E021-022 Room: C304 Time: May 31 16:15-16:30

Storm-time simulation of the coupled Ionosphere-Thermosphere system

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We have developed a 3-dimensional global Ionosphere-Thermosphere. It can be applied to such global scale phenomena as Traveling Atmospheric Disturbances, and Traveling Ionospheric Disturbances, which are associated with the geomagnetic storms and substorms. Traveling Atmospheric Disturbances play an significant role in transporting the energy and momentum, of magnetospheric origin, from high to lower latitudes. The model results can be compared with the observations of thermosphere and ionospheric plasmas, obtained with using sophisticated imaging technology and GPS-TEC global network.

In this presentation, we will examine the response of the ionosphere-thermosphere to the realistic storm occured on September 22-23, 1999.

The empirical models of the Auroral energy flux and magnetospheric convection electric field are used to describe the energy input from the magenetosphere associated with the geomagnetic storm. The AE indices required as an input to the empirical model of the low-latitude disturbance electric field, are obtained from the empirical relationship with the hemispheric Auroral Power input.

From midnight to dawn sector, Joule heating as a consequense of the energetic particle precipitation, and enhancement of the magnetospheric convection electric field, increases the neutral temperature in the high-latitude thermosphere. In addition, the high-latitude thermospheric winds are greatly enhanced due to the E^B drift of the magnetospheric electric field. The equatorward wind is enhanced as a consequence of the increase in the neutral temperature at high latitude, especialy pronounced from the midnight to dawn local-time sector. It could be attributed to the nightside smaller ion drag than that of dayside. The change in the equatorward wind propagats to lower latitude, and the increase in the temperature is observed in mid- and low-latitudes.

The temporal variation of the simulated latituditudinal structure showed that the changes in the meridional wind propagates equatorward even after sunrise, due to the increase in the neutral temperature, then dissipated as the local-time goes by.

The ion-drag plays an important role in the propagation procces of the neutral disturbances. Smaller ion-drag can help propagation easier to lower latitude. The condition of reduced ion-drag are as follows; (1) nightside local time, (2) decrease in the ionospheric density due to the disturbance downward E^B plasma drift, (3) neutral motion in the same direction as the disturbance E^B plasma drift.

We examined the effect of the the mid-/low-latitude disturbance E^B plasma drift in this event. The meridional wind changes were obtained from the model with the low-latitude disturbance dynamo electric field when it was enhanced, as compared to that without disturbance dynamo electric field. It might be resulted from the reduced ion-drag, as ionospheric density was decreased due to the vertically downward(equatorward) plasma drift, associated with the disturbance electric field. In addition, it might be caused by that the neutral wind moves in the same direction with the drift. Therefore, the mid-/low-latitude disturbance eastward electric fields (vertical plasma drift) play an important role, in terms of ion-drag process, in the propagation of the neutral atmospheric disturbances.

It could be a possible cause of the neutral wind disturbances observed in the local-time even after the sunrise. Furthermore, its longitudinal dependence may determine the latitudinal width of the neutral wind disturbances.