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FEATURES OF THE TEC BEHAVIOR IN THE CYCLE OF SOLAR ACTIVITY AND THEIR REFLECTIONS IN THE IONOSPHERIC MODEL

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Abstract. A number of wireless communication systems require knowledge of the total electron content (TEC) of the ionosphere including in the form of the TEC model. To answer for question could the IRI model play the role of the empirical model of TEC comparison of the experimental and model TEC values was performed because the parameter TEC is not empirical in IRI. Results include a comparison of morphological features such as diurnal, from day to day, season, and solar activity variations. It is shown that: 1) the discrepancies may relate not only to the values of TEC, but also behavioral, deviations from day to day can be great, especially at maximum of solar activity, 2) the contributions of two factors connected with the maximum electron density NmF2 and the ionospheric slab thickness can be comparable, 3) the use of real-time values of foF2 reduces the differences between the experimental and model values of TEC, but the residual difference associated with the remains. Coincidence can be improved by using empirical models of τ. 4) The biggest differences are connected with the model TEC determination in disturbed conditions.

1 INTRODUCTION

The total electron content is a key ionospheric parameter in several applications from positioning methods, navigation, modern radio astronomy systems to investigation of space weather influence on environment. These systems require knowledge of the total electron content (TEC) of the ionosphere including in the form of the TEC model. The simplest way to do this is to use the IRI model as it can provide not only median values, but also real-time values of TEC in accordance with the current ionospheric parameters (e.g. foF2, hmF2, M3000). What is more, it includes the storm factor, which takes into account disturbed conditions. But this model is not empirical concerning the TEC parameter. The model TEC values must be compared with the experimental ones.

2 METHOD OF ANALYSIS AND EXPERIMENTAL DATA

The total electron content is defined by $TEC = NmF2 * \tau$ where $NmF2$ is the maximum electron density, $\tau = TEC/NmF2$ is the ionospheric slab thickness. This definition indicates that the discrepancies between the experimental and model TEC values can be determined by means of

$$K(TEC) = K(Nm){*}K(\tau), K(Nm) = NmF2(obs)/NmF2(IRI), K(\tau) = \tau(obs)/\tau(IRI).$$

The coefficient K(TEC) estimates the difference between the experimental and model TEC values. It is the experimental correction coefficient. K(Nm) is a contribution of discrepancies between the experimental and model NmF2 values. $K(\tau)$ is a contribution of discrepancies between the experimental and model values. It is necessary to note that the factor $K(\tau)$ includes also the discrepancy caused by absence of the plasmaspheric part of the IRI model when the model TEC values are compared with GPS-derived TEC data because of different ceiling heights. Global TEC maps of JPL, CODE, UPC, ESA research centers for 1999-2009 and foF2 data from SPIDR are used for comparison.

3 RESULTS OF TEC COMPARISON

Results include a comparison of morphological features such as diurnal, from day to day, seasonal, and solar activity variations. It is shown that: 1) the discrepancies may relate not only to the values of TEC, but also behavioral, deviations from day to day can be great, especially at maximum of solar activity, 2) the contributions of two factors (K(Nm) and $K(\tau)$) can be comparable, 3) the use of real-time values of foF2 reduces the differences between the experimental and model values of TEC (K(Nm) becomes equal 1), but the residual difference associated with the coefficient $K(\tau)$ remains. Coincidence can be improved by using empirical models of $K(\tau)$. 4) The biggest differences are connected with the model TEC determination in disturbed conditions. On the one hand, the IRI model includes the storm factor, on the other hand, in the first place it is also averaging over many disturbances, and secondly, this factor is driven by Ap-index which is responsible not for all types of geomagnetic disturbances. In recent years, some attempts were made to connect experimental variations of TEC (TEC) with the parameters of disturbances because it is important for prediction[1,2]. But to use the model δTEC need to know δNmF2 and δ. Variations of these parameters are illustrated for several disturbances.

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