磁気嵐時の地磁気変動に見られるグローバルな電離圏電場と電流分布について

新堀淳樹 [1], 田中良昌 [5], 辻裕司 [3], 菊池崇 [3], 小山幸伸 [2], 長妻努 [4], 冨川喜弘 [5], 堤雅基 [5]

[1] *京大生存圏研究所*
[2] *京大地磁気センター*
[3] *名大太陽地球環境研究所*
[4] *情報通信機構*
[5] *国立極地研究所*

Global distribution of ionospheric electric fields and currents as seen in geomagnetic field variation during geomagnetic storms

Atsuki Shinbori[1], Yoshimasa Tanaka[5], Yuji Tsuji[3], Takashi Kikuchi[3], Yukinobu Koyama[2], Tsutomu Nagatsuma[3], Yoshihiro Tomikawa[5], Masaki Tsutsumi[5]

[1]*Research Institute for Sustainable Humanosphere (RISH), Kyoto University*
[2]*World Data Center for Geomagnetism, Kyoto University*
[3]*Solar-Terrestrial Environment Laboratory (STEL), Naogya University*
[4]*National Institute of Information and Communications Technology (NICT)*
[5]*National Institute of Polar Research (NIPR)*

It has been well-known that two-cell ionospheric convection in the polar ionosphere driven by a dawn-to-dusk electric field which carries the region-1 (R-1) field-aligned currents (FACs) are significantly intensified and expand to middle-low latitudes during the main phase of geomagnetic storms. The two-cell ionospheric currents produce negative and positive disturbances of the H-component of geomagnetic field in the morning and afternoon sectors of sub-auroral and middle- latitudes, respectively. The geomagnetic field variations are revesed in high latitude above the footprint of R-1 FACs. Moreover, the dawn-to-dusk polar electric field penetrates to the magnetic equator, and cases a significait ehnahcement of the eastward equatorial electrojet current (eEJ) due to the Cowling effect in the daytime sector. During the recovery phase which is caused by the weakness of southward interplanetary magnetic field (IMF) or northward turning of the IMF, the two-cell ionospheric currents in the polar ionosphere are abruptly reduced and the equatorward boundary of auroral electrojet currents (AEJ) move to high latitude. In this case, the geomagnetic field variations at the magnetic equator show a reduction or reversal of the eEJ in the daytime sector associated with an enhancement of the westward equatorial electrojet current (wEJ) component driven by the dusk-to-dawn electric field originating from the R-2 FACs. On the other hand, after the end of a storm, other types of ionospheric electric field are generated due to the dynamo action of storm-related thermospheric winds generated by auroral Joule heating. The ionospheric electric field has been called dysturbance daynamo field. The electric field drives the wEJ near the equatorial region, whose direction is the same as that originating from the R-2 FACs. However, due to the lack of geomagnetic field data in the middle-low latitudes, detailed relationship between the magnetic field variations of high-middle latitudes and at the equator during geomagnetic storms has not been clarified yet. In this paper, we investigated time and spatial evolutions of global geomagnetic field variations from high-latitude to the magnetic equator during several geomagnetic storms, using geomagnetic field data with time resolution of 1 minute obtained from the CARISMA, GIMA, IMAGE, MACCS, and NSWM networks, and provided by WDC geomagnetism in Kyoto.

In the present analysis, we first subtracted 10-day average solar quiet (Sq) daily variaion from the disturbed field during the geomagnetic field for H and D components observed at each station. The 10 quiet days were idenfitied from the list of quiet and disturbed days provided by WDC geomagnetism in Kyoto. As a next step, we excluded the magnetic effects produced by magnetospheric currents (for example, magnetopause and ring currents) by subtracting the low-latitude (10-20 degrees, GMLAT) geomagnetic field variation of the northward component.

The equivalent current system showed that two-cell ionospheric currents are significantly enhanced in the daytime sector together with a strong enhancement of the eEJ at the daytime equator during the main phase of the geomagnetic storm occured on May 23-24, 2002 (Figure 1). The centers of these vortices were located at 70 degrees and 65 degrees in the morning and afternoon sector, respectively. The two-cell ionospheric currents expanded to the low-latitude region of less than 30 degrees (GMLAT). In the nighttime sector of middle-low latitudes, the arrows of the equivalent current were directed in the northward direction. This signature indicates that the nighttime magnetic field signatures are produced by the magnetic effect of the R-1 FACs. On the other hand, during the recovery phase associated with strong northward turning of the IMF, the equivalent current system showed that the two new vortices different from two-cell ionospheric currents driven by the R-1 FACs system appear in the polar cap and middle latitude (Figure 2). The former led to the enhanced NBz current driven by the lobe reconnection due to the strong northward IMF, while the latter was generated by the enhanced R-2 FACs produced by the strongly asymmetric ring current flowing westward in the inner magnetosphere. In this case, the equatorial magnetic field variation showed a strongly negative signature produced by the wEJ current due to the dusk-to-dawn electric field. Therefore, it seems that the enhanced NBz current system plays an important role in the intensification of the dusk-to-dawn electric field from the middle-latitudes to the magnetic equator.

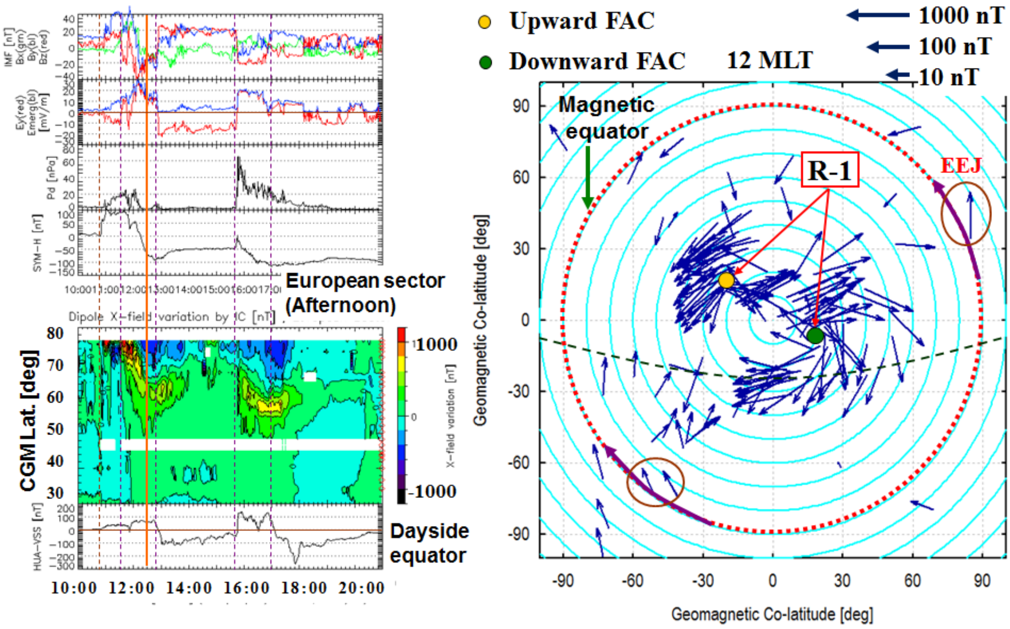

Figure 1. Latitudinal distribution of geomagnetic field variations of the H-component in the Eurpean sector and equivalent ionospheric currents estimated as the geomagnetic field variations on the ground during the main phase of geomagnetic storm occured on May 23-24, 2002. The orange dased line in the left paneld indicates the time of the equivalent currents shown in the right panel.

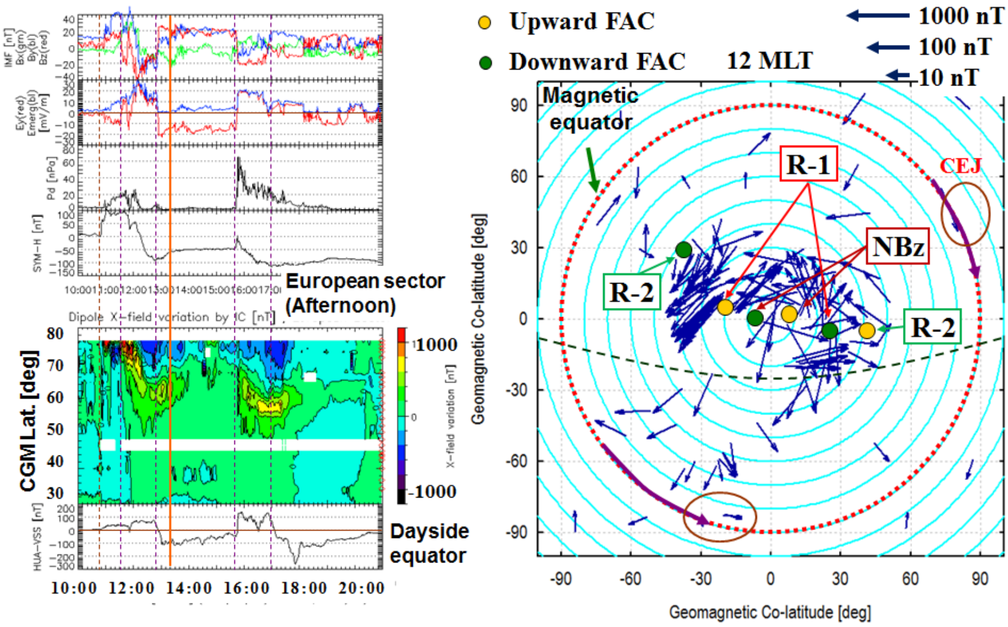

Figure 2. Latitudinal distribution of geomagnetic field variations of the H-component in the Eurpean sector and equivalent ionospheric currents estimated as the geomagnetic field variations on the ground during the recovery phase of geomagnetic storm occured on May 23-24, 2002. The format of this figure is the same as that of Figure 1.