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LOW LATITUDE F-REGION STUDIES USING THE OI6300A^{o} AND 7744A^{o} NIGHTGLOW MEASUREMENTS AT CACHOEIRA PAULISTA, BRAZIL

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14. Abstract/Notes

Regular measurements of the forbidden OI6300A^{o} and the permitted OI7774A^{o} nightglow emissions have been carried out at Cachoeira Paulista (22.7^{o}S, 45.0^{o}W; geomag. 11.9^{o}S), Brazil since 1975 and 1978, respectively. The long series of the OI6300A^{o} emission observations during the ascending phase of the last solar cycle permitted studies of the solar cycle effects and long term variations. The seasonal-nocturnal variations show large changes between years of low and high solar activity. Also, during recent years, meridional scanning observation of these emisions have been carried out to study propagating disturbances and low-latitude F-region dynamics. Salient features of these observations are presented and discussed.

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LOW LATITUDE F-REGION STUDIES USING THE OI6300Å AND 7774Å NIGHTGLOW MEASUREMENTS AT CACHOEIRA PAULISTA, BRAZIL

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Abstract

Regular measurements of the forbidden OI6300Å and the permitted OI7774Å nightglow emissions have been carried out at Cachoeira Paulista (22.7°S, 45.0°W; geomag. 11.9°S), Brazil since 1975 and 1978, respectively. The long series of the OI6300Å emission observations during the ascending phase of the last solar cycle permitted studies of the solar cycle effects and long term variations. The seasonal-nocturnal variations show large changes between years of low and high solar activity. Also, during recent years, meridional scanning observation of these emissions have been carried out to study propagating disturbances and low-latitude F-region dynamics. Salient features of these observations are presented and discussed.

Introduction

Regular measurements of the OI6300Å and 7774Å nightglow emissions, using tilting-filter type zenith photometers, have been carried out at Cachoeira Paulista (22.7°S, 45.0°W; geomagnetic 11.9°S), Brazil since 1975 and 1978, respectively. Also, during recent years, scanning observations of these emissions have been carried out to study propagating disturbances and low-latitude F-region dynamics (Sobral et al., 1980, Sahai et al., 1983, Bittencourt et al., 1983). Simultaneous measurements of these atomic oxygen emissions arising from dissociative recombination and from radiative recombination processes, respectively, are very useful for remote sensing of ionospheric F-region plasma properties, dynamical processes and large scale plasma irregularities.

In this paper we present the nocturnal, seasonal and solar cycle variations of the OI6300Å emission at Cachoeira Paulista based on the data obtained from 1975 to 1982. Simultaneous observations of the OI6300Å and 7774Å emissions on August 7-8, 1983 (a magnetically disturbed night $6 \leq Kp \leq 8-$) are presented. On this night quasi-periodic variations of the OI6300 emission were observed. The OI7774 emission did not show similar behavior. Also, scanning observations of the OI6300Å emission to show the spatial and temporal variations for this night and from two other nights are presented.

Observations and Results

The zenith OI6300Å and 7774Å, and the OI6300Å scanning observations were made with photometers using the tilting filter technique. Scanning observations (north-south and east-west) were obtained by placing the photometers horizontally looking into a mirror inclined at 45° to the horizon. The mirrors were rotated to allow east-west or north-south meridional scans up to 70° zenith distance on either side. In the present analysis the data used were from nights giving observations for more that about 5 hours. The ionograms were obtained from an ionosonde operating on a routine basis at Cachoeira Paulista.

Figure 1 shows a plot of the monthly means of the OI6300Å emission observed at Cachoeira Paulista (1975-1982) along with the Zürich sunspot numbers and 10.7cm flux. In order to remove the seasonal variations from the airglow data, we utilized 12 month running means. If one or two values were missing these were inserted by linear interpolation. The results are shown by smaller dots in Fig. 1. The OI6300Å intensity is approximately in phase with the sunspot cycle and the results are similar to those reported by Barbier (1965) for Haute-Provence (43.1°N, 5.1°E). However, the observed ratio of the intensities during high solar activity (HSA), 1979-1980, and low solar activity (LSA), 1975-1976, is about 7 and is much larger than (~2) that was reported by Barbier (1965).

Figure 2 shows the mean nocturnal intensity variations for different seasons during LSA and HSA. The seasonal-nocturnal variations show large changes between years of low and high solar activity.

Figure 3 shows the monthly mean nocturnal variations. The variations were calculated using half-hour values, which were normalized to the individual nocturnal mean values in order to show the amplitude and phase of the variations. The data used were for the period June 1977 - April 1982 (medium and high solar activities). Significant changes in the month to month nocturnal variations are evident.

Figure 4 shows the mean seasonal variations for HSA, LSA and the data obtained during 1975-1982. In general, semiannual seasonal variations with maximums near the equinox months are observed. It may be noted that the intensities are higher during autumn than spring and the peaks come closer during HSA.

Figure 5 shows the simultaneous OI6300Å and 7774Å zenith intensities in Rayleighs and the h'F determined from the ionograms, as a function of local time, for August 7-8, 1983. The expected OI7774Å intensity variations due to radiative recombination, calculated from the expression $.0023(f_0F_2)^4$ (Sahai et al., 1983), are also shown in Fig. 5. The f_0F_2 values used were obtained from the ionosonde operating at a nearby location. On this magnetically disturbed night, quasi-periodic variations of intensity of the OI6300Å emission and h'F are observed. However, the OI7774Å emission and f_0F_2 do not show such variations. The ionospheric data do not show the presence of spread-F. Figure 6 and 7 show simultaneous north-south (geomagnetic) and east-west scanning observations of the OI6300Å emission, as a function of local time, respectively. The results are presented in the form of computer generated gray level shade maps showing the nocturnal variations. Figure 8 and 9 show the observed OI6300Å intensities at different zenith distances. It is observed from Figs. 6 to 9 that in the beginning of the night the OI6300 emission shows strong intensities in the north, but the airglow enhancements at 2030 and 2200 LT occur simultaneously at all latitudes and longitudes. The enhancement at 0000LT is much stronger in the south.

Figures 10 and 11 show the observed OI6300Å intensities at different zenith distances on June 26-27, 1981 ($2 \leq Kp \leq 3$; no spread-F) and August 24-25, 1981 (weak magnetic disturbance; $2 \leq Kp \leq 5-$; no spread-F). The nocturnal variation on June 26-27 is characterized by the post-twilight decay and enhacements before (propagating from south to north ~1000km/hr) and after (occurring at nearly the same time at all latitudes) midnight. The data on August 24-25 show quasi-periodic varations of intensity propagating from south to north in the premidnight period, whereas a large enhancement occurs simulataneously at all latitudes after midnight. Post-midnight enhancements are much stronger in the northern skies on both the nights.

Conclusions

1. The OI6300Å intensity is approximately in phase with the sunspot cycle with a large (~7 times) intensity increase from LSA to HSA.

2. The seasonal nocturnal variations show large changes between years of low and high solar activity.

3. The monthly mean nocturnal variations show significant month to month changes in the pre-and post-midnight enhancements. The post-twilight decay is dominant during winter months.

4. The mean seasonal variations show semiannual maximums near the equinox months.

5. The airglow observations on August 7-8, 1983, a magnetically disturbed night, show quasi-periodic F-layer height changes. The scanning OI6300 emission observations do not show any propagating feature.

6. The scanning observations shown in Figs. 10 and 11 present the temporal and spatial variations of enhancements before and after midnight. Before midnight the enhancements are characterized by south to north propagation (ionospheric equatorial anomaly). However, the postmidnight enhancements occur simultaneously at all latitudes.

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Figure Captions

Figure 1. Solar cycle variation of the OI6300Å intensities, sunspot numbers and 10.7cm flux. 12-month running mean of the monthly mean intensities are shown by smaller dots.

Figure 2. Mean nocturnal intensity variations of the OI6300Å emission for different seasons during low and high solar activities.

Figure 3. Monthly average nocturnal variations of the OI6300Å emission.

Figure 4. Mean seasonal variations for low and high solar activities, and the data obtained during 1975-1982 of the OI6300Å emission.

Figure 5. Nocturnal variations of the OI6300Å, OI7774Å and h'F for August 7-8, 1983. See text for $.0023(f_0F_2)^4$ variation.

Figure 6. Observed intensity variations of the OI6300Å emission, as a function of local time and zenith distance in the magnetic north-south meridian, for the night of August 7-8, 1983. The intensity scales in Rayleighs are shown at the top.

Figure 7. Same as Fig. 6, in the east-west meridian for the night of August 7-8, 1983.

Figure 8. Observed OI6300Å intensities at different zenith distances (magnetic north-south) on August 7-8, 1983.

Figure 9. Same as Fig. 8, in the east-west direction on August 7-8, 1983.

Figure 10. Same as Fig. 8, on June 26-27, 1981.

Figure 11. Same as Fig. 8, on August 24-25, 1981.

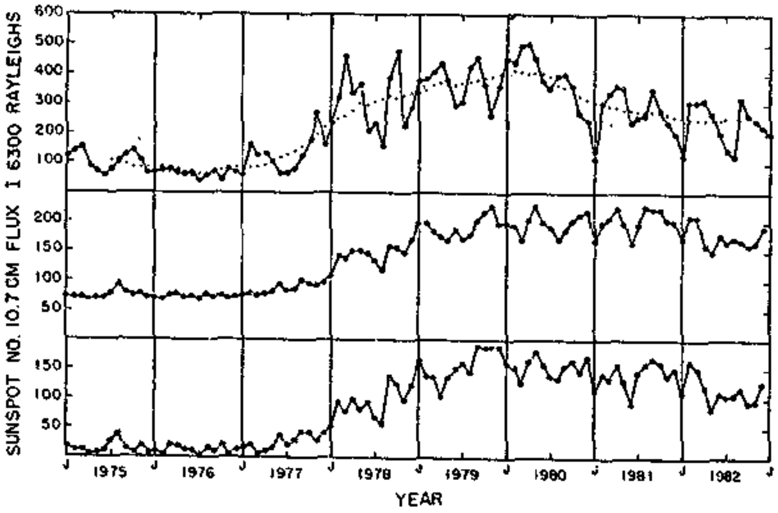


Fig. 1

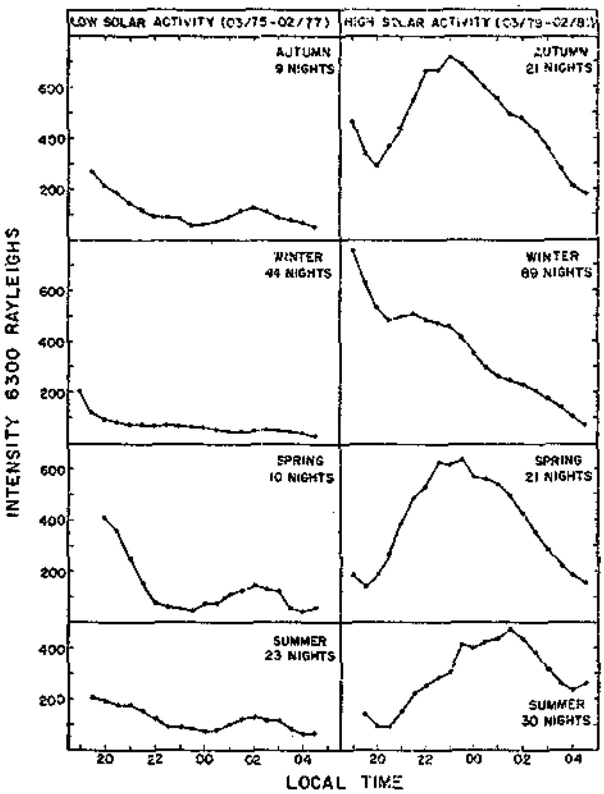
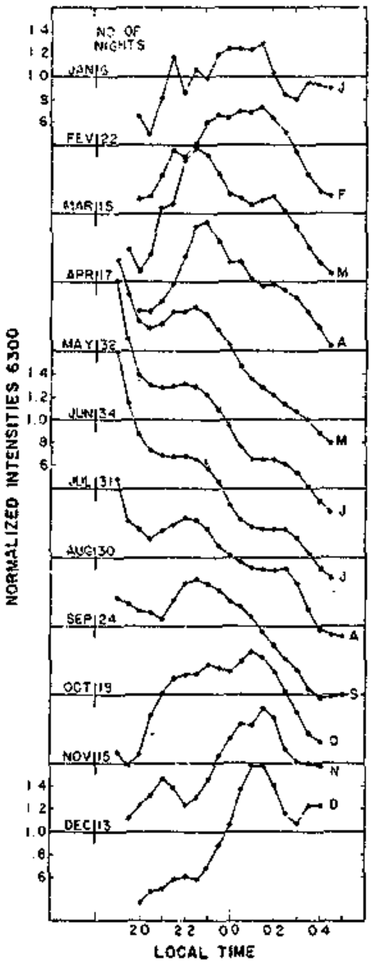


Fig. 2



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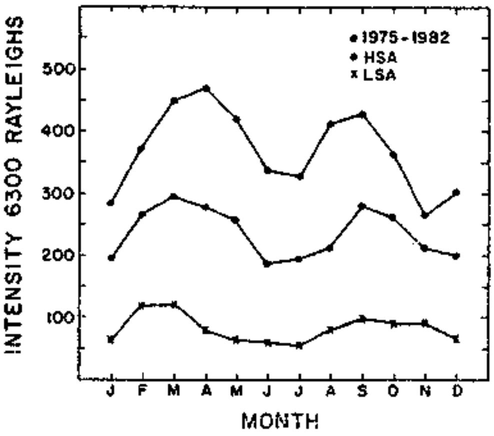

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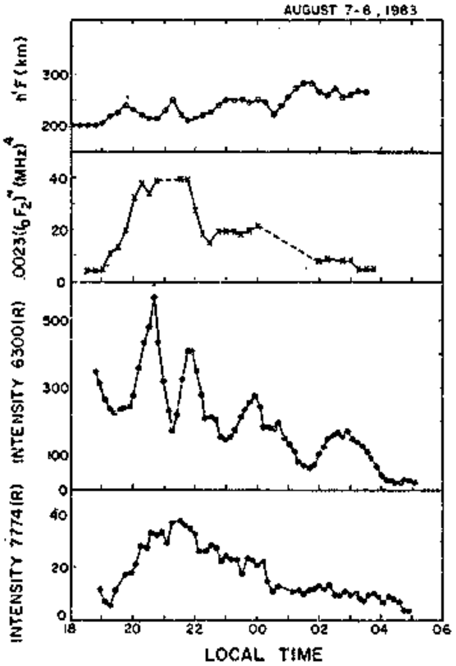


Fig. 5

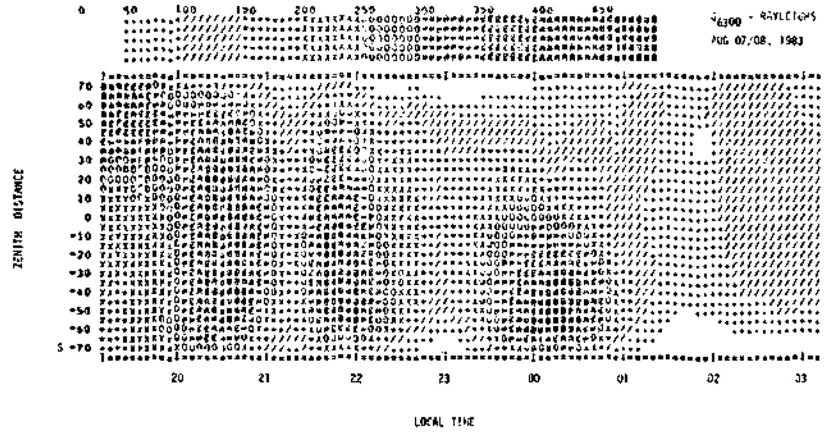
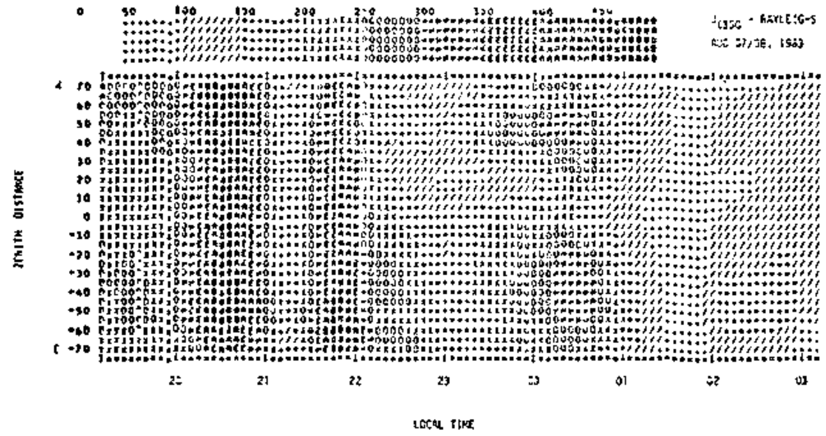


Fig. 6



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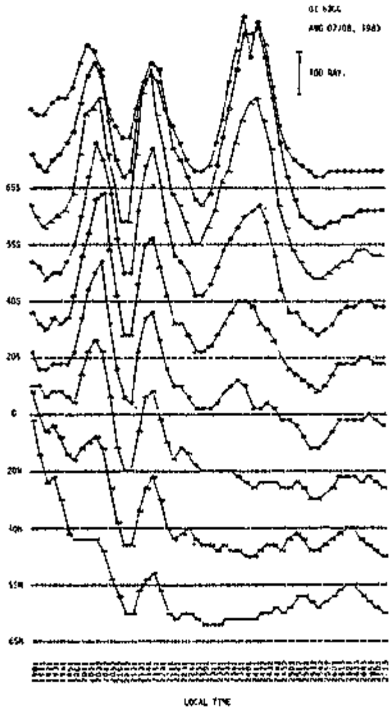

Fig. 8

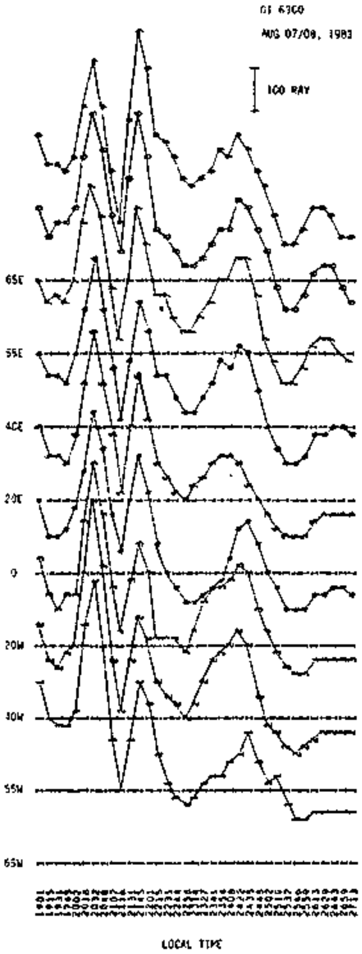

Fig. 9

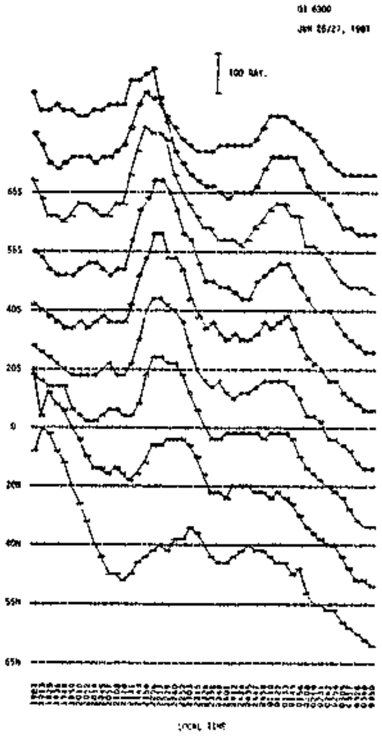

Fig. 10

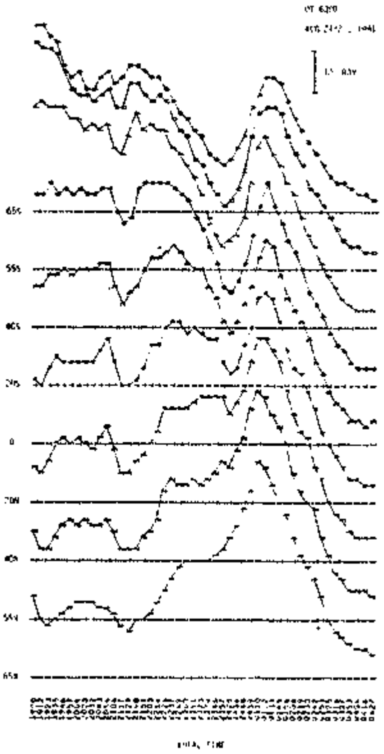

Fig. 11