Characterization of the direct penetration of magnetospheric electric field convection at the equator

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September 8, 2005

Abstract

Ionosonde data and magnetic field recorded at Korhogo (9,34^0 N; 5,43^0 O; Dip -0.67^0) are used to characterize the disturbances observed in the equatorial region as result of the mechanism of direct penetration of magnetospheric electric convection from high to low latitude during the magnetic storms of November 3rd and 18th, 1993. The H component of the magnetic field for the disturbed day is compared to the quietest day used as reference. The variation of the H component of magnetic field during the disturbed day shows a negative deflection which lasts approximately 3 hours (1600-1900) and represents a westward disturbance of the zonal electric field. This corresponds to the inversion of the equatorial electrojet current during a time period of 3 hours attesting the direct penetration of the magnetospheric electric field from high latitudes towards the magnetic equator. During that event, we observe an increase of the F2 region electron density at equatorial latitudes as a response of an inversion of the vertical drift that is downward for time interval (1600-1900).

1 Introduction

The remarkable variations of the terrestrial magnetic field and the electrodynamic parameters on a planetary scale during the magnetic storms are due to the magnetospheric disturbances which are connected to the ionosphere at high latitudes. These disturbances influenced electric fields and currents at mid and low latitudes; following two main processes which are the direct penetration of magnetospheric electric convection [2] and the disturbed dynamo [3]. The magnetospheric electric convection which penetrates the mid and low latitudes is associated with variations of the interplanetary magnetic field B [5], intensification of the auroral electrojet [6] and variations of the equatorial Dst index [1]. We selected cases of direct penetration of magnetospheric convection during two periods of storm on the basis of Dst index and auroral electrojet data analysis, and characterize their influence on the equatorial electrojet and ionospheric parameters at Korhogo (9,34^0 N; 5,43^0 O; Dip -0.67^0) a station next to the magnetic equator.

2 Data used and method of analysis

The DCF and DT index, respectively the Chapman Ferro Current and the magnetic tail current are used to investigate the disturbance generated by various magnetospheric current. The AU and AL index used are recorded at hihg latitude. The H component of the magnetic field is used to estimate the equatorial electrojet current. The ionograms are inverted with the NHPC code

Days	$\sum Kp$	Remark
November, 3 1993	15^-	Quiet day
November, 4 1993	47	Disturbed day
November, 5 1993	35^-	Disturbed day
November, 12 1993	7^-	Reference quiet day
November, 17 1993	10	Quiet day
November, 18 1993	27^-	Disturbed day
November, 19 1993	32^-	Disturbed Day

Table 1: The geophysical context of the cases studied

[7] to compute the ionospheric parameters $foF2$, $NmF2$. For each period of storm studied, the equatorial effect of the DP current due to the magnetospheric convection is estimated by the following equation

$$DP = H - Dst\cos(L) - S_R \tag{1}$$

where L represents the geomagnetic latitude of the station and S_R the daily magnetic quiet variation of the H component. The disturbances are evaluated by comparison with a reference magnetic quiet day [4]. We have selected two storm periods N1 (From November, 3^{rd} to 5^{th}) and N2 (from November, 17^{th} to 19^{th}). November 12^{th} is used as the reference day. The geophysical context is presented in table 1

3 Results

Figure 1 a - f show the diurnal variation of the Dst, AU, AL, DP index and the H component. The letters A, B and C on each plot indicate the commencement of the compression phase, the main phase and the recovery phase of the storms. The diurnal variation of AU and AL, indicate that no auroral electrojets are observed during the compression phase. The auroral activity begins and intensifies during the main phase. Figure 1 e - f compare the diurnal variation of the H component with the reference day. The plots in dash line are the reference day, while the plots in continous line present the actual value of H for N1 and N2 periods. During the compression phase of the storms an amplification of the H component is observed. A negative deflection occures between 2300 on November 3^{rd} and 0330 the next day for N1 period during the main phase. The same situation is observed for N2 between 1600 and 0400 from November 18^{th} to 19^{th}. Figure 1 g shows the diurnal variation of DP on November 3^{th} and 18^{th}. Figure 1h - i compare NmF2 and hmF2 of November 18^{th} with the reference day. The westward auroral electrojet is more intense than the eastward auroral electrojet

4 Discussion and Conclusion

During the storms, the H component has a very particular morphology different from the regular variation $S_R(H)$ of the quiet days. This denotes the existence of an other currents that suppose th quiet day ionospheric currents variations. During the compression phase of the storms, there is no auroral electrojet thus no penetration of the magnetospheric electric field convection . The amplification of H component is probably due to the effects of DCF and DT currents which superposes the permanent ionospheric currents. DCF and DT currents result from the dynamic pressure of the solar wind which is more intense during the compression phase. During the main phase, the negative deflection observed during the time intervall 1600-2000, corresponds to an inversion of the equatorial electrojet current which is westward. We also observe the circulation of intense auroral electrojets which attests of penetration of the magnetospheric electric field convection electric field in the auroral ionosphere. The DP current due to the magnetospheric convection could be at the origin of the inversion of equatorial electrojet current. Also a direct influence of DR and DT currents is prevalent during this phase of the storm. An influence of DP current at the equator is observed on November 18^{th} between 1600 and 1800 during the

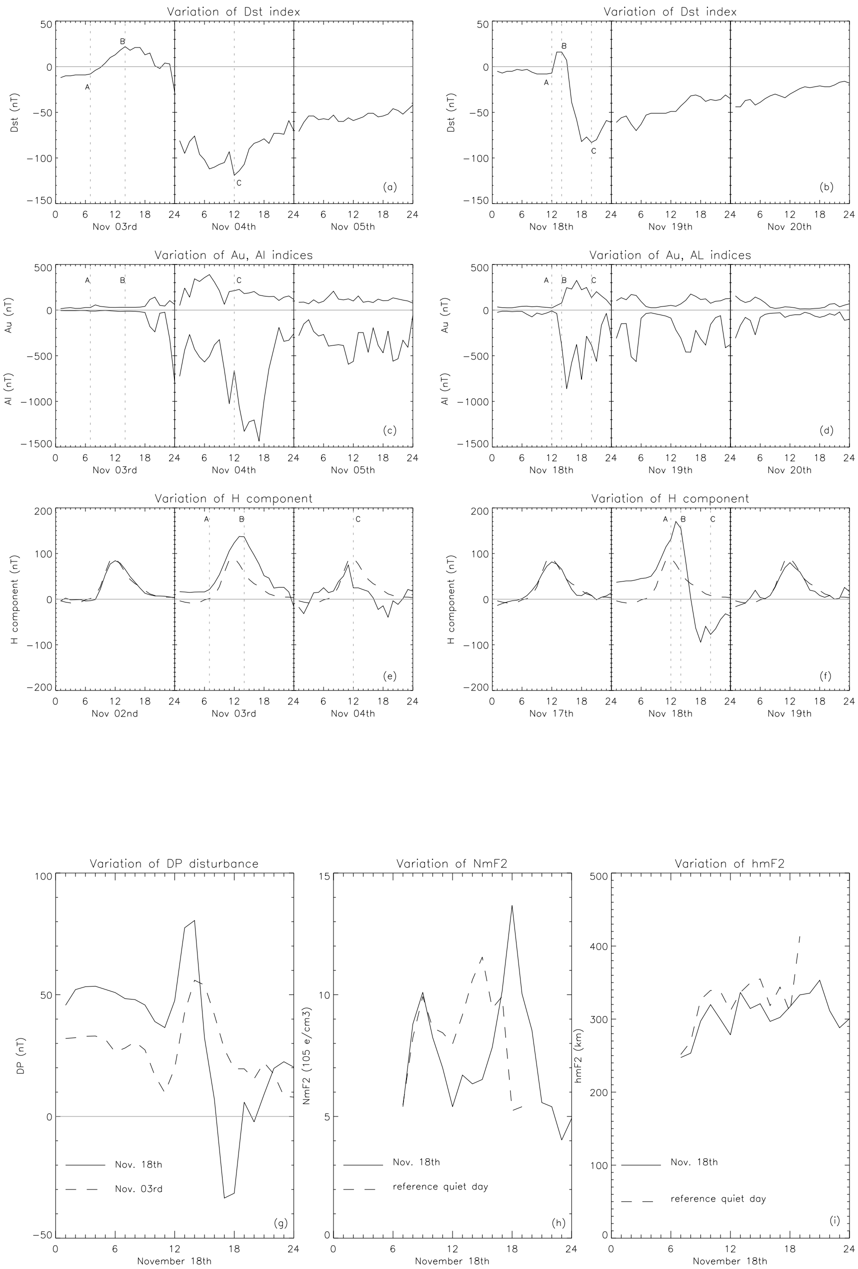

Figure 1: Diurnal variations of Dst (a-b) ;AU, AL (c-d); H (e-f); DP(g); NmF2(h), hmF2(i) the storms N1 and N2

main phase characterized by the negative deflection. The effect of this current is not observed at the equator for N1. In this time interval , we note the circulation of an intense westward auroral electrojet; which confirms the transmission of the electric field convection from the poles towards the equator during approximately 3 hours (1600 1900). From 1600 to 1900 local time, the influence of the direct penetration of the magnetospheric convection involves an increase of the F2 layer's electron density compared to that of the reference day (figure 1-h). That is probably due to the manifestation of precipitations of the particles energy in the auroral regions. It's also noted a decreasing of the F2 layer height during the time interval 1800 - 1900, observed on the variation of hmF2 (Figure 1-i). This is explained by the inversion of the vertical drift velocity that turned into downward as a result of the electric field inversion. The variations of the H component of the Earth's magnetic field in the equatorial region for magnetic storm periods allowed to highlight the influence of the electric field due to the magnetospheric convection on equatorial ionospheric electrical fields, currents and electrodynamic parameters. The direct penetration of the magnetospheric convection at the equator generally occurs at the end of the main phase of the storm. It is an event of short duration (approximately 3 hours for cases studied) which is accompanied by a temporal inversion of the equatorial electrojet current and an increase of the F2 layer's electronic density.

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