Relationship between geomagnetic disturbances at high latitudes and ionospheric negative storms at middle and low latitudes

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When the enhancement of Joule heating during geomagnetic disturbances at high latitudes is assumed to be a cause of negative ionospheric storms at mid-latitudes, estimation of the spatial distribution of the enhancement region and its temporal evolution are essential to clarify the relationship between geomagnetic disturbances at high latitudes and ionospheric negative storms at mid-latitudes.

Prolss (1993) proposed a scenario, such as:(1) Strong ionospheric current flow during geomagnetic disturbance at high latitudes causes high Joule heating. (2)The high Joule heating produces 'storm surge', which is the neutral atmosphere composition disturbance containing high ratio of N2/O. The storm surge propagates from high latitudes to mid-latitudes. (3) The atmosphere containing high ratio of N2/O makes the loss of ionization in the F region at mid-latitudes progress. Therefore, the electron density in the F region at mid-latitudes decreases.

Geomagnetic indices, Kp and/or AE, were hitherto used to infer geomagnetic disturbances in his analysis and in analyses by other researchers. However, these indices are simple 'scalar' values and have not spatial information on geomagnetic disturbances. To overcome this problem, we use multi-point geomagnetic observations for our analysis.

Analyzed parameters concerning geomagnetic disturbances at high latitudes are starting time (MLT, UT), central location in longitude, longitudinal extent, duration, and magnitude.

Analyzed parameters concerning ionospheric negative storms at mid-latitudes are starting time (MLT, UT), observing longitude, longitudinal difference between the source region and the observing point, and time delay from the start of the high-latitudes geomagnetic disturbance.

To reduce an ambiguity in correspondency, we select the cases of the geomagnetic disturbance which is fully isolated from other geomagnetic disturbances. If we would not select isolated disturbances, we have the problem related to the effect of the prompt electric field penetration from high latitude to mid-latitude, as following: On one hand, the propagation time of the storm surge from high latitude to mid-latitude usually takes several hours. On the other hand, the electric field penetration is prompt. In the case of that the second geomagnetic disturbance occures several hours after the first one, it is rather hard to clearly identify the effect of storm surge from the ionosperic variation that is affected by both effect at the almost same time.

This is another reason why we select the isolated geomagnetic disturbances as case studies.

At the 2004 fall SGEPSS meeting, we presented the result about the analysis focusing on the cases of typical ionospheric negative storms observed over Japan. In other words, analyzed region of ionospheric negative storms is one longitudinal zone at mid-latitude. Two types of corresponding patterns are found. The first type is that the corresponding large geomagnetic disturbance has a wide longitudinal extent. The second type is that the corresponding large geomagnetic disturbance occurrs not in Siberia but in Northern America. As Siberia is located near Japanese longitude and Northern America is located far east from Japanese longitude, the second type suggests that the storm surge propagates not only equatorward but also westward.

At this 2005 Joint meeting, we will presents the results which we analyzed ionospheric negative storms not in one limited longitude but globally. Therefore, spatial relationship between high-latitudes geomagnetic disturbance and ionospheric negative storms at mid-latitudes

is investigated more clearly. Based on the detected time evolution of the negative storm region, we will discuss the effect of the background neutral wind on the propagation of the storm surge.