Preliminary results from COPEX campaign

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Abstract

Ionospheric data at five Brazilian stations are analyzed in order to study the longitudinal and latitudinal differences in the ionospheric parameter and spread F variabilities. Although the general patterns of the ionospheric variations at the two equatorial stations (Cachimbo and São Luís) are similar, very significant differences are observed during particular periods, mainly regarding the dynamics that leads to spread F generation.

Introduction

The Conjugate Point Equatorial Experiment (COPEX) was conducted in Brazil from October 1 to December 10, 2002. The configuration of the experiment was planed in such a way that the equipments should be located in three sites along a magnetic meridian, one at the magnetic equator and the other two at magnetically conjugate points. The magnetic conjugate points should be located such that the conjugate E layers were field line mapped to the F layer peak, or to the bottomside, over the magnetic equator. The three selected locations were Campo Grande (20.5° S, 54.7° W, southern conjugate point); Boa Vista (2.8° N, 60.7° W, northern conjugate point) and Cachimbo (9.5° S, 54.8° W, magnetic equatorial point). Various instruments such as Digital Portable Sounders (DPS-4), optical imagers, GPS receivers for scintillation monitoring and for TEC measurements, magnetometers, HF receivers and a 50 MHz radar were operated during the campaign. The campaign was coordinated by the Aeronomy group at the Brazilian National Institute for Space Research (Instituto Nacional de Pesquisas Espaciais- INPE), in collaboration with the Brazilian Air Force group from CTA (Centro Técnico Aeroespacial) and with international groups from the Center for Atmospheric Research, University of Massachusetts Lowell (Lowell, MA, USA), the Air Force Research Laboratory Space Vehicles Directorate (AFRL/VSBX, Hanscom AFB, MA, USA), and the Japanese group from the Communication Research Laboratory (CRL), Tokyo. The data collected by the two digisondes that are continuously operated at the ionospheric stations São Luís (2.6° S, 44.2° W) and Cachoeira Paulista (22.7° S, 45° W), were also used in this study, in order to complement the data at a different longitude. The geographic and magnetic coordinates of the five stations are shown in Table 1.

Table 1 – List of ionospheric stations

	Cachimbo (CA)	Boa Vista (BV)	Campo Grande (CG)	São Luís (SL)	C. Paulista (CP)
Latitude	9.5° S	2.8° N	20.5° S	2.6° S	22.7° S
Longitude	54.8° W	60.7° W	54.7° W	44.2° W	45° W
Dip angle	-4.2°	22°	-22.3°	-3.85°	-33.7°
Magnetic Lat.	-2°	11°	-11°	-1.6°	-16°
Declination	-16.7°	-14°	-15.1°	-20.7°	-20.6°

Data Analysis and Results

Figures 1a to 1d show comparative plots of the F layer critical frequency (foF2) and peak height (hmF2) at the five stations, for the campaign period October 24-27, 2002. The stations at the experiment configuration (CA, BV and CG) have magnetic declination around –15° while the other two stations are in longitude with higher declination (around –20°). Although CA and SL have very similar magnetic latitudes, CA is almost 7° south of SL. In spite of those differences, we can see from the Figures 1a and 1c that foF2 and hmF2 are very similar at both locations. Spread F occurrence (shown as bars at the bottom of Figure 1a) is also very similar at the two locations, except on the night 27-28, which will be discussed latter.

When we compare the off-equator sites (BV, CG and CP, Figures 1b and 1d) we notice very different behavior. The general behavior of foF2 at BV is similar to that at CG but we can see that the northern location (BV) shows many structures, mainly between 12 and 21 UT. The values of foF2 at CP differ from the other two locations mainly from 00 to 03 UT, when foF2 at CP is generally smaller than the values at the other two locations. This shows that during this observational period the equatorial anomaly peak did not reached the latitude of CP (-16° magnetic latitude). The differences in the peak heights are even more pronounced than those in the critical frequencies. The day-to-night variation in BV can be as high as 300 km, while in CG it is of the order of 200 km and at CP is around 150 km. The diurnal variations of hmF2 at BV and CG are similar to those of the equatorial stations CA and SL. The height variations at CP, on the other hand, have no similarities with those of the equatorial stations.

From Figure 1 we can see that spread F was observed at all but the night 24-25 October. The spread F at the night 27-28 October was much weaker than at the other three nights in which the same phenomena was observed. As expected, the spread F occurred on nights when the F layer elevation was more pronounced and the evening pre reversal vertical plasma drift (shown in Figures 1e and 1f for CA, BV and CG) in higher. It is already well known that the pre reversal enhancement on the F region vertical plasma drift is a necessary condition for the spread F initiation (Abdu et al., 1981a, 1981b; Batista et al., 1986; Fejer et al., 1991).

Despite of the general agreement between the ionospheric parameters at the two equatorial stations, some peculiar and distinct behavior are observed. One example is the spread F behavior at the night 27-28 October. Over CA the spread F is first seen at 2310 UT coming from southeast and from west directions (see Figure 2). Around 2315 UT the bottomside spread F (BSSF) is initiated but it remains very week during all the period, while the spread that comes from off-vertical direction becomes more intense. In São Luís, on the other hand, the BSSF initiates at 2130 UT (Figure 3) and continues until 0100 UT. We can see also, from Figure 1, that the evening F layer peak uplift is much more pronounced over SL than over CA in this particular day.

The period analyzed in this paper was magnetically disturbed. The values for the magnetic index ap at the four days were 48, 80, 27 and 15, respectively. Although it was a period of decreasing magnetic activity, it increased again at the end of day 27 and decreased on day 28. Magnetic disturbances introduce a lot of perturbation in the ionosphere, even at the low and equatorial latitudes. Longitudinal differences in the effects are expected, but they are known to occur in a larger scale. The reason why CA and SL respond differently to the disturbance is not yet known once the two locations are separated by only 10^{o} in longitude (this correspond to 40 minutes difference in local time). Those aspects will be better investigated further.

Conclusions

Preliminary analysis of a short period of data (October 24-27, 2002) from the COPEX campaign showed that the ionospheric effects of a magnetic disturbance can vary from one longitude to another, even for locations that are only 10^{o} degrees apart. Further investigation will be done in order to determine the main factors responsible for such variability.

Acknowledgments

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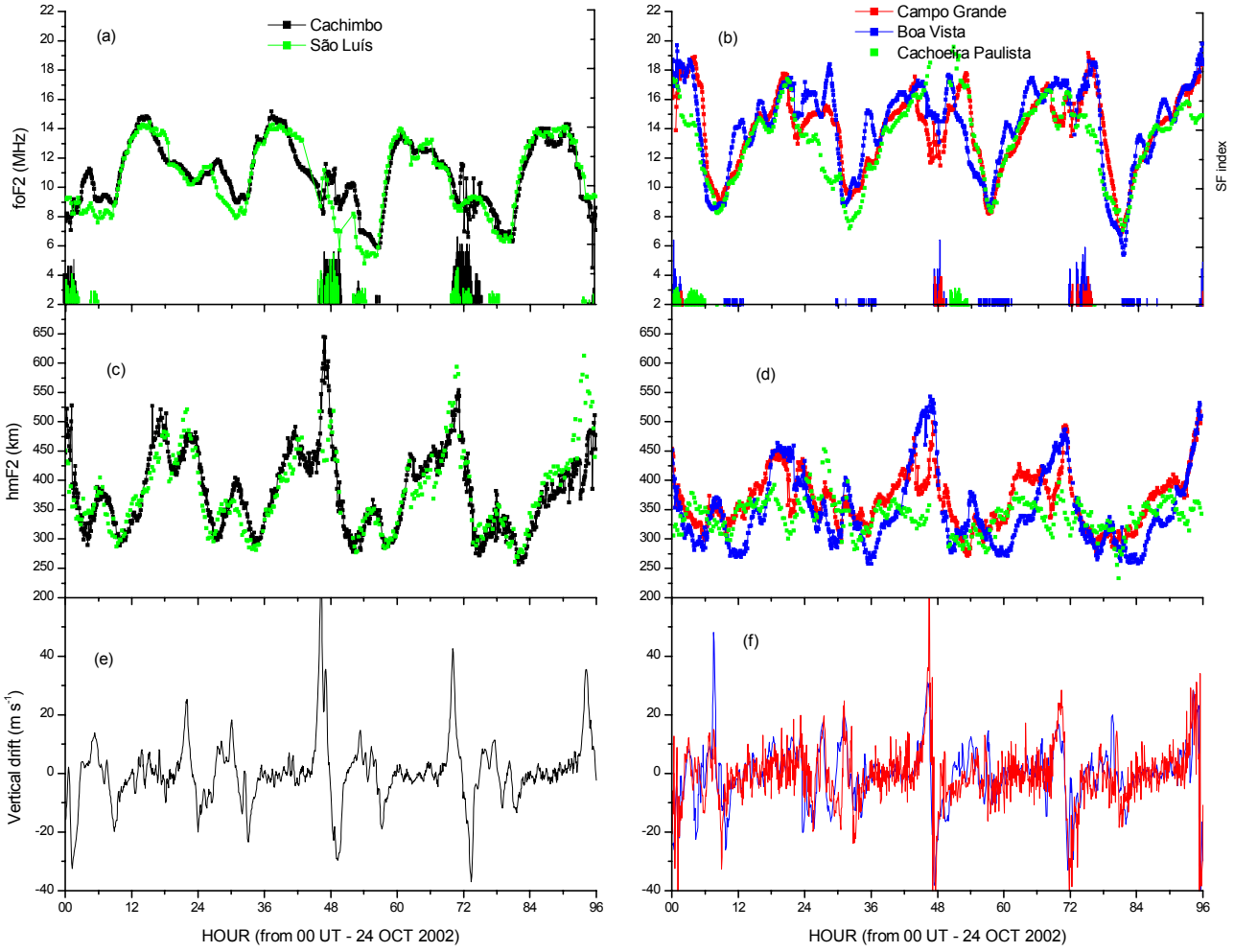

Figure 1 – Ionospheric parameters for the five stations, during the period October 24-27, 2002. In the left side frames are the equatorial stations and in the right side the off-equatorial stations.

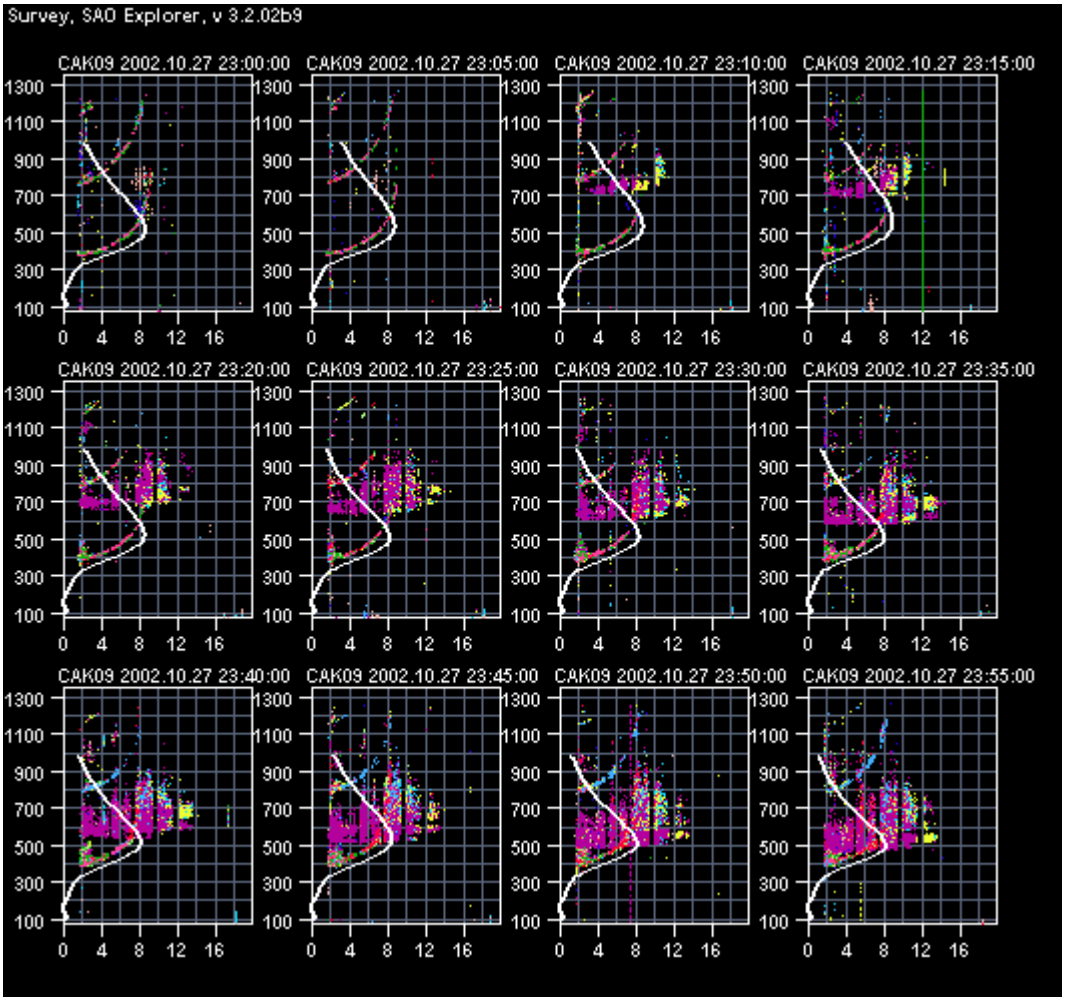

Figure 2 – Sequence of ionogramas from Cachimbo, for October 27, 2002, showing the spread F onset at that location.

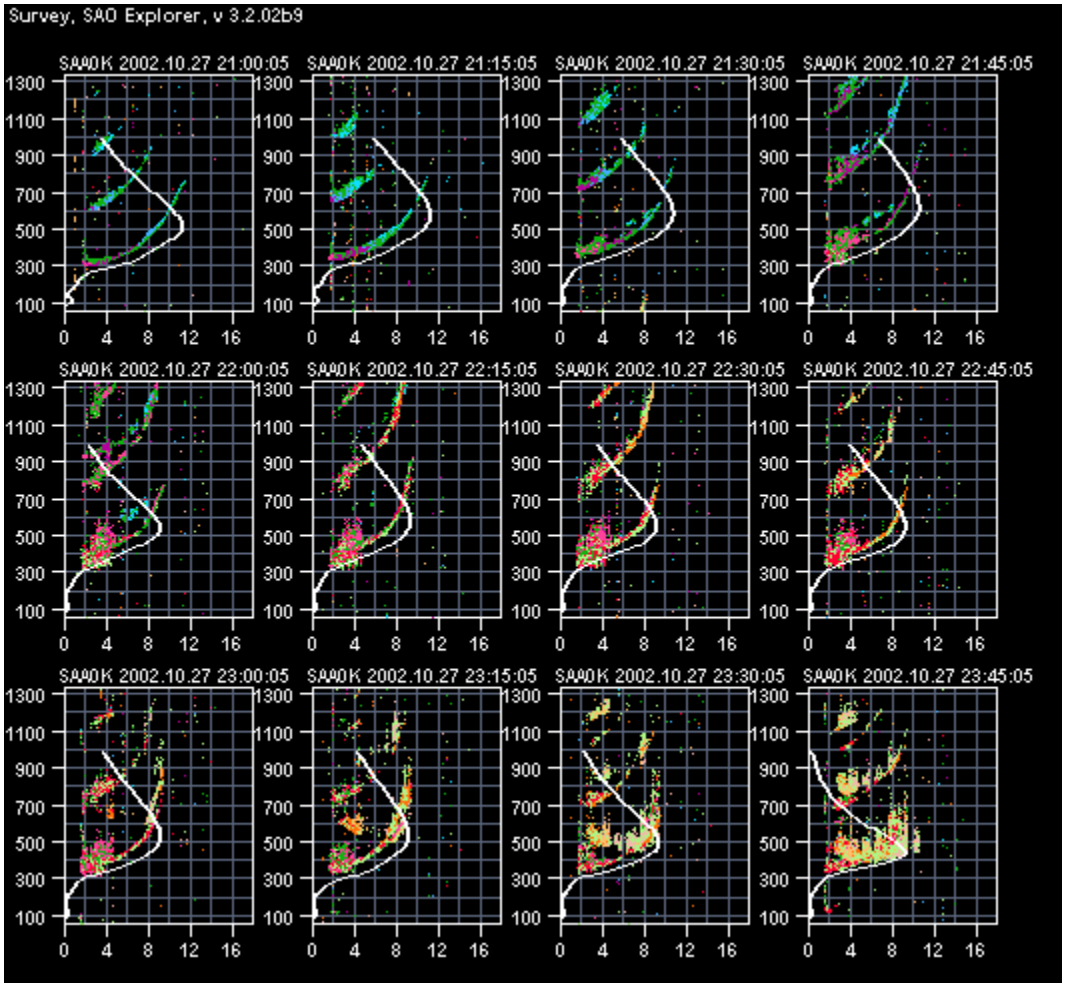

Figure 3 – Sequence of ionogramas from São Luís, for October 27, 2002, showing the spread F onset at that location.