

Real time assimilative foF2 maps for IRI

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Ionospheric models are mostly unable to correctly predict the effects of space weather events on the ionosphere. This is especially true for the International Reference Ionosphere (IRI) which by design is a monthly median (climatologic) model (Bilitza et al., J. Geodesy, 85, 909–920, 2011). The IRI electron density profile is critically dependent on the correct values of the F2 layer peak height and density, hmF2 and NmF2 (or foF2). For the ionospheric characteristics IRI uses predictions based on CCIR/URSI coefficients (W. B. Jones and R. M. Gallet, ITU Telecomm. J. 29(5), 129-149, 1962) that were derived from the monthly median values of hourly ionosonde measurements. The diurnal variation of the foF2 characteristic, for example, is presented by the Fourier series

$$foF2(T, \phi, \lambda, \chi) = a_0(\phi, \lambda, \chi) + \sum_{n=1}^6 (a_n(\phi, \lambda, \chi) \cos nT + b_n(\phi, \lambda, \chi) \sin nT),$$

where T is Universal Time in hours, and ϕ, λ, χ are the geographic latitude, longitude, and modified dip latitude, respectively. The coefficients a_n and b_n are in turn expanded as functions ϕ, λ, χ resulting in a set of 24 global maps of 988 coefficients each, one for each month of the year and for two levels of solar activity, $R_{12}=10$ and 100, where R_{12} is the 12-month running-mean of the monthly sunspot number R_m ($2*12*988 = 23,712$ coefficients in all) (ITU-R, Information Document on Ionospheric Mapping, Oct. 2011). Real time data from the Digisonde GIRO network (B. W. Reinisch and I. A. Galkin, Earth, Planets and Space, 63(4), 377-381, 2011) can be used to adjust the coefficients to produce more accurate foF2 maps. Adjusting 988 coefficients with merely 42 measured foF2 values is a completely underdetermined problem requiring special techniques (e.g., Galkin et al., Radio Sci., 47, RS0L07, 10 PP, 2012). We have applied the mathematical tool of linear optimization to determine new sets of 988 coefficients that reduce the global deviation of the model prediction from the measured values by a factor of 2.