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

S. Nakano1,2,3 and T. Iyemori3
1) The Institute of Statistical Mathematics 2) JST CREST 3) Data Analysis Center for Geomagnetism and Space Magnetism, Kyoto University

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 systems 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 suggest 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.

Analysis of two summarizing parameters

In order to roughly divide the two patterns, we defined two parameters below. (The basic idea will be explained on 28 July [Session GAI007].)

\[ \phi : \text{the average of } \Delta D \text{ within } 21-23 \text{MLT} \]
\[ \zeta : \text{the average of } \Delta D \text{ within } 21-0 \text{MLT} \text{ minus that within } 03 \text{MLT} \]

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

Hypothetical models for each disturbance pattern

List of the observatories

<table>
<thead>
<tr>
<th>Observatory</th>
<th>Compositional MLT:</th>
<th>Average</th>
<th>Min.</th>
<th>Max.</th>
<th>Std. dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td>06:00</td>
<td>304.8</td>
<td>77.7</td>
<td>736.8</td>
<td>21.98</td>
</tr>
<tr>
<td>South America</td>
<td>06:00</td>
<td>364.4</td>
<td>80.7</td>
<td>736.8</td>
<td>21.98</td>
</tr>
<tr>
<td>Europe</td>
<td>06:00</td>
<td>183.6</td>
<td>60.7</td>
<td>736.8</td>
<td>21.98</td>
</tr>
<tr>
<td>Asia</td>
<td>06:00</td>
<td>364.4</td>
<td>80.7</td>
<td>736.8</td>
<td>21.98</td>
</tr>
<tr>
<td>Australia</td>
<td>06:00</td>
<td>183.6</td>
<td>60.7</td>
<td>736.8</td>
<td>21.98</td>
</tr>
<tr>
<td>Africa</td>
<td>06:00</td>
<td>364.4</td>
<td>80.7</td>
<td>736.8</td>
<td>21.98</td>
</tr>
<tr>
<td>Antarctic or Enderby Islands</td>
<td>06:00</td>
<td>183.6</td>
<td>60.7</td>
<td>736.8</td>
<td>21.98</td>
</tr>
</tbody>
</table>

Minutes of \( \phi > 20 \) per day for each month (top left), minutes of \( \zeta > 20 \) 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 \( \Delta D \) disturbances in the post-midnight

Probability of \( \Delta D > 20 \) (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 \( \Delta D \) in the post-midnight (9-11 UT) for each year at TUC (magnetic latitude: 40.1° longitude: 44.7°)

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
Correspondence with magnetic disturbances in the auroral region

Probability of $\Delta H < -300$ at CMO (magnetic latitude: $65.3^\circ$, longitude: $-99.0^\circ$)

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

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 suggest 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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