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Comparisons of observed ionospheric F2 peak parameters with IRI-2001 predictions over South Africa

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ABSTRACT

The monthly means of the ionospheric F2 peak parameters (*foF2* and *hmF2*) over three stations in South Africa (Grahamstown, 33.3°S, 26.5°E, Madimbo, 22.4°S, 26.5°E, and Louisvale, 28.5°S, 21.2°E) were analyzed and compared with IRI-2001, using CCIR (Comité Consultatif International des Radio communications) and URSI (Union Radio-Scientifique Internationale coefficients) options. The analysis covers a few selected quiet and disturbed days during various seasons represented by the months of January, April, July and October 2003. IRI-2001 generally overestimates *hmF2* for both quiet and disturbed days and it overestimates and underestimates *foF2* at different times for all the stations. In general, *foF2* is predicted more accurately by IRI-2001 than *hmF2*, and on average, the CCIR option performed better than the URSI option when predicting both *foF2* and *hmF2*.

In general, the model generates good results, although some improvements are still necessary to be implemented in order to obtain better predictions. There are no significant differences in the model predictions of *hmF2* and *foF2* for quiet and disturbed days.

1. Introduction

Several researchers have examined the prediction ability of the International Reference Ionosphere (IRI) model for ionospheric parameters (e.g. Adeniyi and Radicella, 1998; Batista and Abdu, 2004; Bittencourt and Chryssafidis, 1994; Souza et al., 2003; Sethi et al., 2004; Pandey and Sethi, 1996). IRI is an empirical ionospheric model based on experimental observations of the ionospheric plasma either by ground or by in-situ measurements. The IRI model provides two options for the prediction of *hmF2* (height of the maximum electron density of the F2 layer) and *foF2* (critical frequency of the F2 layer); one uses the CCIR coefficients developed by Comité Consultatif International des Radio communications (CCIR, 1967, 1991) and the other uses the URSI coefficients developed by the Union Radio-Scientifique Internationale (Rush et al., 1983, 1984, 1989; Fox and McNamara, 1988). Over the years, testing and modification of the IRI have led to improvements through several versions (IRI-80, IRI-86, IRI-90, IRI-95, IRI-2000, IRI-2001) (Rawer et al., 1978a, b, 1981; Rawer and Minnis, 1984; Bilitza, 1997, 2001).

Bittencourt and Chryssafidis (1994), Batista et al. (1996) and Shastri et al. (1996) have compared observed *hmF2 and foF2* with IRI-90 (Bilitza, 1990), during different solar activity periods. Bittencourt and Chryssafidis (1994) compared IRI-90 model predictions with observed values at a magnetic equatorial station located at Fortaleza (4°S, 38°W) in Brazil. Batista et al. (1996) used the Digisonde database from Cachoeira Paulista (22.5°S, 45°W) and Shastri et al. (1996) analyzed and compared observed *foF2* data from ionosonde measurements for three low-latitude Indian stations, namely Delhi (28.6°N, 77.2°E), Ahmedabad (23.0°N, 72.6°E) and Kodaikanal (10.2°N, 77.5°E). Their work showed that the IRI-90 model predictions are quite reasonable for the different solar activities considered, except for post-sunset conditions during high solar activity, when IRI-90 highly underestimates the observed *hmF2*.

Sethi et al. (2004) compared IRI-2001 model predictions with ionospheric data from New Delhi (28.6°N, 77.2°E). They reported that major discrepancies occur when the IRI underestimates observed *hmF2* for local times from about 14:00 to 18:00 UT and 04:00 to 05:00 UT during winter and equinox periods.

Similarly, Bertoni et al. (2006) compared IRI-2001 model predictions with ionospheric data from Brazilian low-latitude stations, namely Palmas (10.17°S, 48.20°W) and São José dos Campos (23.20°S, 45.86°W). The comparison shows quite a reasonable agreement for both parameters (*hmF2* and *foF2*). They report that some improvements are still necessary in order to obtain better predictions for equatorial ionospheric regions.

Also, Oyeyemi et al. (2005, 2006) have compared observed values of *foF2* with neural network and IRI model predictions.

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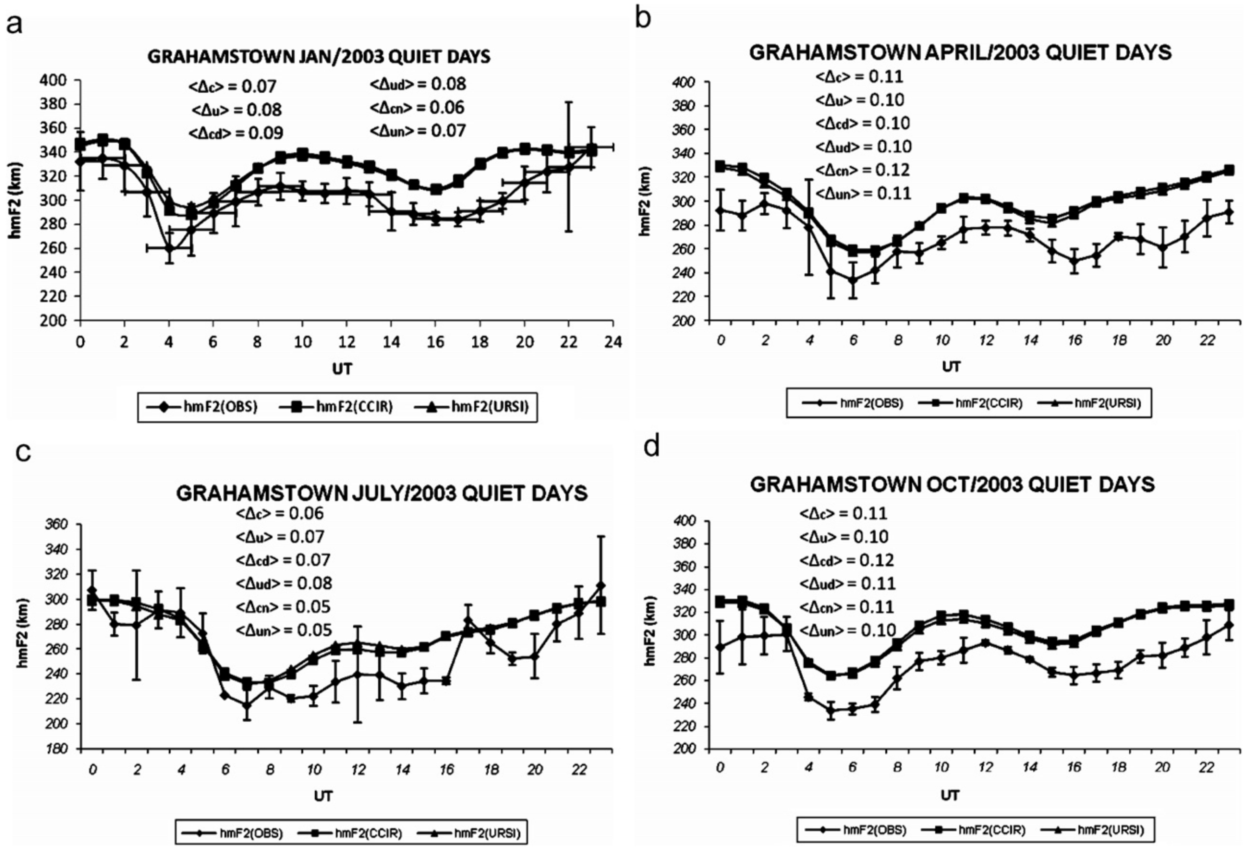

Fig. 1. (a–d) Graph of the observed average *hmF2* variations for different seasons at Grahamstown for quiet days. The IRI-2001 model predictions, using both CCIR and URSI coefficients, for different seasons are also shown.

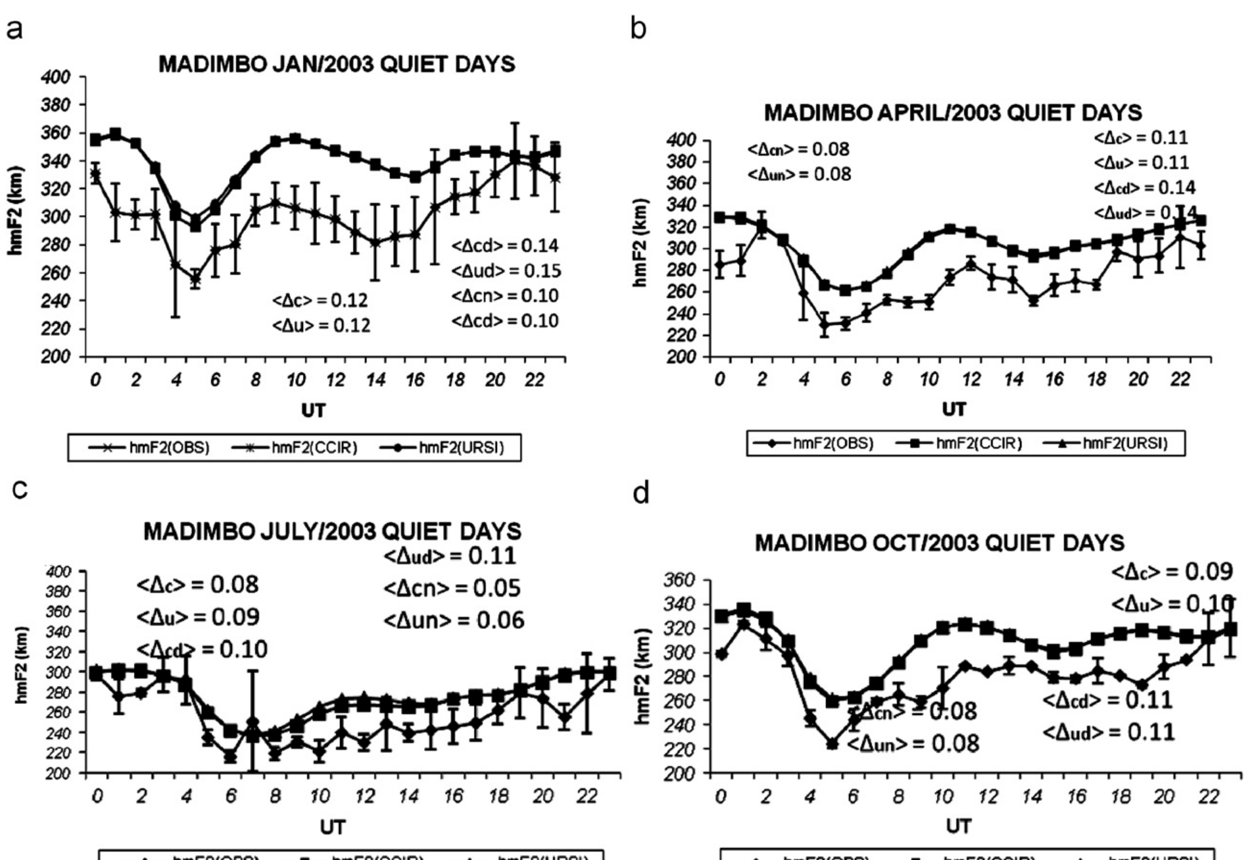

Fig. 2. (a–d) Graph of the observed average *hmF2* variations for different seasons at Madimbo for quiet days. The IRI-2001 model predictions, using both CCIR and URSI coefficients, for different seasons are also shown.