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Relationship between geomagnetic disturbances at high latitudes and ionospheric negative storms at middle latitudes (3)

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For study on the developing mechanisms of the negative ionospheric storm, it is important to specify the temporal and spatial relationship between the cause and the result of the negative ionospheric storm.

The storm surge hypothesis was proposed by Prolls (1993), such as: (1) Strong ionospheric current flow during geomagnetic disturbance at high latitude enhances Joule heating. (2) The enhanced Joule heating produces 'storm surge', which is the neutral atmosphere composition disturbance containing high ratio of N2/O. The storm surge is transported from high latitudes to middle latitudes. (3) The atmosphere containing high ratio of N2/O increases the loss of ionization in the F region. The electron density in the F region at middle latitudes decreases.

Fuller-Rowell et al. (1996) discussed about several effects, for example, the background wind, on the surge transportation, based on their numerical simulation.

Therefore, researches about how the storm surge is transported and about what effects contribute the surge transportation have been desirable, based on data analyses. In order to infer the way of the development of the storm surge clearly, it is necessary to do following procedures: (i) Estimation of the spatial distribution of the source region at high latitudes by use of multi-points geomagnetic variation data referring large geomagnetic disturbances as a proxy of the enhanced Joule heating region, (ii) Estimation of the spatial distribution of the negative ionospheric storm at middle latitudes by use of ionosonde data, (iii) Derivation of the longitudinal difference between the distribution of the source region and the distribution of the negative ionospheric storm, (iv) Derivation of the time delay from the appearance of high latitude source to the appearance of the negative ionospheric storm. We select the cases whose source is temporally isolated and spatially compact because such cases help us to determine unambiguously the longitudinal difference and the time delay. At the 2005 fall SGEPSS meeting, we showed the cases in which the west end of the appearing longitude of the negative ionospheric storm is west of the west end of the source region. It suggests that the storm surge is transported not only equatorward but also westward.

After that time, we are progressing three new analyses.

(I) Analyses about the longitudinal difference between the east end of the source region and the east end of the ionospheric negative storm.

(II) Analysis about not only foF2 (which is related to the peak electron density of the F-region) but also hmF2 and hpF2 (which are related to the peak height of the F-region). This analysis would be helpful for estimating the meridional neutral wind variation in the F-region.

(III) Analysis about the ionospheric variations in the latitudinal zone between high latitude and middle latitude. This analysis is helpful for researching the early stage in the development of the storm surge. Near and at the high latitude, ionospheric convection could change the background neutral wind through the ion drag. In our selected cases, IMF By is positive. As the convection cell in the dawn side is usually smaller than that in the dusk side during positive IMF By, it is expected that the ion drag effect is smaller in the dawn side.

Based on the results from these analyses, we will discuss the effects of the prevailing neutral wind (with diurnal and seasonal variations), the Coriolis force, and the ion drag on the transportation of the storm surge.