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Ionospheric Forecast Based on Ingestion of TEC Measurements into the NeQuick 2 Model

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ABSTRACT

GNSS ionospheric correction for single frequency user is usually realized by the combination of ionospheric model and measurements of TEC data[1, 2].

Based on the previous studies[3], we know that there is an optimum solar flux input value, defined as daily effective ionization level parameter (called ER in this abstract) to minimize the TEC residual error at the position of vTEC measurement. We have studied the variations of ER with MODIP on different longitudes in a day for different seasons. Figure 1 gives four examples of the typical ER variations of all longitudes in different seasons of one year (15th March, 15th June, 15th September, 15th October, 2003). The characteristic of W shape is discovered from ER variation with MODIP. Consequently, the characteristic of the W shape variations reveals that ER varies with MODIP periodically.

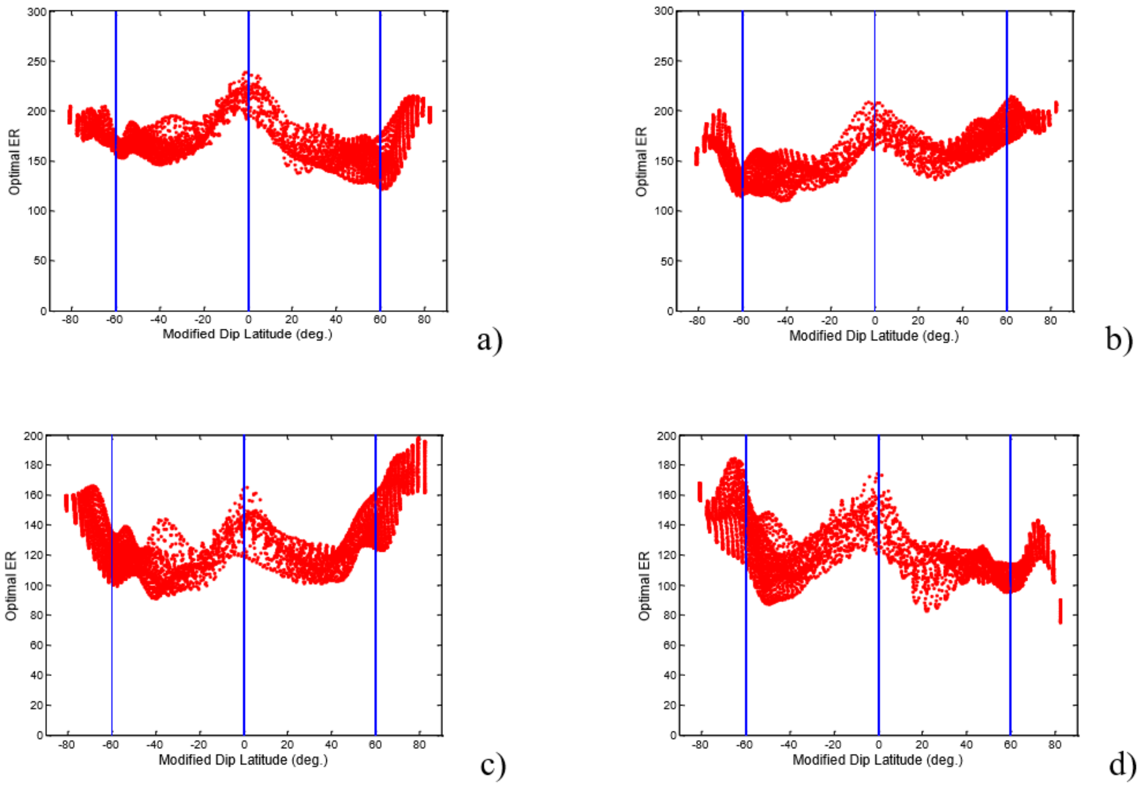

Figure 1. Variation of *ER* with *MODIP* in different seasons of 2003， a) for 15th March, b) for 15th June, c) for 15th September， and d) for 15th October.

In according to the spatial and temporal variations of ER parameters, the following model is established:

$$ER = a_0 + a_1 \cdot MODIP + a_2 \cdot MODIP^2 + a_3 \cdot MODIP \cdot \cos\left(a_4 \cdot MODIP + a_5\right)$$

Then, we make comparison of the results of two adjacent days to access the predictability of the modeled ER value. As a result, we found the results of two adjacent days consist well in most cases. So, the established ER model could be used to forecast ER for the following day.

To evaluate the NeQuick with ER function, the following steps have been performed.
(1) The optimal ERs (denoted as ER_R) are estimated based on measurements from IGS stations called monitor sites. Then the modeled ERs are matched to the measurements and coefficients a_0, a_1, a_2, a_3, a_4, a_5 are obtained through the least square method.
(2) The other IGS stations called test sites are chosen for assessment. The ER for the next day could be estimated with the coefficients at each test site. The forecasted ER is denoted as ER_F.
(3) The modeled TEC values of the following day of each test sites are calculated by the input parameters such as the forecasted ER_F, position of each IGS station, and the time of following day.
(4) We make comparison between modeled TEC values and observation through deriving cumulative distribution.
Figure 2 shows the cumulative probability distribution of relative error for the updated NeQuick model driven by modeled ER values for 2012 and 2008 respectively. The updated

NeQuick has the cumulative probability of relative errors of 77% (1σ) for 2012 and 76% (1σ) for 2008.

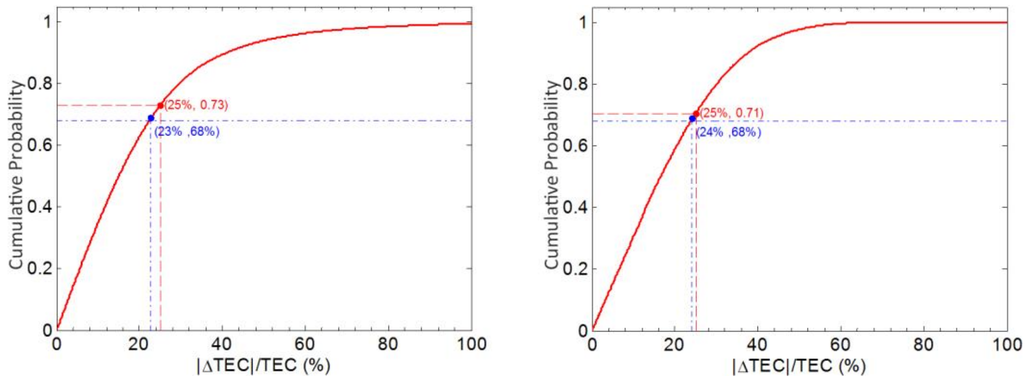

Figure 2. Cumulative probability distribution of relative errors of vertical TEC at ionospheric pierce points for 2012(left) and 2008(right).

The results show that the established ER model could be used to forecast ER for the following day, and the forecasted ER values could be used as the driving factor for NeQuick model updating.

Key words: Ionospheric forecast, GNSS, TEC measurement.

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