Effects of the penetration of magnetospheric convection electric field at equator on ionospheric parameters

M. N. MENE [1], A. T. KOBEA [2], O. K. OBROU [3] and K. Z. ZAKA[4]

[1] Laboratoire de Physique de l'Atmosphère, Université de Cocody, 22 BP 582 Abidjan 22, COTE D'IVOIRE, medardmene@yahoo.fr

[2, 3,4] Laboratoire de Physique de l'Atmosphère, Université de Cocody, 22 BP 582 Abidjan 22, COTE D'IVOIRE,

Abstract

The penetration of magnetospheric electric field at equator influences the ionospheric parameters. To investigate the effects of this penetration on the F2-layer peak height (hmF2) and the total electron content (TEC), we study the variations of those parameters during the magnetic storm of 17 February 1993, using ionosonde data of an equatorial station. We have an increase and a decrease of the hmF2 at equator respectively during the prompt penetration and overshielding events. Few minutes after the prompt penetration and the overshielding we have respectively high and low TEC values compared to those of a quiet day.

1. Introduction

The geomagnetic disturbances observed nearly simultaneously over the globe are often attributed to the magnetospheric electric fields and currents that connect to the high-latitude ionosphere and penetrate through the middle- and low-latitude ionosphere all the way to the equator [1]. The penetration of magnetospheric electric field at the equator influences the equatorial ionosphere. For the equatorial stations, the rate of change of the F2-layer peak height generally indicates electric field perturbation [2]. In general, low-latitude auroral events are associated with severe ionospheric disturbances [3, 4]. The dynamic behavior of the equatorial ionosphere parameters can provide further evidence of the penetration of convection electric field at low-latitude. To have a good understanding of the behavior the hmF2 and the TEC during magnetic disturbances days , we are investigated the effects of zonal electric field perturbations of magnetospheric origin on the variations of those parameters during the magnetic storm of 17 February compared with that of quiet day (15 February).
In section 2, we present the data used and the method of analysis. The section 3 presents the magnetic field variations of 17 February 1993. The related ionospheric parameters analyses at equatorial latitude are presented in section 4. This paper is ended by a conclusion in section 5.

2. Data used and the method of analysis

To investigate the hmF2 and TEC variations we are used the ionosonde data recorded at Korhogo (Latitude + 9.3; Longitude – 5.4; Dip -0.67). The penetration of magnetospheric convection electric field at equator is characterized by its magnetic effects. The coordinates of ground-based magnetometers used are related in table 1. The penetration events are generally observed during the main phase of the magnetic storm. During this period, the important magnetic effects of currents are the electric current systems generated by the penetration of

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magnetospheric convection electric field at equator (DP), the equatorial electrojet effect (S_R), the ring current effect D_R. The geomagnetic H-component can be express as follows [5].

$$H = S_R\ D_R + DP \quad (1)$$

The ring current (D_R) in the magnetosphere is evaluated by the following equation derived from Dst index which gives a good approximation of the symmetric ring current:

$$D_R = Dst^*cos(L) \quad (2)$$

Where L is the geomagnetic latitude of the station.

We may infer the magnetic disturbance DP as follows:

$$DP = H - Dst^*cos(L) - S_R \quad (3)$$

The positive increasing and negative decreasing of DP from high latitude to low latitude characterize respectively the prompt penetration and the overshielding events [6].

3. The magnetic field variations of 17 February 1993.

Figure 1a shows the equatorial Dst time variation of the 17 February 1993. An initial phase of the storm started at 0200 TU that reached +40 nT as peak amplitude at 0600 TU. This period is followed by the main phase characterize by the decrease in Dst that peaked at value of -110 nT at 1500 TU. This storm ends by the recovery phase that takes many hours.

Figure 1b-g present the DP variations from high latitude to equator. At all latitudes, appreciable positive bay and negative bay are clearly detected respectively at those time interval [0815; 0930] and [0930; 1215] TU. Those DP variations are the magnetic signature of the prompt penetration (positive bay) and the overshielding event (negative bay) [6].

4. Effects of the penetration of magnetospheric convection electric field at equator on ionospheric parameters

4.1. Effects of the penetration on the hmF2

Figure 2a presents the DP variation at Niellé (dip-equator). The vertical dotted lines indicate the start of the prompt penetration and the overshielding. Figure 2b shows the time variations of hmF2 at Korhogo on 17 February 1993 overlaid in dotted line by those of the reference quiet day (15 February 1993).

During the prompt penetration of magnetospheric convection electric field at equator, we observe the increasing rate of the hmF2 is high compared to that of the quiet day. During the oversielding event, we have a decreasing of the hmF2 while that of quiet day presents an increasing during this period.

This time coincidence of events shows that the disturbances observed on the hmF2 variation are the effects of the penetration of magnetospheric convection electric field at equator.

4.2. Effects of the penetration on the TEC

Figure 3a is the DP variation at Niellé. Figure 3b presents the time variations of the TEC at Korhogo on the 17 February 1993 and that of the reference quiet day, 15 February 1993 (dotted line). After the start of prompt

penetration, the TEC takes high values than those of the quiet day. After the overshielding we observe a decreasing of TEC values when the TEC of the quiet day presents an increasing. We note that the disturbances of the TEC are observed few minutes after the start of the penetration phenomena.
Those TEC disturbances are occurring during the penetration of magnetospheric electric field at equator. Therefore, they are the effects of this penetration on the TEC.

5. Conclusion

The equatorial ionosphere is influenced by the penetration of magnetospheric convection electric field at equator. The effects of this penetration on the hmF2 are an increasing and decreasing of this parameter respectively during the prompt penetration and the overshielding. Few minutes after the prompt penetration and the overshielding we have respectively high and low TEC values compared to those of a quiet day. The results of this study can be use to introduce the IRI (International Reference Ionosphere) model in the forecasting of ionospheric parameters during magnetically disturbance days.

Reference

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Table 1: Locations of magnetic stations

Code	Name	Geographiccoordinates.		Magneticcoordinates		LT
		Latitude	Longitude	Latitude	Longitude	
ABK	Abisko	68.36	18.82	66.06	114.66	TU+1
LOV	Lovo	59.34	17.82	62.37	106.36	TU+1
FUR	Furstenfelbruck	48.17	11.28	48.40	94.61	TU+0
TAM	Tamanrasset	22.79	5,53	24.66	80.31	TU+1
MOP	Mopti	14.51	-04.09	03.85	69.90	TU+0
NIE	Niellé	10.20	-05.64	-00.89	67.88	TU+0

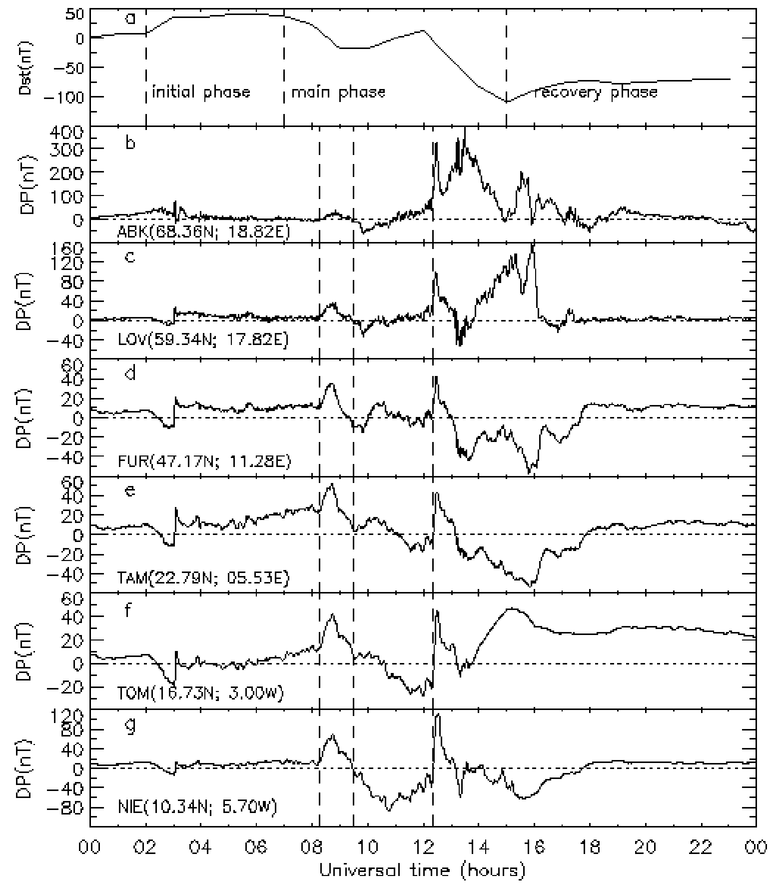

Figure 1: Variations of the Dst index (a) and the geomagnetic H-component disturbance (DP) from high to low latitude (b-g) on 17 February 1993.

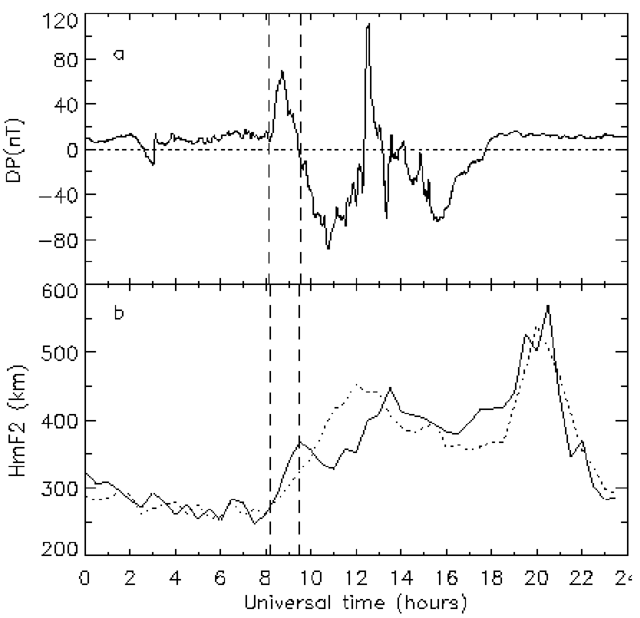

Figure 2: variations of DP at Niellé (dip-equator) and the hmF2 at Korhogo on the 17 February 1993 overlaid in dotted line by those of the reference quiet day (15 February 1993).

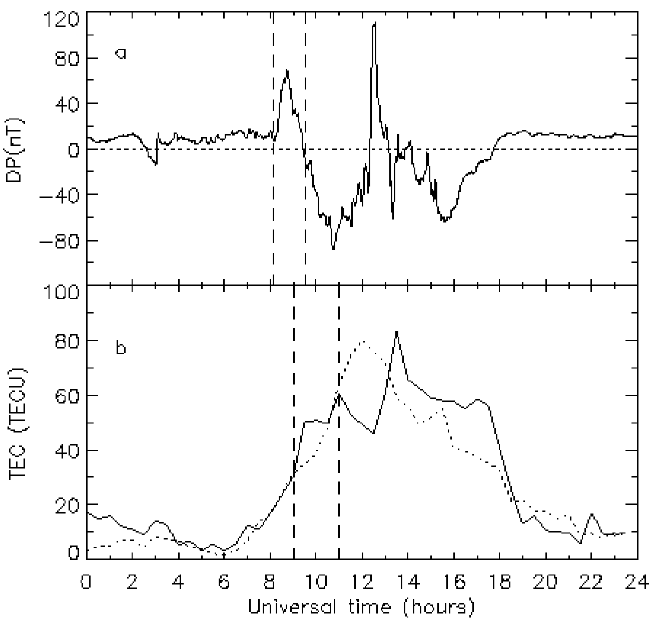

Figure 3: variations of DP at Niellé (dip-equator) and the TEC at Korhogo on the 17 February 1993 overlaid in dotted line by those of the reference quiet day (15 February 1993).