An adaptive three-dimensional regional assimilative ionospheric model

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An adaptive three-dimensional regional ionospheric model is presented. It is able to ingest the real time data from different ionosondes, providing the bottomside electron density $N(h)$ on the Italian area. Results of the testing of the model adapted with data from Rome (41.8° N, 12.5° E) and Gibilmanna (37.9° N, 14.0° E) are presented using data of the ionospheric station of San Vito dei Normanni (17.7° N, 40.7° E).

The model is built using as base the maps of MUF(3000)F2$_{\text{monthly-median}}$ and of f_oF2$_{\text{monthly-median}}$. Through these maps, applying Bradley and Dudeney's formula (1973), is evaluated h_mF2$_{\text{monthly-median}}$ on the considered geographic region. For the region F1 the estimate of f_oF1 due to DuCharme and Petrie (1973) is used, and is introduced a simple model for the estimation of the Reinish and Huang (1996) D_1 parameter, depending on solar zenith angle.

This modeling can then be adapted to the actual conditions at the time and area of interest, through the determination of the the values of some free parameters, allowed to vary within different ranges. These are δf_oF2 = f_oF2$_{\text{real-time}}$ - f_oF2$_{\text{monthly-median}}$, $\delta h_m f_o$F2 = $h_m f_o$F2$_{\text{real-time}}$ - $h_m f_o$F2$_{\text{monthly-median}}$, and the width of the E region valley $\delta h_v E_{\text{real-time}}$. The procedure is based on the minimization of the standard deviation obtained from the comparison of the plasma frequency profiles modelled at some location and the correspondent profiles obtained by measurements.

One can then estimate the functions f_oF2(θ, φ) and $h_m f_o$F2(θ, φ) throughout the geographical area considered by the relation f_oF2$_{\text{real-time}}(\theta, \varphi) = f_o$F2$_{\text{monthly-median}}(\theta, \varphi) + \delta f_o$F2 and h_mF2$_{\text{real-time}}(\theta, \varphi) = h_m$F2$_{\text{monthly-median}}(\theta, \varphi) + \delta h_m$F2. These values are used as coordinates of the principal anchor points in $N(h)$ model derived from the Adaptive Ionospheric Profiler, used by Autoscala. The value of $\delta h_v E_{\text{real-time}}$ is instead fixed in the whole area and it is associated to other anchor points.

The software developed up to now is able to produce maps of electron density, transverse and longitudinal sections of the ionospheric bottomside in scale of colors. Profiles of electron density and associated simulated ionograms are easily producible for each geographic location across the geographic area considered in the model.