academy of sciences, Moscow, Russia

e-mail: susanna.bekker@gmail.com

Nowadays we have many theoretical estimates and experimental data on the processes occurring in the ionospheric plasma and on the spatial distribution of components' concentrations. However, the accuracy of predicting ionospheric parameters' dynamics is still low under certain heliogeophysical conditions.

Many years monitoring of the radiophysical characteristics of the VLF-signals reveal significant amplitude and phase variations even under calm heliogeophysical conditions. Such variations are related to a continuous change in the ionospheric parameters. This fact confirms the need to describe the parameters of the medium by the probability density functions, rather than median values.

The probability density functions of the ionospheric parameters (first of all, electron concentration) are used in calculating the probability densities of the amplitude and phase of the radio wave on selected paths and frequencies, during the different level of solar and magnetic activity, at different latitudes, seasons, and times of day.

The probabilistic plasma-chemical model is based on a system of differential equations of the ionization-recombination cycle of the ionospheric D-region. Input parameters of the system are varied: ionization rate q, neutral temperature T, concentration [O_2], [N_2], [H_2O], [O_2] and [CO_2].

To determine the distribution laws of the variable parameters experimental AURA databases on T, [O_2], [N_2], [H_2O], [O_2] and TIMED databases on [CO_2] are statistically processed. Four seasons are analyzed: winter (November–February), spring (March, April), summer (May–August), autumn (September, October); the daytime and nighttime are hours of the dayside and nightside ionosphere respectively (depending on the track and season). The probability density functions of T, [O_2], [N_2], [H_2O], [O_2], and [CO_2] were obtained for all combinations of heliogeophysical conditions in the altitude range from 50 km to 85 km. Ionization rate was calculated using main sources of D-region ionization.

Further, N height profiles of the parameters were generated according to the obtained distributions (N is determined by the series of PDFs convergence). And selected system of equations of the ionization-recombination cycle was solved with them.

A comparative analysis of the obtained median and the most probable values of Ne showed that they may significantly differ from each other depending on the selected heliogeophysical conditions. It means that the probability density functions of Ne (like the rest of the neutral and charged components of the D-region of the ionosphere) generally do not described by the normal distribution law. It is concluded that the environment cannot be correctly described with the median values (or average values), and therefore a change to the probability density functions is necessary.