Performance of the new formulation of the bottomside B2 parameter in NeQuick model under disturbed geomagnetic conditions

K. Alazo-Cuartas[(1)], Y. Migoya-Orue[(1)], S. Radicella[(1)], B. Nava*[(1)] and C. Amory-Mazaudier[(1,2)]
(1) The Abdus Salam International Centre for Theoretical Physics (ICTP), Strada Costiera 11, 34151, Trieste, Italy, email: kalazo_c@ictp.it, yenca@ictp.it, rsandro@ictp.it, bnava@ictp.it,
(2) Sorbonne Paris, UPMC Univ. Paris VI, LPP, Paris, France, christine.amory@lpp.polytechnique.fr

Ionospheric empirical models or profilers like IRI and NeQuick use thickness parameters to describe the shape of the electron density profiles below the F2 region peak. IRI introduced a B0 parameter proposed originally by [1] and NeQuick uses the B2 parameter proposed by [2]. In this last paper the B2 parameter is defined as:

$$B2=0.385N_m/(dN/dh)_{max} \quad (1)$$

where N_m is the peak electron density of the F2 region and $(dN/dh)_{max}$ is the maximum value of the first derivative of the electron density with altitude below the F2 region peak. In turn, the value of $(dN/dh)_{max}$ was assumed as the one empirically modeled by [3] as:

$$\ln (dN/dh)_{max} = -3.47 +0.86 \ln (foF2)^2 + 2.02 \ln M(3000)F2 \quad (2)$$

where foF2 and M(3000)F2 are quantities routinely scaled in the ionograms and are also modelled in the ITU-R coefficients. From this formula the resulting thickness parameter is called "B2(MR)". It has been shown that an improvement of the modelling of B2 will have an impact on the ability to model the electron density profile of the NeQuick model [4]. In [5] it is presented that the B2 formulation can be improved adding a dependence with the solar elevation angle and by recalculating the empirical coefficients of the equation (Eq.2) using a large series of experimental data (from now on "B2(AR)"). The B2(AR) formula was obtained without discriminating quiet from disturbed periods considering it essentially a "climate" predictor of B2. In the present research the ability of the new formula to reproduce experimentally derived B2 data when experimental F2 parameters are used, has been tested during geomagnetic storms of different intensity to investigate the use of the formula under "Space Weather" conditions. Data used are from around 7000 ionograms from different digisonde stations of the GIRO network manually scaled and correspond to the 17 March 2015 St. Patrick's day superstorm (Ap=108), the two largest storms of 2013 (17 March with Ap=72 and 2 October with Ap=58) and two minor storms of the same year (9-10 July with Ap=26 and 17 January with Ap=14). The complete statistical analysis will be presented. An example of it, the correlation between experimentally derived and modelled values of B2 with the B2(MR) formula and with the B2(AR) formula, is indicative of the results obtained. In this statistic example the data used correspond to one day before and one day after the onset of the geomagnetic storm. In all the cases, a net improvement introduced by the B2(AR) formula in the values of the coefficient of determination, R^2 and RMS is observed. Table 1 gives both values considering all the storms together. These results indicate that the B2 improvement introduced by the B2(AR) formula, could lead to a better representation of the electron density profile by the NeQuick model.

Table 1. Statistics obtained 24 hours before and after the onset of the selected storms.

Period	**24 hr before onset**	**24 hr after onset**	**24 hr before onset**	**24 hr after onset**
Formula	*B2(MR)*	*B2(MR)*	*B2(AR)*	*B2(AR)*
R^2	0.68	0.58	0.84	0.75
RMS [km]	12.3	15.2	7.4	10.9

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