SOME EFFECTS OF GEOMAGNETIC ACTIVITY ON THE F2 REGION OF THE IONOSPHERE OVER LEOPOLDVILLE (4·4° S, 15·3° E)

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The solar diurnal variation of the critical frequency of the F2 layer, foF2, has been shown by Rastogi (1959) to be very different at stations having the same geomagnetic, but different magnetic latitudes. The value of foF2 at Ibadan (geomagnetic latitude = 10° N) reaches two maxima in the morning and in the evening hours during the years of low solar activity, a feature characteristic of the equatorial stations. However, at Leopoldville, the diurnal variation of foF2 shows a single afternoon peak, a feature characteristic of temperate latitude stations (Rastogi, 1960). These features of foF2 at Ibadan and Leopoldville are consistent with the magnetic latitudes of the stations being 2·5° S and 19° S respectively.

In a later communication, Rastogi (1961) showed that the lunar semi-diurnal variation of midday foF2 at Leopoldville has maximum positive deviation at about 11 lunar hours whereas the same at Ibadan is found by Brown (1956) to occur at about 03 lunar hours. It was shown that a similar type of lunar semi-diurnal variation of foF2 is observed at stations having the same magnetic latitudes.

In view of the large differences in the solar and lunar variations of foF2 at Ibadan and Leopoldville, a comparison is made in this paper of the effect of geomagnetic disturbances in the F2 region of the ionosphere at the two stations.

Martyn (1953) has shown that the disturbance daily variation (difference between the diurnal variations on the magnetically disturbed and quiet days) of the foF2 and the minimum virtual height, h′F2, of the F2 layer depends upon the latitude of the station. There is a general tendency of the electron density to be raised at low latitudes but to be decreased at higher latitudes.

Skinner and Wright (1955) have examined in detail the differences between the magnetically quiet and disturbed day variations of the maximum electron density, NmF2 $\propto$ (foF2)^2, minimum virtual height, h′F2, the height of maximum ionization (hmF2) in the F2 layer at Ibadan during the year 1952. Following their criterion, the days are taken as magnetically quiet or magnetically disturbed according to the daily sum of geomagnetic planetary three-hour range indices, *i.e.*, $\Sigma K_p \leqslant 15$ or $\Sigma K_p \geqslant 31$ respectively. The average values of the ionospheric characteristics at Leopoldville for such classified groups of magnetically quiet and disturbed days are evaluated separately. The virtual height of the F2 layer at a frequency equal to 0·834 times foF2, designated by hpF2, is taken as the height of maximum ionization in the F2 layer at Leopoldville. The hpF2 is known to be very close to the hmF2 values derived by Appleton and Beynon's method (1940).

Figure 1 shows the whole year average diurnal variation of NmF2, h′F2 and hmF2 or hpF2 on the magnetically quiet and disturbed days at Ibadan and Leopoldville. The curves for Ibadan are those given by Skinner and Wright (1955). The values of NmF2 at Ibadan are distinctly greater during the disturbed than during the quiet days. But there is no significant difference between the quiet and disturbed day values of NmF2 at Leopoldville. The values of h′F2 for the daylight hours at Ibadan are decreased during the disturbed days, but there is only a slight tendency of the same at Leopoldville for a few hours around noon. The values of hmF2 at Ibadan are greater on quiet than on disturbed days for the forenoon hours, but it is otherwise for the afternoon hours. At Leopoldville, there is a tendency for the hpF2 variation to be opposite to the variation of hmF2 at Ibadan. The disturbed day values of hpF2 at Leopoldville are greater than the corresponding quiet day values for the forenoon hours, but are less during the afternoon hours.

The very little difference between the quiet and disturbed day values of NmF2 at Leopoldville could be due either to the fact that the magnetic disturbance has little effect on NmF2 at all seasons, or it may have large but opposite effects in the different seasons. Therefore, the variations of these parameters at Leopoldville are evaluated separately for the northern and southern solsticial months and are shown in Fig. 2.

One finds large differences between the quiet and disturbed day values of NmF2 during either of the seasons. The electron density, NmF2, for any hour of the day is greater on the disturbed than on the quiet days during the northern solsticial months (local winter). But, during the southern solsticial months (local summer), the values of NmF2 are much smaller on the disturbed than on the quiet days. This effect at Leopoldville is similar to that at Canberra and Watheroo as found by Martyn (1953), *i.e.*, during the magnetically disturbed days the mean values of foF2 are depressed in summer months and are slightly raised in winter months. The disturbance daily variation of foF2 at Leopoldville (geomagnetic latitude $\phi = 3 \cdot 1°$ S, magnetic latitude $\mu = 18°$ S) thus resembles the same at Watheroo ($\phi = 41 \cdot 7°$ S, $\mu = 47°$ S) and Canberra ($\phi = 43 \cdot 8°$ S, $\mu = 47°$ S), but is very different from

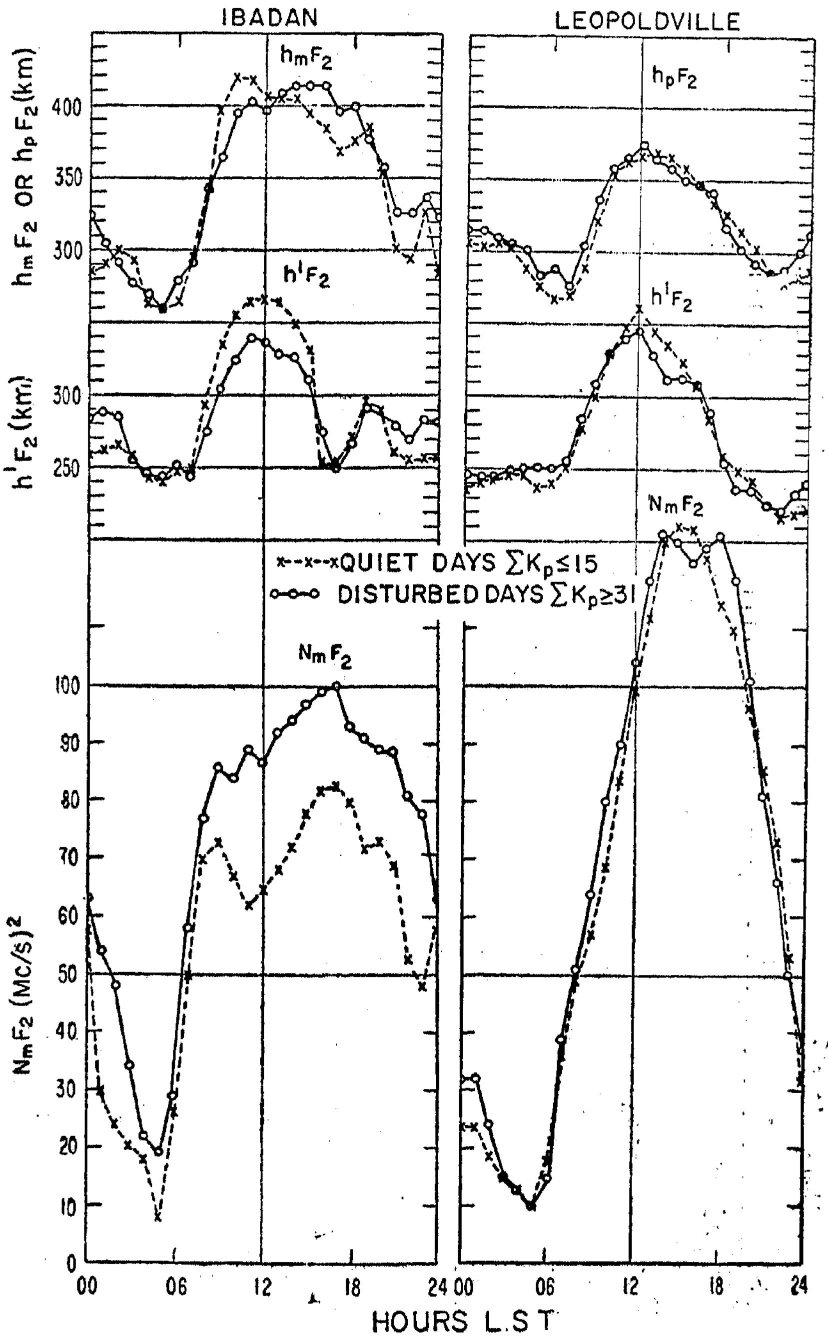

FIG. 1. The quiet and disturbed day variations of the maximum electron density (NmF2), the minimum virtual height (h′F2) and the height of the maximum ionization (hmF2 or hpF2) of the F2 layer at Ibadan and Leopoldville for the year 1952.

that of Ibadan ($\phi = 10 \cdot 6°$ N, $\mu = 2 \cdot 5°$ S). This shows the consistency of the results grouped on the basis of magnetic latitudes.

The effect of magnetic storms on the F2 layer can also be described by the storm time (Dst) variation of foF2. This is generally expressed as the variation of 200 ($\tilde{f}$oF2-$\tilde{f}$oF2)/foF2 with the time since the commencement of the storm, where foF2 is the value during the hours following the storm and $\tilde{f}$oF2 is the monthly median value corresponding to the same local time.

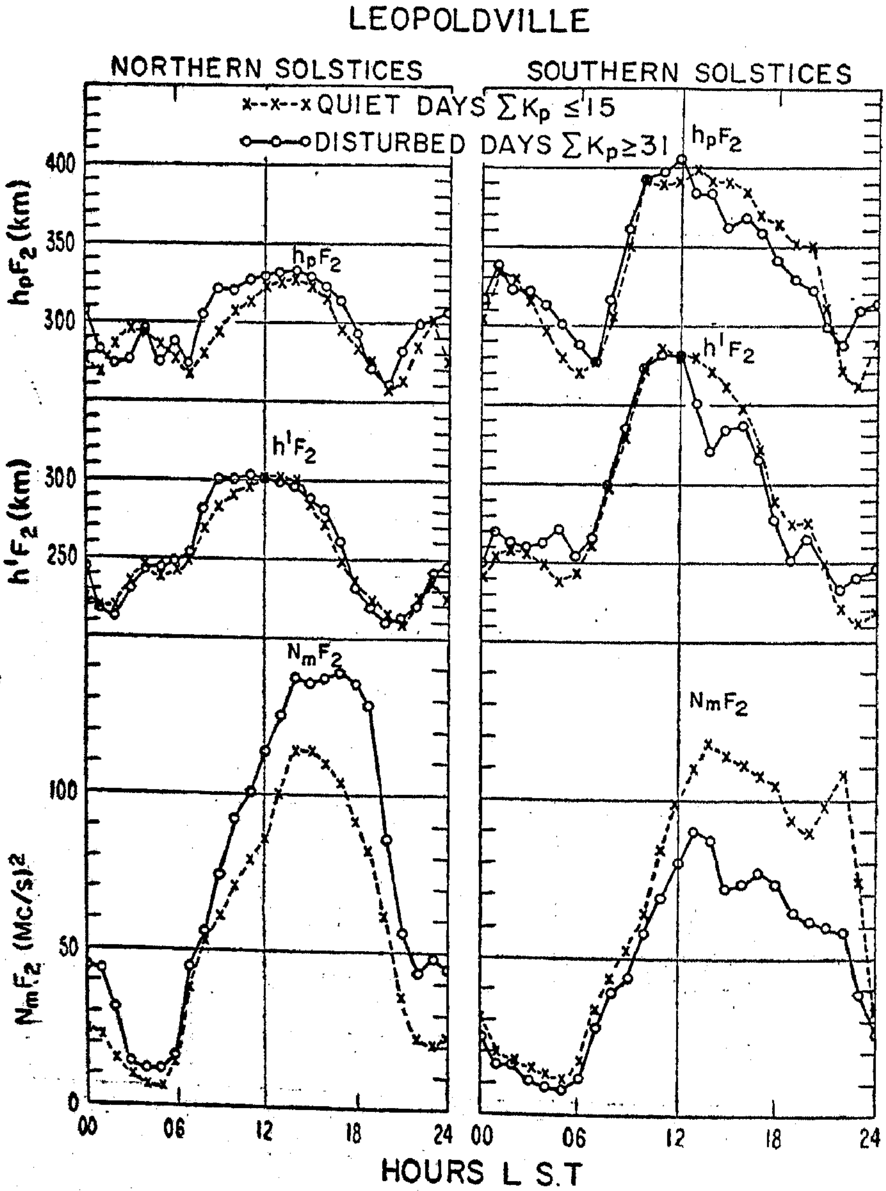

FIG. 2. The quiet and disturbed days variations of maximum electron density (NmF2), the minimum virtual height (h'F2) and the height of the maximum ionization (hpF2) of the F2 layer over Leopoldville during the northern and southern solsticial months of 1952.

This quantity approximately equals the percentage variation of the maximum electron density, NmF2, in the F2 layer. Matsushita (1959) has studied the Dst variation of foF2 at a large number of stations, which were grouped into different zones according to the geomagnetic latitude of the stations. It was stated that the Dst variations at individual stations within zones so defined were very similar to each other. At the equatorial zone within geomagnetic latitudes $\pm 10°$, the magnetic storm is followed by a short decrease and later by an increase reaching a maximum at about $1\frac{1}{2}$ days after the commencement of the storm. At higher latitudes, the magnetic storm causes an initial short increase of foF2 followed by a large decrease with a maximum at about $1\frac{1}{2}$ days after the commencement of the storm.

In Fig. 3 are shown the storm time variations of foF2 at Ibadan and Leopoldville averaged for 19 strong sudden commencement type magnetic storms (maximum $A_p \geqslant 50$) during the period 1952–1956. The Dst variation

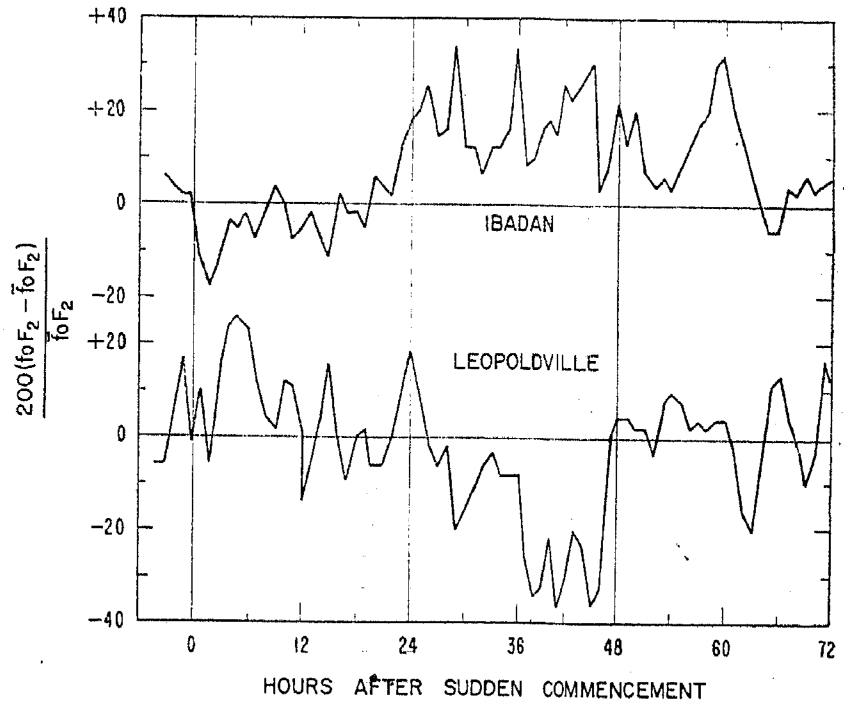

FIG. 3. The averaged percentage variation of the maximum electron density in the F2 layer at Ibadan and Leopoldville at hours following sudden commencement of magnetic storm during 1952–56.

of foF2 at Ibadan consists of a small decrease during the first day and large and consistent increases during the second day of the storm. Contrary to this, the Dst variation of foF2 at Leopoldville consists of a short increase during the first day followed by large decreases, with the minimum at about

40 hours after the commencement of the storm. The curves for the two stations are distinctly opposite in nature. The variation at Ibadan is of the equatorial type. However, the variation at Leopoldville is of the high latitude type.

It is concluded that the effect of geomagnetic activity on the variations of the F2 layer ionization at low latitudes is determined by the magnetic and not by the geomagnetic latitude of the station.

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