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Technique for building the global maps of MUF(3000) analysis and forecast

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HF radio waves can propagate on the long distances with low losses due to reflection from the ionospheric plasma. This feature of HF radio waves is used to organize a communication over the long distances. Ionospheric channel bandwidth is relatively narrow (in order of several kilohertz). However, ionospheric communication is quite simple to use, relatively inexpensive and very reliable. During failure of satellite systems the ionospheric channel remains operational, since it depends only on the Sun and Earth's atmosphere. The ionospheric plasma is a nonuniform and nonstationary medium. Therefore, the propagation conditions of HF radio waves are continuously changing. One of the main parameters of the ionosphere determining the propagation of radio waves is a maximum usable frequency (MUF) for a given radio link. For unification MUF is calculated for the radio path of 3,000 km length, namely MUF(3000). Analysis and forecast of MUF(3000) is a key task in determining the HF propagation conditions. At different times the large research groups and whole institutions were engaged in solving this problem. Nevertheless, the accuracy of the MUF(3000) estimations is still insufficient for purposes of radio services. The thing is that the only empirical models of the upper atmosphere and the ionosphere are available at present time. Dynamic models of geospace are currently under development. Other causes of the limited accuracy in determining ionospheric parameters also lie in the insufficient coverage of the Earth by measuring means as well as in the errors in estimating the ionosphere parameters from vertical sounding data.

This paper aimed at upgrading the techniques, algorithms, and software for building the global maps of MUF(3000) analysis and forecast in real time base using modern tools for calculation and visualization. The problem is solved by constructing a background map in frames of NeQuick ionospheric model [1] and further correction of the map using data of MUF(3000) measured by ionosondes (fig. 1). Forecast maps (fig. 1) are built by correcting the background map by the forecast data of vertical sounding on the ionosonde network obtained using statistical prediction methods [2]. Correcting interpolation of the maps is carried out using the natural neighborhood algorithm. The MUF(3000) global maps obtained by this way can be used for analysis and short-term prediction of HF propagation conditions and selecting the optimal frequencies for communication in different regions of the Earth. We suppose to use the developed approach to find the optimal operating frequencies for radio services of civil aviation. In the future it is necessary to proceed to prediction of HF propagation based on forecast of ionosphere obtained in frames of physics-based dynamic models.

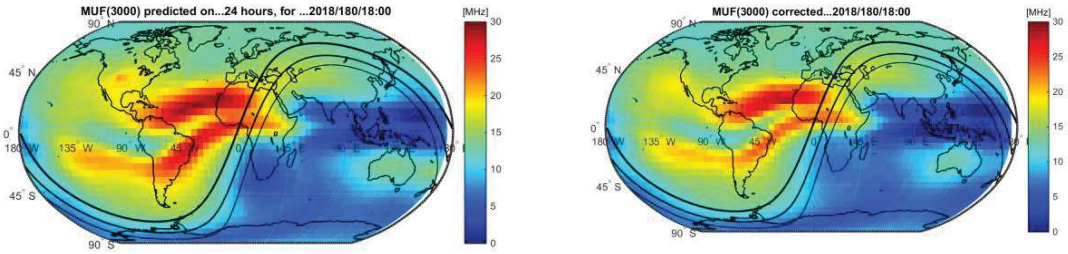

Figure 1. Maps of MUF(3000) forecast for 24 hours (left) and analysis (right) for 18:00 UTC 29 June, 2018.

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