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16. Summary/Notes

Meridional profiles of OI 6300 Å nightglow emission measured using a scanning photometer over Cachoeira Paulista, a low latitude station, often show propagating patches of airglow disturbances with North to South and West to East velocity components, occurring mostly in the premidnight period. 132 measurements carried out during a period of 26 months since January 1978, show significant seasonal seasonal dependence in the occurrence of these disturbances, with most of the event occurring in the spring - summer months and with very rare occurrence during the winter solstice. The North to South propagation velocities lie in the range of 150 to 350 m/s. A case by case comparison of the occurrences of these airglow disturbances with simultaneous ionograms over Cachoeira Paulista show that almost the totality of these disturbances are accompanied by strong range type echoes in the ionograms and vice versa. These results therefore support our earlier contention that these types of airglow disturbances might be manifestations of the equatorial ionospheric plasma bubbles.

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ASSOCIATION BETWEEN PLASMA BUBBLE IRREGULARITIES AND AIRGLOW DISTURBANCES OVER BRAZILIAN LOW LATITUDES

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Abstract. Meridional profiles of OI 6300 Å nightglow emission measured using a scanning photometer over Cachoeira Paulista, a low latitude station, often show propagating patches of airglow disturbances with North to South and West to East velocity components, occurring mostly in the premidnight period. 132 measurements carried out during a period of 26 months since January 1978, show significant seasonal dependence in the occurrence of these disturbances, with most of the events occurring in the spring - summer months and with very rare occurrence during the winter solstice. The North to South propagation velocities lie in the range of 150 to 350 m/s. A case by case comparison of the occurrences of these airglow disturbances with simultaneous ionograms over Cachoeira Paulista show that almost the totality of these disturbances are accompanied by strong range type echoes in the ionograms and vice versa. These results therefore support our earlier contention that these types of airglow disturbances might be manifestations of the equatorial ionospheric plasma bubbles.

Introduction

The ionosphere dynamics over Cachoeira Paulista (22° 41'S, 45° 00W), a low latitude station, is studied by observing the propagation of OI 6300 Å airglow disturbances using a scanning photometer. Studies of the ionosphere dynamics in the vast Brazilian equatorial and low latitude regions have been very rare.

The 6300 Å photometer has its photomultiplier tube (PMT) oriented horizontally, looking at a mirror placed at 45° with respect to the axis of the PMT, such that the scanning of the sky within a zenith angle range of ± 75° and with a period of 4.5 minutes, was accomplished by suitably rotating the mirror. A tilting interference filter was used in such a way that during one way scan of the sky the pass band was centered around λ = 6300 Å and during the return

sweep, a second tilt position, that allowed a passband centered a few Angstrom away from 6300 Å, provided the background level. The filter bandwidth was about 3 Å and the photometer receiving angle was about 5°.

An ionosonde was operated in the immediate vicinity of the photometer and ionograms were taken at 15 minutes interval.

Results and Discussion

Regular observation of the red line nightglow disturbances in the magnetic meridional plane has been carried out over Cachoeira Paulista, for 26 months, from January 1978 till March 1980. An often observed feature of the meridional profile of the airglow intensity is the propagating disturbances superimposed on otherwise rather slowly varying spatial gradients. An example is presented in Figure 1. Airglow disturbances are clearly seen propagating from North to South. They usually occur in the premidnight period having onset times around 2130 LT. Their occurrence, in the post midnight hours, is very rare. Simultaneous measurements carried out by ionosonde and riometer, on some occasions, have shown that these N → S disturbances are caused by corresponding disturbances in the electron density rather than the height changes of the F-region (Sobral et al, 1980). The North to South velocity component of these disturbances have been estimated for many cases and are found to lie between 150 to 350 m/s. More recently, simultaneous scanning measurements in the magnetic E-W plane were also started and the results have revealed that these disturbances have a velocity component also from West to East.

The occurrence statistics of these nightglow disturbances (ND's) during the 26 months of observation is presented in Figure 2 in the form of histogram, so as to show up the seasonal behaviour during an year. It is interesting to note that these ND's are occurring mainly during spring and summer months, namely, during a 6 month period extending from September till March. During the remaining 6 months centered around winter solstice, the occurrence is very rare indeed, considering the fact that the number of observable nights were much more numerous during this period than during the other half of the year.

The seasonal variations in the occurrence rate of the ND's shown here resemble closely those of the range type spread F occurrence at the magnetic equatorial station Fortaleza (3°S). Equatorial

type spread F is frequently observed also over Cachoeira Paulista, and hence a case by case study of all the observed nights was carried out to verify possible association between the occurrence of the ND's and Spread F over Cachoeira Paulista. Figure 3 shows the statistics of their simultaneous occurrence rates. It is seen that all the cases of ND's observed during this period were accompanied by Spread F and vice versa (with only one exception). Thus, the association between the Airglow N-S propagating disturbances and the spread F in the premidnight hours seems to be confirmed from our present set of observations. We may point out that in the postmidnight period, spread F (mostly of frequency type) has been observed without ND's.

We interpret these ND's as manifestations of the plasma irregularites in the equatorial ionosphere. The eastward velocity component observed by us agrees eith the radar observations of the spread F irregularities over Jicamarca, reported by Woodman and La Hoz (1976). The plasma bubbles, in which these irregularities are present, also move upward as the radar and satellite results have shown (see for example, Woodman and La Hoz 1976, McClure et al 1977, Tsunoda, 1979) and they are also field aligned (Heron and Dorling, 1979). Thus, the poleward velocity component of the ND's observed over Cachoeira Paulista could be resulting from the vertical motion of the field aligned plasma bubbles over the magnetic equator.

Another possible source of the disturbances could be thought of as the medium scale TID's produced by cumulus convection in the rain forest region in the Amazon, located northeast of Cachoeira Paulista, as has been suggested by Röttger (1977) to explain his HF propagation results conducted near Huancayo. However, since the lower atmosphere meteorological processes are unlikely to produce equatorial spread F irregularities, the strong association observed by us of these ND's with the spread F irregularities would support a bubble hyppothesis for the source of the ND's.

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Fig. 1. Meridional profiles of OI 6300 Å nightglow. Each profile represents the latitudinal variation of the nigthglow. The extreme left and right hand points of each curve correspond to the zenith distances of 75°S and 75°N, respectively.

Fig. 2. The dashed and blank parts of the hystogram represent the number of days during which the nightglow disturbances, discussed in the text, were seen and not seen, respectively, during the 26 months period of observations at Cachoeira Paulista. It is clear, in this figure, that the nightglow disturbances occur practically during spring and summer months only.

Fig. 3. Simultaneous occurrences or otherwise of North to South propagating disturbances (NS) and the range type spread in the ionograms (SF). Cases a and b are those in which the nightglow disturbances were observed and spread F was present and not present, respectively. Cases c and d are those in which the nightglow disturbances were not observed and spread F was not present and present, respectively.

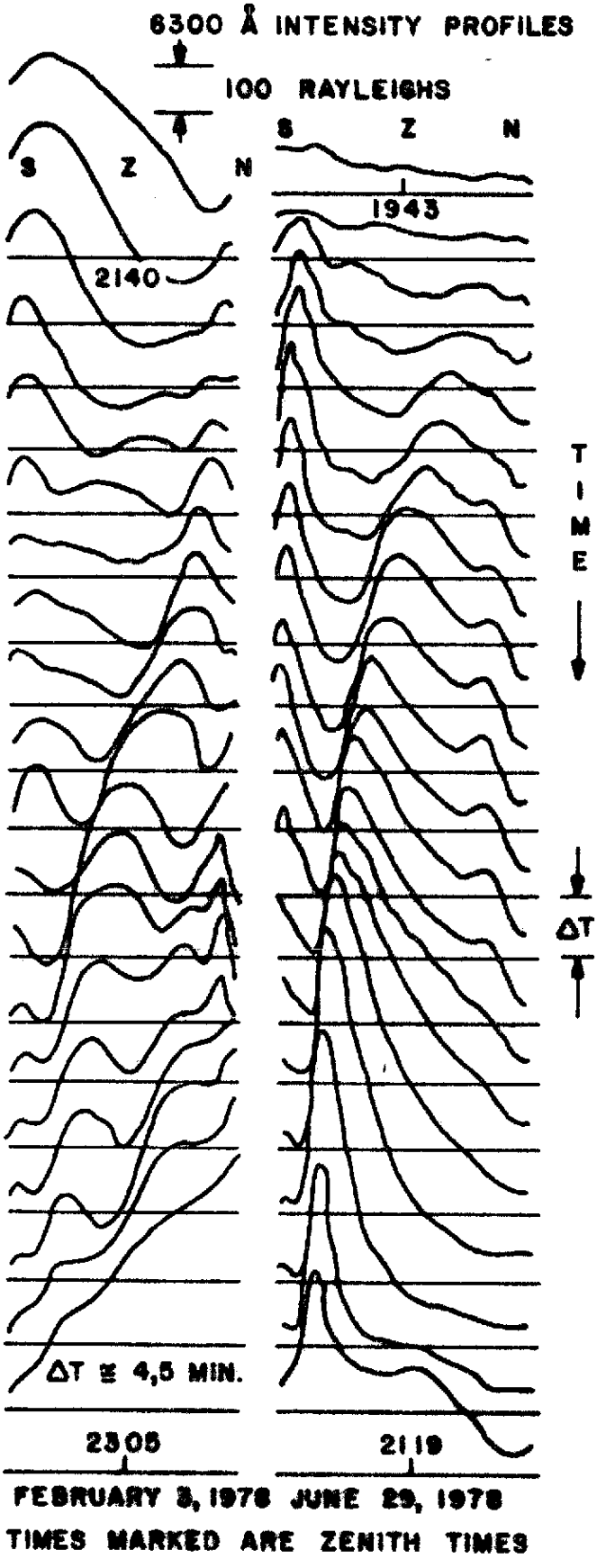
6300 Å INTENSITY PROFILES
100 RAYLEIGHS
S Z N
S Z N
2140
1943
TIME
ΔT
ΔT ≅ 4,5 MIN.
2305
2119
FEBRUARY 3, 1978 JUNE 29, 1978
TIMES MARKED ARE ZENITH TIMES

Fig. 1

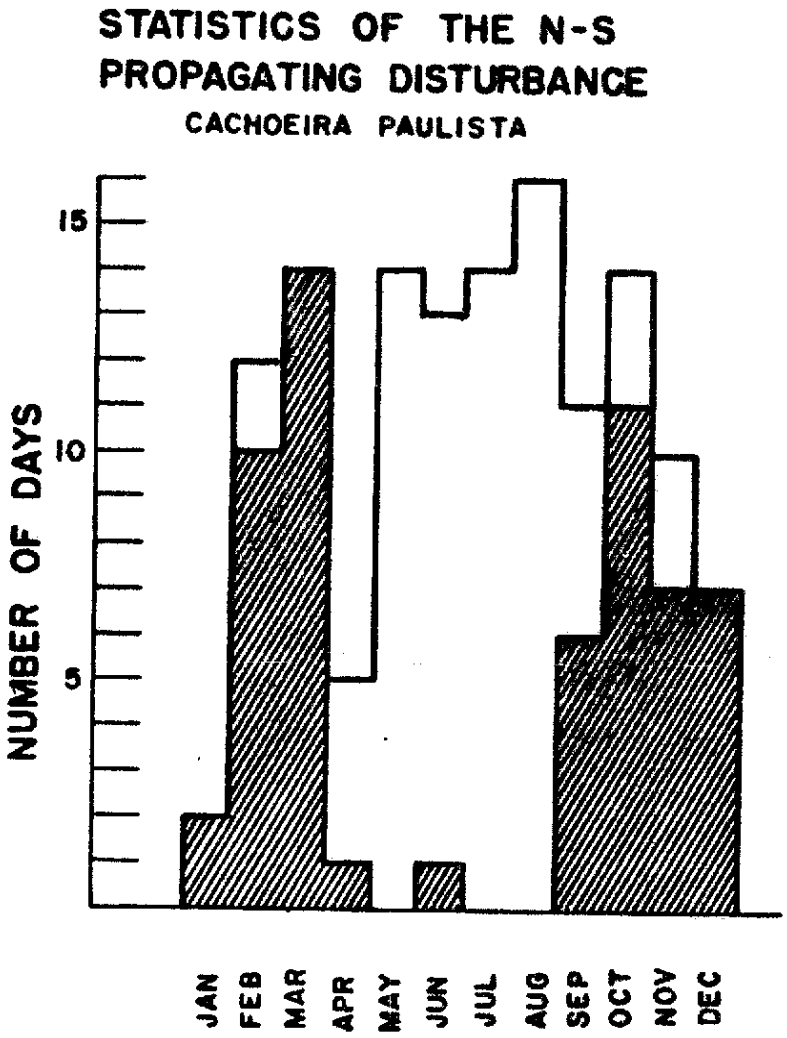
STATISTICS OF THE N-S
PROPAGATING DISTURBANCE
CACHOEIRA PAULISTA
NUMBER OF DAYS
15
10
5
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

Fig. 2

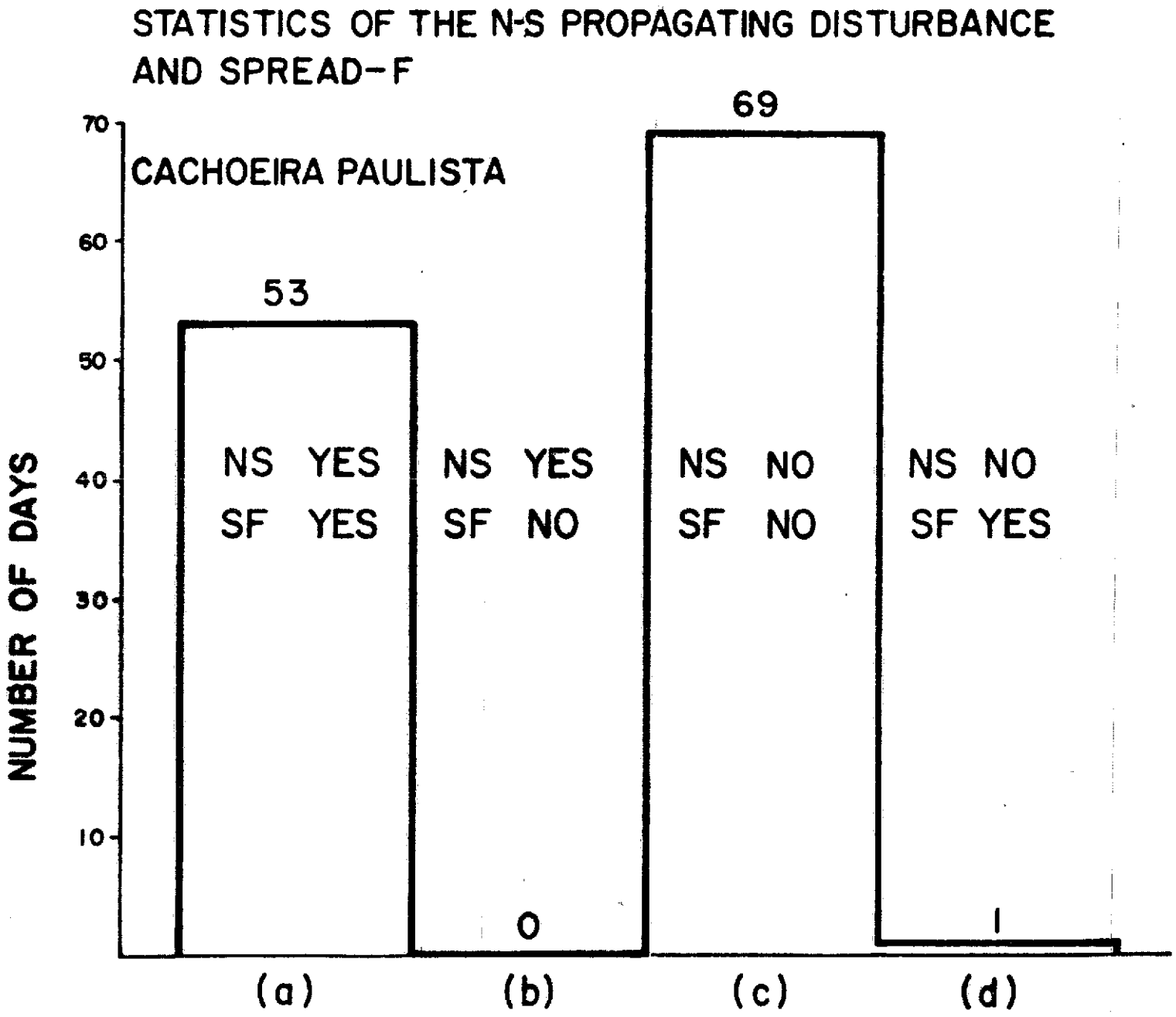
STATISTICS OF THE N-S PROPAGATING DISTURBANCE AND SPREAD-F
CACHOEIRA PAULISTA
NUMBER OF DAYS
70
60
50
40
30
20
10
53
69
0
1
NS YES
SF YES
NS YES
SF NO
NS NO
SF NO
NS NO
SF YES
(a)
(b)
(c)
(d)

Fig. 3