Long-term variations in nightside geomagnetic disturbances at mid-latitudes

S. Nakano[1,2]* and T. Iyemori[3]

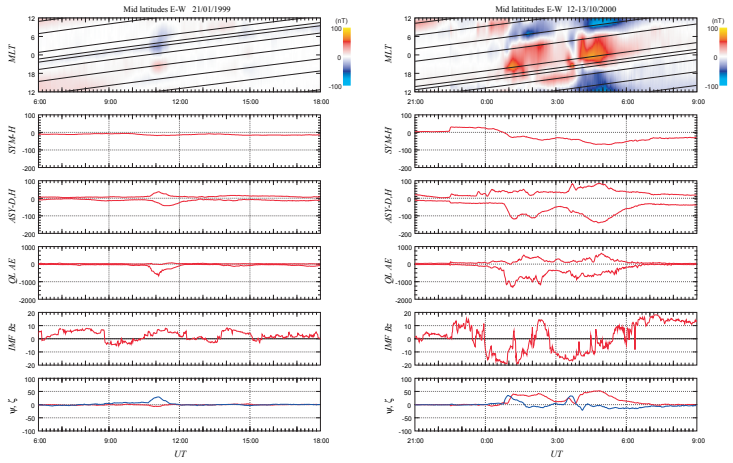
1) The Institute of Statistical Mathematics 2) JST CREST 3) Data Analysis Center for Geomagnetism and Space Magnetism, Kyoto University

* *E-mail*: shiny@ism.ac.jp

Abstract

It has been suggested that auroral electrojets are of two types, and each of them is associated with a different current system: the wedge current system and a current system related with magnetospheric convection. Each of the two current system is associated with a different field-aligned current system, which causes a different pattern of geomagnetic disturbances at mid latitudes. The difference between the two pattern of magnetic disturbances particularly appears east-west magnetic disturbances in the post-midnight. We investigated long-term variations in the east-west magnetic disturbances in the post-midnight at mid latitudes. The results suggests that the two current systems have different solar cycle dependence. The current system related with magnetospheric convection has a good correlation with *Dst* activity, and it tends to be enhanced around a solar maximum. On the other hand, the wedge current system is enhanced in the late declining phase of a solar cycle. It was also found that the long term variation in the MLT dependence of auroral magnetic disturbances is consistent to that in the mid-latitude disturbances. Some implications of the results are also discussed.

Two typical patterns of east-west magnetic disturbances at mid-latitudes



Hypothetical models for each disturbance pattern

Substorm current wedge

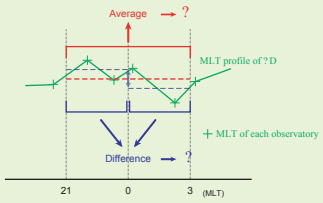
Storm time disturbance

Analysis of two summarizing parameters

Parameterization

In order to roughly divide the two patterns, we defined two parameters below. (The basic idea will be explained on 28 July [Session GAIII07].)

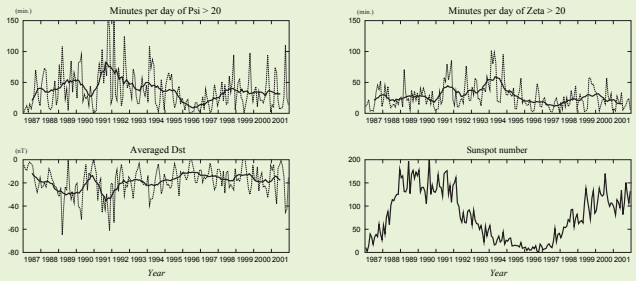
- ϕ : the average of ΔD within 21−3 MLT
- ζ : the average of ΔD within 21−0 MLT minus that within 0-3 MLT



	Geographic (deg.)		Dipole (deg.)		Std. dev.
	Lat.(N)	Long.(E)	Lat.(N)	Long.(E)	of ΔD (nT)
Fresno(FRN)	37.1	240.3	43.7	304.5	9.58
Boulder(BOU)	40.1	254.8	48.7	319.8	13.22
Fredericksburg(FRD)	38.2	282.6	48.8	352.9	11.50
Chambon-La-Foret(CLF)	48.0	2.3	49.9	85.8	12.34
Martin De Vivies(AMS)	−37.8	77.6	−46.8	143.6	11.28
Memambetsu(MMB)	43.9	144.2	34.9	210.8	8.19
Honolulu(HON)	21.32	202.00	21.60	269.45	4.42

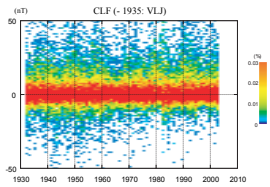
List of the observatories

Long-term variation of each parameter

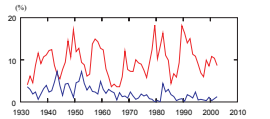


Minutes of ϕ >20 per day for each month (top left), minutes of ζ >20 per day for each month (top right), monthly averages of the *Dst* index (bottom left), and monthly values of the sunspot number (bottom right).

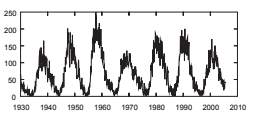
Long-term variations in the tendency of ΔD disturbances in the post-midnight



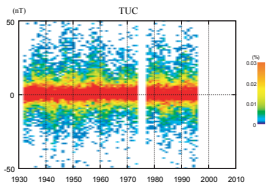
Histogram of ΔD in the post-midnight (1-3 UT) for each year at CLF (magnetic latitude: 49.9° longitude: 85.7°)



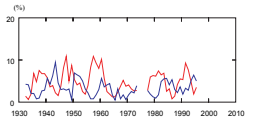
Probability of $\Delta D > 15$ (the red line) and that of $\Delta D < 15$ (the blue line) at CLF in the post-midnight (UT: 1-3)



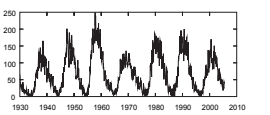
Sunspot number



Histogram of ΔD in the post-midnight (9-11 UT) for each year at TUC (magnetic latitude: 40.1° longitude: −44.4°)

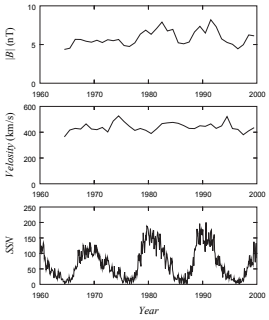


Probability of $\Delta D > 15$ (the red line) and that of $\Delta D < 15$ (the blue line) at TUC in the post-midnight (UT: 9-11)



Sunspot number

Variations in solar wind parameters

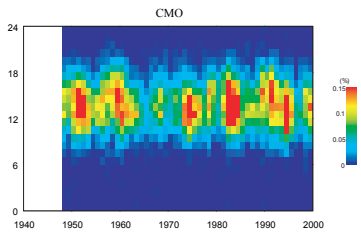


Yearly averages of intensity of the solar wind magnetic field (IMF) in the OMNI data

Yearly averages of solar wind velocity in the OMNI data

Sunspot number

Correspondence with magnetic disturbances in the auroral region



Probability of $\Delta H < -300$ at CMO (magnetic latitude: 65.3° longitude: −99.0°)

Summary

- During solar maximum, eastward/westward magnetic disturbance fields in the northern/southern hemisphere are observed more frequently than during solar minimum in the post-midnight. This result would suggests that strong IMF is favorable for the development of the upward field-aligned currents in the post-midnight.
- In the late declining phase of the solar cycle, westward/eastward magnetic disturbance fields in the northern/southern hemisphere are frequently observed. This suggests that the condition of the solar wind is favorable for the formation of the wedge current system in this phase.

Acknowledgements

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