

Correction of $B2_{\text{bot}}$ for NeQuick during low solar activity at Hainan station

S.G. Wang^{a,b,*}, J.K. Shi^a, X. Wang^a, G.J. Wang^a, H.F. Zhang^c, G.M. Chen^b

^a State Key Laboratory of Space Weather, Center for Space Science and Applied Research, Chinese Academy of Sciences, Beijing, China

^b Beijing Institute of Applied Meteorology, Beijing 100029, China

^c Beijing Aviation Meteorological Institute, Beijing 100085, China

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Abstract

This work is a continuation of the previous article and it focuses on low solar activity and modeling effort. NeQuick model uses Epstein layer formalism to model each part of the profile. We study the diurnal and seasonal variations of $B2_{\text{bot}}$, $\Delta B2$ ($B2_{\text{best}} - B2_{\text{NeQuick2}}$) and R ($B2_{\text{best}}/B2_{\text{NeQuick2}}$) at Hainan station during low solar activity. The results show it is possible to improve the $B2_{\text{bot}}$ parameter of the NeQuick model at that region during low solar activity. Then, we use a function $f(t)$ with LT in different seasons to correct the $B2_{\text{bot}}$ formula of NeQuick 2. The correction shows that (1) By the correction formula, the $B2_{\text{bot}}$ of NeQuick is improved. The maximum standard deviation is improved for 9 km. (2) The correction formula is more effective in summer than in equinox and winter and performs better during early morning hours than during the rest of the day.

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1. Introduction

The NeQuick model has been developed at the Aeronomy and Radiopropagation Laboratory of The Abdus Salam International Centre for Theoretical Physics (ICTP), Trieste, Italy, and at the Institute for Geophysics, Astrophysics and Meteorology (IGAM) of the University of Graz, Austria. It uses a modified DGR profile (Di Giovanni and Radicella, 1990) formulation to describe the electron density of the ionosphere. Some papers on NeQuick (e.g., Coisson et al., 2004, 2008a,b, 2009; Leiting et al., 2005; Nava et al., 2008) have been published. It has been observed that there are some discrepancies for electron

density profiles and TEC between the experimental data and the modeled data. It also has been found that it may not be accurate to use a constant (0.385) for all time to compute $B2_{\text{bot}}$ during high solar activity at Hainan station (Wang et al., 2010).

In this paper we use the data of Hainan station in China during low solar activity period to assess the bottomside behavior of the NeQuick 2 in that region. Finally, we use a correction function to improve the $B2_{\text{bot}}$ formula of NeQuick.

2. NeQuick 2 $F2$ bottomside

The $F2$ bottomside of the NeQuick 2 (Nava et al., 2008) can be expressed as follows:

$$N_{F2}(h) = \frac{4NmF2}{\left(1 + \exp\left(\frac{h - hmF2}{B2_{\text{bot}}}\right)\right)^2} \exp\left(\frac{h - hmF2}{B2_{\text{bot}}}\right) \quad (1)$$

* Corresponding author at: State Key Laboratory of Space Weather, Center for Space Science and Applied Research, Chinese Academy of Sciences, Beijing, China. Tel.: +86 1062542554.

E-mail addresses: shengguo007@sohu.com (S.G. Wang), jkshi@spaceweather.ac.cn (J.K. Shi), wangx@cssar.ac.cn (X. Wang), gjwang@spaceweather.ac.cn (G.J. Wang), chengm@spaceweather.ac.cn (G.M. Chen).

$$B2_{\text{bot}} = \frac{0.385 \text{NmF2}}{(dN/dh)_{\text{max}}} \quad (2)$$

where NmF2 is the maximum electron density of F2 layer (10^{11} m^{-3}) and the value of the maximum of the electron density derivative with respect to height $(dN/dh)_{\text{max}}$ is computed using the empirical relation (Mosert de Gonzales and Radicella, 1990):

$$\ln \left(\left(\frac{dN}{dh} \right)_{\text{max}} \right) = -3.467 + 1.714 \ln(\text{foF2}) + 2.02 \times \ln(M(3000)\text{F2}) \quad (3)$$

where dN/dh is in $10^9 \text{ m}^{-3} \text{ km}^{-1}$ and foF2 in MHz.

3. Data analysis

This work is a continuation of the previous article (Wang et al., 2010) and it focuses on low solar activity and modeling effort. Time coverage of the data is from January 2005 to December 2007. There are no data in September, October 2005 and December 2006. In the following, the data in the year are studied by grouping into three seasons as equinox (spring: March, April; autumn: September and October), summer (May, June, July and August) and winter (November, December, January and February).

The data analysis has been based on seasonal median values for the $B2_{\text{best}}$ (that reproduced the semi-Epstein layer closest to each experimental profile was found), $\Delta B2$ (that is defined as $B2_{\text{best}} - B2_{\text{NeQuick2}}$) and R (that is defined as $B2_{\text{best}}/B2_{\text{NeQuick2}}$). Using the F2 layer peak values (foF2 and M(3000)F2) as basic inputs, $B2_{\text{NeQuick2}}$ was calculated with model formulae.

4. Results

4.1. Diurnal and seasonal variations of $B2_{\text{best}}$

In order to find the diurnal and seasonal variations of the seasonal median values of $B2_{\text{best}}$ at Hainan station during low solar activity, the seasonal median values of $B2_{\text{best}}$ have been calculated and plotted as a function of LT. Figs. 1–3 illustrate the seasonal median values of $B2_{\text{best}}$ against local time during equinox, summer and winter months for 2005–2007, respectively. From these figures, it is possible to see that the $B2_{\text{best}}$ diurnal variation during low solar activity is similar in different years, and the year-to-year variations are about 15 km for equinox (Fig. 1), 10 km for summer and winter (Figs. 2 and 3).

It can be observed from Figs. 1–3 that the $B2_{\text{best}}$ has two peaks in daily evolution (one before sunrise and one in the early afternoon). The peaks of $B2_{\text{best}}$ are found during the pre-sunrise hours and 1000–1400 LT in equinox, during the pre-sunrise hours and 0800–1200 LT in summer (Fig. 2) and during the pre-sunrise hours and 1200–1400 LT in winter (Fig. 3). In the afternoon hours the value of $B2_{\text{best}}$ gradually decreases for all seasons.

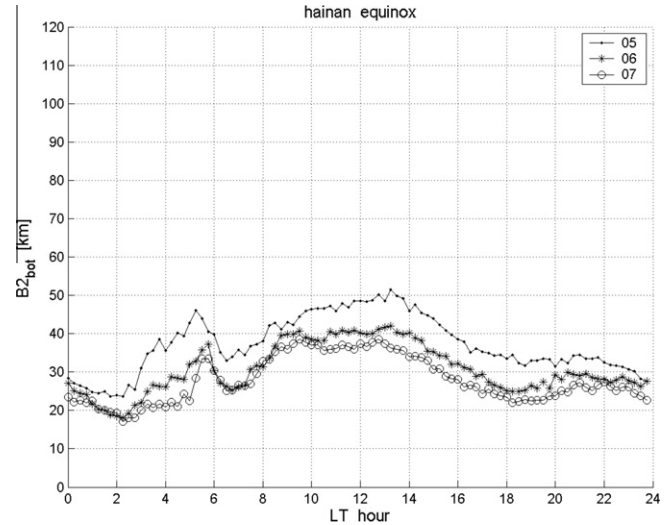


Fig. 1. Diurnal variations of seasonal median values of $B2_{\text{best}}$ in equinox.

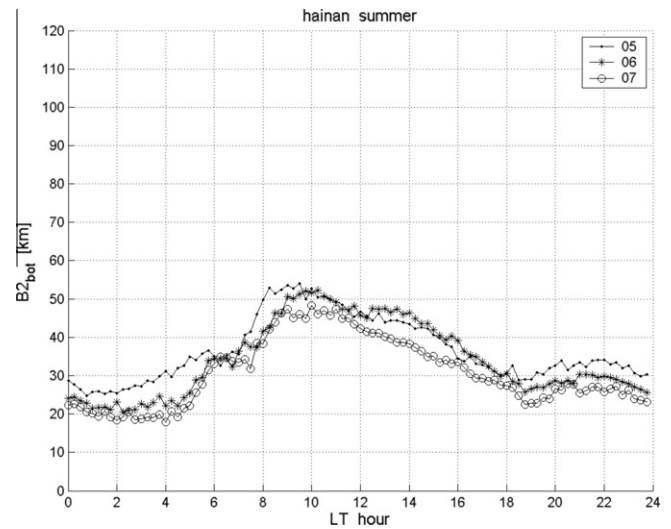


Fig. 2. Diurnal variations of seasonal median values of $B2_{\text{best}}$ in summer.

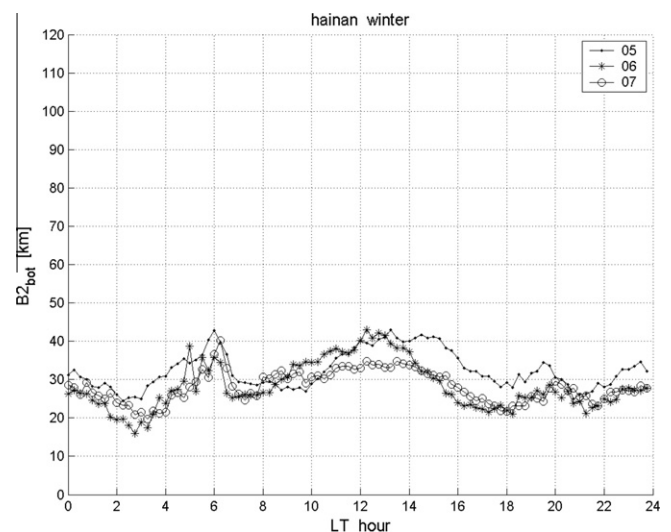


Fig. 3. Diurnal variations of seasonal median values of $B2_{\text{best}}$ in winter.

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