Electric field transmission between two different altitudes; Akebono-GEOTAIL simultaneous observation

Ayako Matsuoka[1], Hajime Hayakawa[1], Toshifumi Mukai[1]

[1] ISAS

We have investigated the propagation of electric field from the distant magnetosphere to the ionosphere for wide spatial and long temporal scale, and proposed a model of traveling Alfven waves.

In our model, the amplitude ratio of the electric field at ionospheric altitude to that in the distant tail decreases with the frequency of fluctuations. It means that the relatively high-frequency variations are diminished at ionospheric altitude. Moreover, our model suggests that the reflection of waves causes time delays longer than the wave transit time.

We applied our model to the data obtained by GEOTAIL and AKEBONO , and proved that our model using realistic physical parameters explains observed data very well.

It has been suggested that the electric field is significantly fluctuating at higher altitude than several earth radii while the electric field measured at ionospheric altitude is relatively smooth and constant.

Some previous works have theoretically investigated the propagation of electric field from the distant magnetosphere to the ionosphere in regard to the auroral phenomena. They suggested that the characteristic time of the variation of the ionospheric electric field is defined by the ionospheric conductivity and by the transit time of Alfven waves between the ionosphere and the source region in the magnetosphere.

We extended this story to electric fields having wider spatial and longer temporal scale, and have tried to explain the dependence of electric field feature on the distance from the earth by traveling Alfven waves. In our model, the amplitude ratio of the electric field at ionospheric altitude to that in the distant tail decreases with the frequency of fluctuations. It means that the relatively high-frequency variations are diminished at ionospheric altitude, and well explains why the electric fields in the ionosphere are smooth. Moreover, our model suggests that the reflection of waves causes a phase rotation and time delays longer than the wave transit time between two different altitudes.

We applied our model to the data obtained by two satellites, GEOTAIL in the magnetotail and AKEBONO at ionospheric altitude. It is proved that our model using realistic physical parameters, e.g. the height-integrated Pedersen conductivity and Alfven wave transit time, explains observed data very well.

We may extend our model to the electric field transmission from the solar wind to the ionosphere. It is strongly suggested that the long time-scale variations in the solar-wind velocity propagate to the terrestrial ionosphere with significant time delay. Meanwhile, high-frequency variations in the solar wind velocity do not propagate to the ionosphere.