Bull. Astr. Soc. India (2007) **35**, 663–668

A developed numerical mapping technique

Najat M. R. Al-Ubaidi*
Department of Astronomy & Space, College of Science, Baghdad University, Iraq

Abstract. An automated mapping technique for representing the hourly behaviour of the ionosphere was presented by Rush in 1976. The technique is based on updating the predicted monthly median maps of ionospheric parameters with hourly observations. The procedure was accomplished by computing the differences between the predicted medians and the hourly values of ionospheric parameters that are observed at specific locations on the globe. This technique provides the basis for extending and extrapolating the influence of an observation from the observing location to the region surrounding the observing location, this method is very complicated, so in our research we have used another newly developed method. Our programme suggests a new mapping technique method to draw the maps based on updating the monthly median of ionospheric parameters predicted with geographic coordinates.

Keywords : mapping technique – ionospheric maps – field strength

1. Introduction

Ionospheric mapping techniques are applied to represent the monthly median ionospheric parameters. In some instances, these mapped parameters form the basics of ionospheric models like Nisbet (1971), Bradley & Dudeney (1973), Dudeney (1978), and IRI models (1993), which are used in different scientific studies, especially those concerned with the determination of median radio propagation conditions and for simulating and predicting radio propagation conditions, since day-to-day changes in ionospheric parameters used to determine the propagation conditions can be quite large. An automated mapping technique for representing the hourly behaviour of the ionosphere was presented by Rush et al. (1983), the technique is based on updating the predicted monthly median maps

*e-mail: najatmr10@yahoo.com

of ionospheric parameters with hourly observations, this method is very complicated. In our research we have used a new developed method. The designed and implemented programme in our work for mapping technique will be demonstrated in the following section.

2. A new numerical mapping technique

Following steps have been used for developing the mapping technique.

(1) Read data (latitude θ_i, longitude ϕ_i, ionospheric parameter V_i)

(2) Set grid map steps (θ_{stn}, ϕ_{stn}) in latitude and longitude respectively.

(3) Determine the coverage extent, i.e. the minimum and maximum values for latitude ($\theta_{\min}$, $\theta_{\max}$), longitude ($\phi_{\min}$, $\phi_{\max}$), and the range of ionospheric parameter V (i.e. $V_{\min}$, $V_{\max}$)

(4) Set $\theta = \theta_{\min}$

(5) Set $\phi = \phi_{\min}$

(6) Find the nearest left-top sample data (θ_k, ϕ_k) to the point (θ, ϕ), then set

$$\theta'_1 = \theta_k; \phi'_1 = \phi_k; V'_1 = V_k \tag{1}$$

(7) Find the nearest right-top sample data (θ_j, ϕ_j), and set

$$\theta'_2 = \theta_j; \phi'_2 = \phi_j; V'_2 = V_j \tag{2}$$

(8) Find the nearest left-bottom sample data (θ_m, ϕ_m), and set

$$\theta'_3 = \theta_m; \quad \phi'_3 = \phi_m; \quad V'_3 = V_m \tag{3}$$

(9) Find the nearest right-bottom sample data (θ_n, ϕ_n), and set

$$\theta'_4 = \theta_n; \phi'_4 = \phi_n; V'_4 = V_n \tag{4}$$

(10) Determine the distances (D_i) between the point (θ, ϕ) and (θ'_i, ϕ'_i) for $1 \leq i \leq 4$

(11) Determine (V) by using the formula,

$$V = \frac{\sum_{i=1}^{4} V'_i D_i}{\sum_{i=1}^{4} D_i} \tag{5}$$

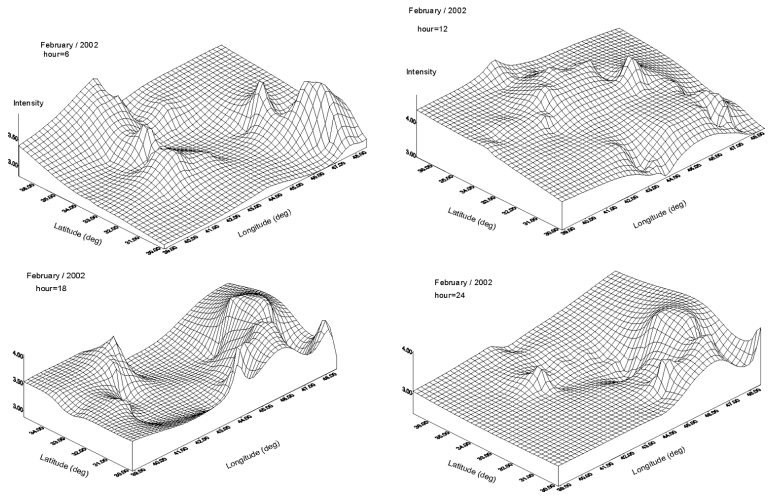

Figure 1. Monthly median field strength with geographic coordinates for February 2002.

(12) Set the point (θ, ϕ) with value V

(13) Set $\phi = \phi + \phi_{\text{stn}}$

(14) If $\phi \leq \phi_{\max}$ then goto step (5)

(15) Set $\theta = \theta + \theta_{\text{stn}}$

(16) If $\theta \leq \theta_{\max}$ then goto step (4)

(17) Stop algorithm.

3. Variation of received HF-field strength intensity

A large amount of data collected from 81 stations distributed along the Iraq region from north to south, between 39°E and 48°E, 30°N and 37°N were used to describe the HF-communication links. (It should be noted that this data values were not so correct because they depend on the ability and the kind of instrument used which differs from place to place. It take, the range between (1) for no intensity or no communication and (5) for very high intensity or very good communication). The data are collected within the time period (October 2001 through May 2002); these data are used to draw a three dimension surfer map to see the variation of the field strength distribution with geographic coordinates (longitude and latitude). Fig. 1 shows the variation of monthly median received field strength values at four chosen local times; sunrise (LT=6), midday (LT=12), sunset (LT=18) and midnight (LT=24) respectively with geographic coordinates for February 2002. Fig. 2 shows the corresponding predicted values for the four hours, produced by

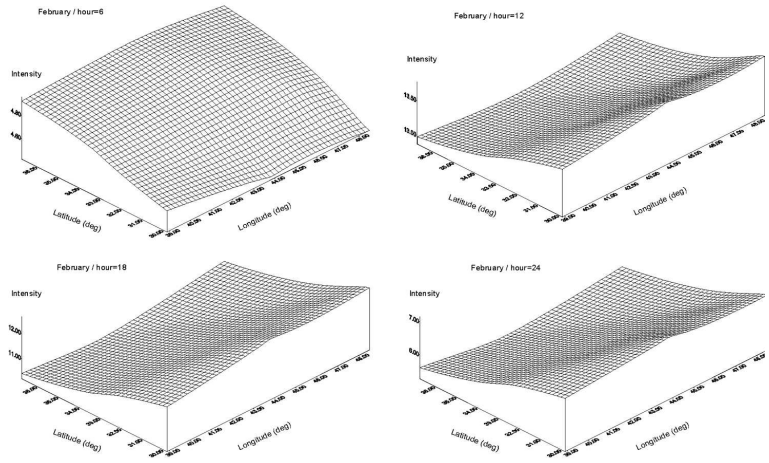

Figure 2. Predicted monthly median foF2 with geographic coordinates for February 2002.

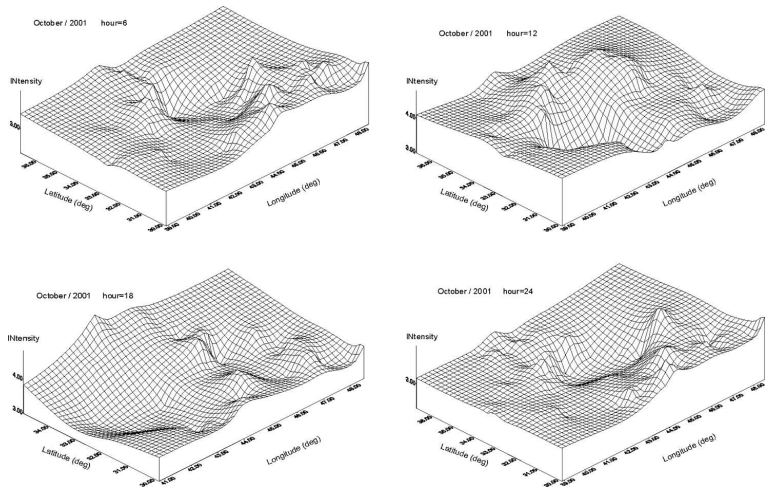

Figure 3. Monthly median field strength with geographic coordinates for October 2001.

using the Ionospheric Prediction Model (IPM) (Najat 2003). Also Fig. 3 presents the same median field strength values for October 2001 and for the same hours as mentioned above respectively.

By using the suggested mapping technique (which is discussed in Section 2) the map for February 2002 monthly median field strength values with their geographic coordinates is drawn as shown in Figs (4–7) for four chosen hours. Maps for October 2001 are present in Figs (8–11) for the same chosen hours.

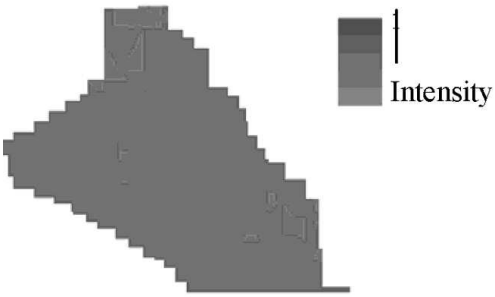

Figure 4. February of 2002 monthly median field strength with geographic coordinates at sunrise (LT=6).

Figure 5. February of 2002 monthly median field strength with geographic coordinates at midday (LT=12).

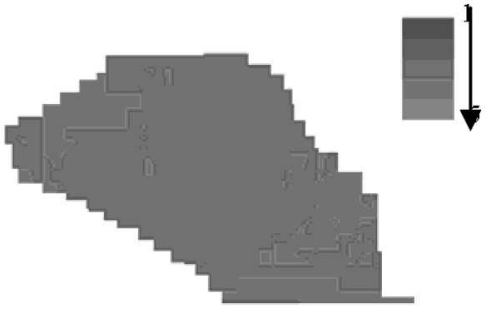

Figure 6. February of 2002 monthly median field strength with geographic coordinates at sunset (LT=18).

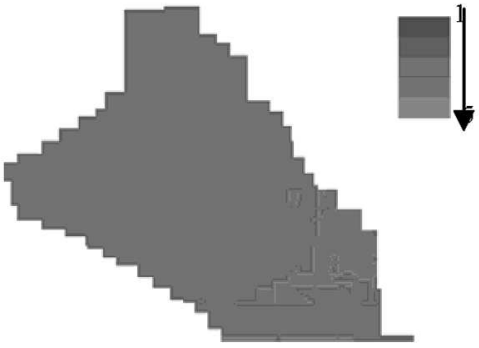

Figure 7. February of 2002 monthly median field strength with geographic coordinates at midnight (LT=00).

4. Conclusions

A large amount of observation data from 81 stations were used to draw a three dimensional contour map which represents the distribution of received strength of HF-field with geographic coordinates. These data are used to show the monthly median field strength values for four chosen local times (sunrise LT=6, midday LT=12, sunset LT=18 and midnight LT=24) in February 2002 and October 2001. The corresponding predicted values for four hours and for February were produced by using the Ionospheric Prediction Model (IPM). Also the same data for four chosen local times (sunrise LT=6, midday LT=12, sunset LT=18 and midnight LT=24) were used to draw the map.

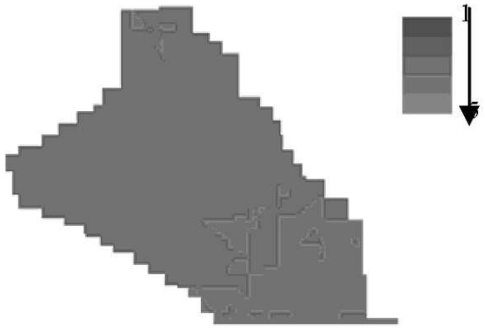

Figure 8. October of 2001 monthly median field strength with geographic coordinates at sunrise (LT=6).

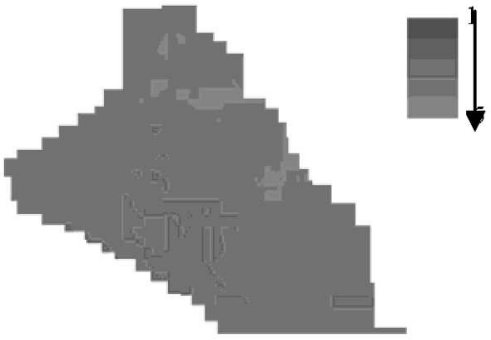

Figure 9. October of 2001 monthly median field strength with geographic coordinates at midday (LT=12).

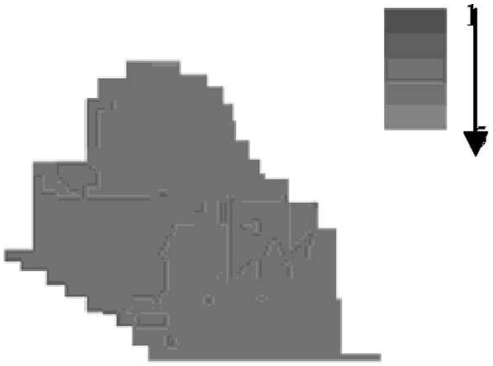

Figure 10. October of 2001 monthly median field strength with geographic coordinates at sunset (LT=18).

Figure 11. October of 2001 monthly median field strength with geographic coordinates at midnight (LT=00).

References

Al-Ubaidi, Najat, M. R., 2003, Ph D thesis, Baghdad University
Bilitza, D., Rawer, K., Bossy, L. & Gulyaeva, T., 1993 AdSpR, 13, 3
Bradley, P. A., & Dudeney, J. R., 1973 JATP, 35, 2131
Dudeney, J. R., 1978, JATP, 40, 195
Nisbet, J. S., 1971, RaSc., 6, 437
Rush, C. M., PoKempner, M. Andeson, D. N., Stewart, F. G., & Perry, J., 1983, RaSc, 18, 95