# Behavior of the equatorial ionosphere over Palmas-TO during geomagnetic quiet days

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**Abstract (Font: Arial Bold, 9)**

This work presents a study of the ionospheric parameters obtained a digital ionosonde type know as Canadian Advanced Digital Ionosonde – CADI located Palmas (10.17°S, 48.20°W), Brazil for the winter month of July and the equinoctial month of September. A comparison of the ionospheric parameters (*h´F, hpF2 and foF2*) for the 2002 and 2003 year during periods of geomagnetically quiet days, although similar, shows same significant differences during particular periods.

## Introduction

A digital ionosonde, of the type known as Canadian Advanced Digital Ionosonde (CADI) (Grant at al, 1995), has been in routine operation at Palmas (10.2°S, 48.2°W; dip latitude 5.5°S), Brazil since April 2002. This CADI is part of a new network being established in a collaborative program between UNIVAP and CEULP/ULBRA, to study the equatorial and low-latitude ionospheric regions in Brazil.

In this paper we present and discuss the behavior of the ionosphere over the equatorial area at Palmas during the geomagnetically calm days, for the months of July and September of 2002 and 2003.

## Method

In this work we have analyzed the average value of minimum virtual height of the F-layer (*h´*F), the critical frequency f0F2 and the corresponding virtual height the frequency 0,834 of f0F2 (*hp*F2) (PIGGOT AND RAWER, 1972). We have chosen the magnetically quietest days of the months of July and September in the years of 2002 and 2003. The chosen months are typical of the seasons, in this case, winter (July) and Equinox (September). In the other seasons there are no available data simultaneously for the two years. The universal time (UT) for this station is 3h ahead of the local time (LT). The observed ionospheric parameters are values recorded every 15 min (ionospheric sounding is carried out every 5 min.) The solar activity in the year of 2003 was inferior to the year 2002, period of high solar activity.

The table 1 shows the days observed for the year 2002 and 2003. The months of September/2002 and July/2003 had the complete set of 5 quietest days of measurements. While for July/2002 and September/2003 we had only 4 days.

Recent works have been analyzing the response of the equatorial and low-latitude ionospheric regions during magnetic storms (Lima et al, 2004), Becker-guedes at, al. 2004, Bertoni, 2005, Rishbeth, 2000, Abdu et al., 2001). In these studies it is usually analyzed as the ionospheric parameters vary through comparisons among calm and magnetically disturbed periods.

Table 1 – Magnetically quietest days of the observation period (year 2002 and 2003)

| | | | | | |
|---|---|---|---|---|---|
| July/2002 | 14 | 3 | 15 | 2 | |
| September/2002 | 23 | 25 | 24 | 29 | 20 |
| July/2003 | 8 | 9 | 22 | 21A | 10A |
| September/2003 | 28 | 29 | 7 | 30 | |

Source: http://www.gfz-potsdam.de/pb2/pb23/GeoMag/niemegk/kp_index/quietdst/qs20000x.html

## Results and discussion

The figure 1 shows the *f0F2* variation, *h´F* and *hpF2* for the month of July, typical of winter. The behavior of the critical frequency is very similar in the two years, with minimum values of 2,1 MHz around 09:00 UT and maximum values of 11,8 MHz on the afternoon between 15:00 and 21:00 UT. At night there is a decrease continue until dawn. However, between 2:00 and 4:00 UT a stable behavior is observed, around 6,2 MHz. A significant difference is observed on the period between 11:00 h and 14:00h UT, where *f0F2* for 2002 is until 2,0 MHz larger compared with 2003. The diurnal pattern of *h´F* is very similar for the two years, with a peak at 09:00h UT (around 260 km) and other at 20:30h UT (around 240km). In the night, there is another peak for h´F that happens at different schedules every year. For 2002 year the peak, around 280km, occurs around 2:00 UT, while for 2003 it happens about 00:30 UT. The average values of *hpF2* are very similar at the two years. It has a maximum of approximately 450km around 17:00 UT, which value is closely the night peak that happens around 2:00 UT at 2002 and 00:30 at 2003.

The figure 2 shows the ionospheric parameters for September, typical month of autumn. Initially we can

observe that the *f*0F2 graphs and *hpF2* don't present data between 22:30 and 02:00 UT, which is due the large occurrence of spread-F events in range and frequency that disables the identification of the parameters in subject. The occurrence of the spread-F at night is more frequent in September when compared with the month of July.

The variations of f0F2 for 2002 are larger than the 2003 any time. A stability is observed between 12:00 and 15:00 h UT, no observed in the month of July. A peak in the night period around 3:00 UT appears to happens, although that observation can be questioned due to uncertainty generated by the spread-F.

The diurnal behavior for *h´F* for September is similar on the two years, with values around 200km. At night there is a continuous uplifting after the evening with a peak around 23:00 UT, reached 410 km in 2002, higher the observed in 2003. That peak, associated with the pre-reversal enhancement, is not observed in the month of July and is important in the formation of the irregularities that happen with more frequency in this period. Between 06:00 and 08:00 UT *h´F* it presents a local maximum that is higher on the year of 2003.

The hpF2 has similar behavior on the two years between 02:00 and 18:00 UT with higher value of 460 km at afternoon and lower around 300 km about 03:00 UT. There is a fast Uplifting after 20:00 UT reaching values of up to 650 km, in 2002, about 22:30 UT. Due to the spread-F we cannot identify precisely the schedule of the peak. It can be observed that the maximum in hpF2 is higher in the year of 2002, being compatible with observed for h´F.

**Conclusions**

The comparison of the average values of the ionospheric parameters of the geomagnetically quiet days over Palmas-TO they show some differences among the years 2002 and 2003. Further analyses, including others months and comparison with theoretical models are important to explaining this preliminary results.

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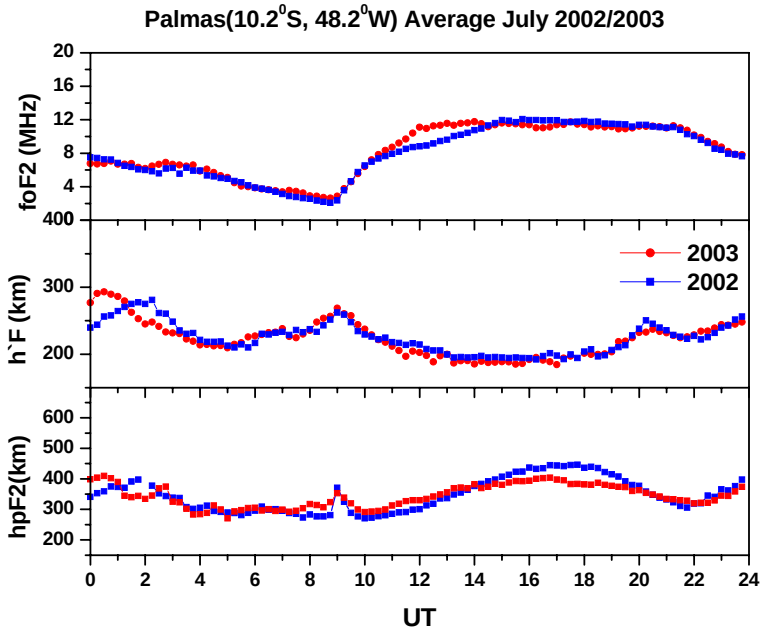


Figure 1 - The average quiet-day variation of *the h´F, foF2, e hpF2* at Palmas for July 2002 and 2003

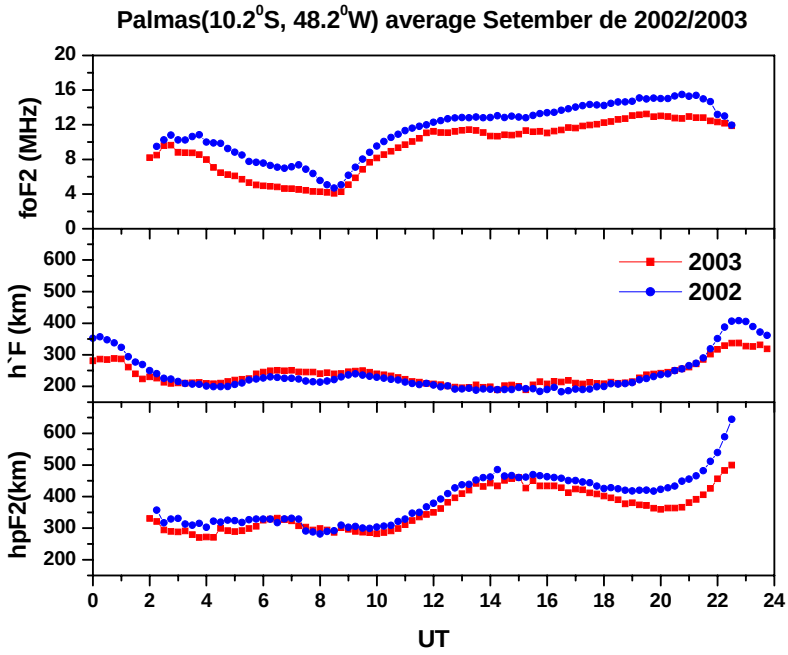


Figure 2 - The average quiet-day variation of the *h´F, foF2, e hpF2* at Palmas for September 2002 and 2003