TOPSIDE ELECTRON DENSITY: COMPARISON OF EXPERIMENTAL AND IRI MODEL PROFILES DURING LOW SOLAR ACTIVITY PERIOD

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Abstract: The pattern of the topside electron density profiles is not yet very well represented by the IRI model. In this work the topside profiles obtained by the ISIS-2 satellite during low solar activity conditions are compared to those modeled by IRI. We take the quantitative parameter ε to measure the deviation of the model from the observed profiles. The results showed that the IRI overestimation of the topside profile is higher for low dip latitudes. The dispersion of the epsilon values is from 40 to 140%, more in equinoctial months and some lower for Winter. The best modeling is about 20% to 40% in middle and high latitudes of the North Hemisphere.

Introduction

Continuous efforts have been made for the improvement of the IRI topside model. The overestimation of measurements at high altitudes is one of the main problems of the current model. Authors as Bilitza (2001) and Coïsson *et al.* (2002) are involved in the development of a height-dependent correction term for the IRI topside model using Alouette, ISIS and IK-19 topside sounders .

In this paper, a total of 1634 topside electron density profiles from ISIS-2 database (NSSDC) are used to make a comparison with the topside profiles from IRI topside model for different seasons (Equinox, Summer, Winter) and local time (day hours: 08 - 17 LT; night hours: 20 - 05 LT) based in the quantitative parameter ε as a measure of the precision of a model to fit the experimental profiles.

Data Source and methods

Electron density profiles for the ionosphere above the F2 maximum up to 1400 km were taken from ISIS-2 database, made available on-line at the ftp site of NASA National Space Science Data Center ftp://nssdcftp.gsfc.nasa.gov/spacecraft_data. The estimated quality of the profile inverted from the scaled trace data is evaluated from 1 to 3. We choose only the best profile quality (q= 3). The retrieved data cover the years 1974-1977, a period of low solar activity (Figure 1).

We use the concept of ε (epsilon), a hint of how good a model is to represent the real height profiles. Epsilon is defined by Zhang *et al.* (1998a) as:

$$\varepsilon(\%) = \frac{\int_A^B \left| Ne(h)_{\text{model}} - Ne(h)_{\text{measured}} \right| dh}{\int_A^B Ne(h)_{\text{measured}}\, dh} \cdot 100\%$$

The model profiles have being computed from hmF2 specific to each experimental profile.

Results

As Zhang *et al.* (1998b) have proved the fitting of a model to an experimental profile which is reasonably good when ε is less than 4-5%. Figure 2 shows the computed epsilon values for each season and Local Time range. It can be seen that in all the cases the epsilon values are far from this condition.

The ε values are lower around middle latitudes of the north hemisphere, as could be expected. A high dispersion of ε is found. It is more pronounced for the profiles of low dip latitudes and to the negative values of dip.

In Figure 3 we can find some examples of local profiles. All of them are from the station LAU45S_170E during geomagnetically quiet days of January 1976 (Wolf Number = 15.2) between 1.01 – 3.93 LT. It can be seen that the asimptotic tendency of the IRI profile does not represent a real behaviour.

Figure 4 shows the comparison of the experimental and modeled profiles at fixed heights. In this case it is not ε properly, since it does not represent an area. The result of computing the mean difference (%) shows that the fitting of the profiles has poor agreement, worse for larger heights.

Summary

- IRI always shows overestimation of the topside profile, depending on dip, higher for low dip latitudes.
- The dispersion of the epsilon values is higher for low dip latitudes.
- For Low Solar Activity periods, topside profiles are better described by IRI in the middle dip latitudes of the North Hemisphere.
- For Low Solar Activity periods, in general, Winter topside profiles are better described that Equinoxes and Summer.
- There is an asymmetric distribution of the epsilon values during Day Hours, the maximum values are moved to the Southern hemisphere. During Night Hours the distribution is more symmetrical.

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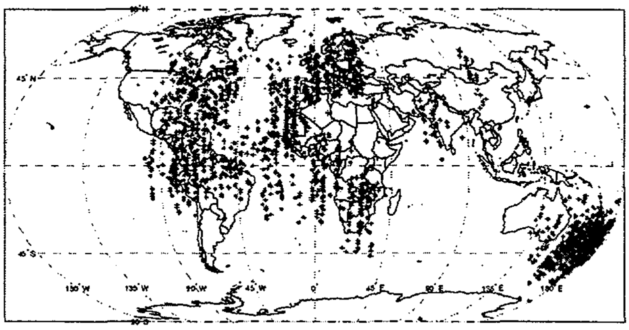


Figure 1: Geographical Distribution of the data. Each * point represents the position of a profile.

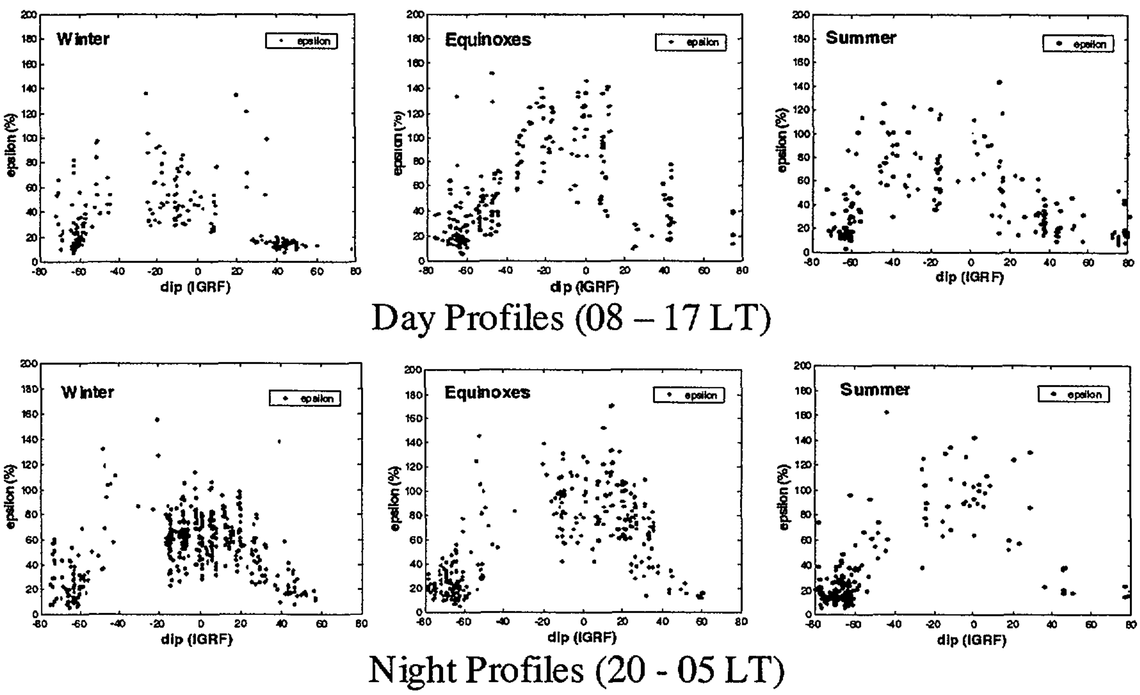
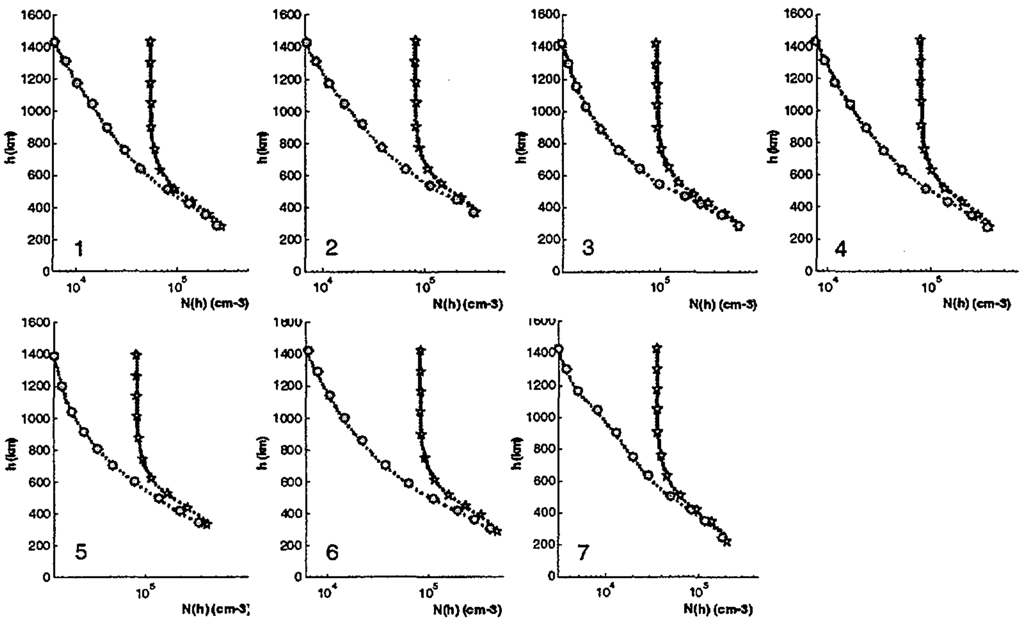


Figure 2: Distribution of epsilon values as function of dip location. Each point represents a profile



No. Profile	1	2	3	4	5	6	7
Date(dddyy)	11476	11776	11776	11676	12376	10776	12776
Local Time	1.93	2.32	3.85	1.01	3.14	2.46	2.92
Geogr. Lat. (°)	-50.5	-44.9	23.7	-54.4	-33.3	-34.6	-45.1
Geogr.Lon. (°)	179.9	176.7	176.1	172.6	169.8	162.9	156.2
Dip (° IGRF)	-16.5	-9.0	-5.9	-1.4	5.9	19.4	31.9
ε (%)	60.6	87.5	67.3	83.0	78.9	98.3	55.1

Figure 3: Examples of topside electron density profiles. Round symbols are the experimental profiles and the others represent the IRI modeled profiles.

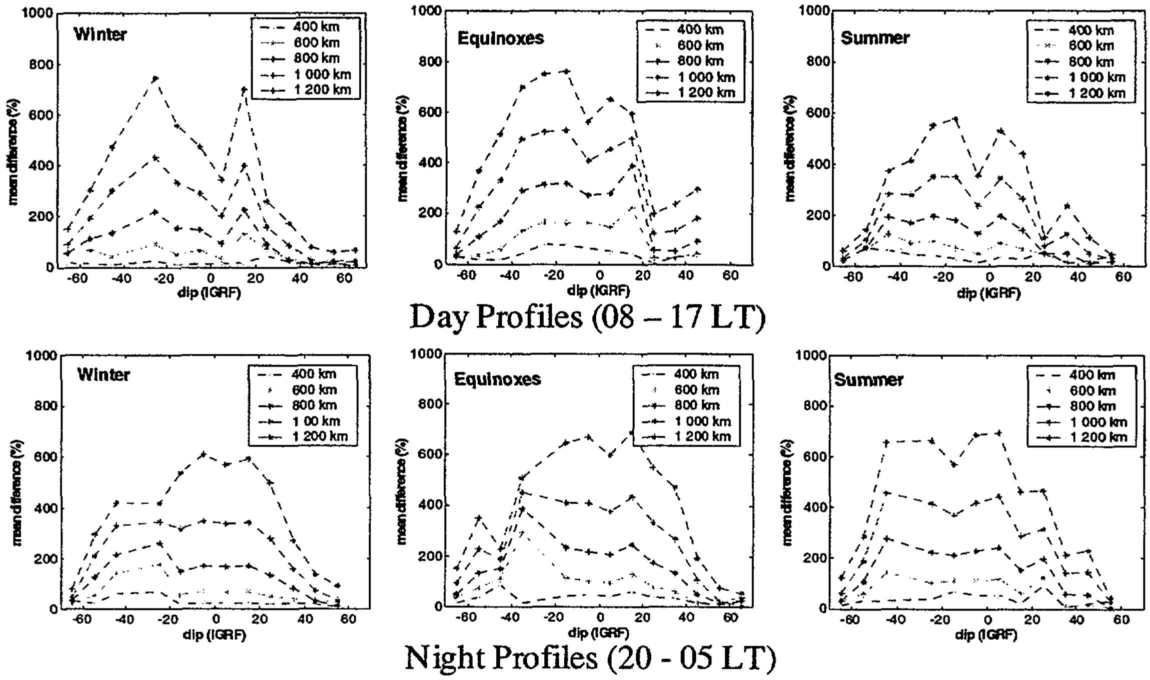


Figure 4: Comparison of experimental and modeled profiles taking epsilon at fixed heights (400 km, 600 km, 800 km, 1000 km, 1200 km).