Variations of the ionospheric dynamo currents induced by neutral winds obtained from Kyushu-GCM

Keiko Kawano[1]; Saburo Miyahara[1]

[1] Earth and Planetary Sci. Kyushu Univ.

It has long been known that Sq shows fluctuations in various timescales and considered that these fluctuations could not a little owe to neutral wind variations in the lower thermosphere. To investigate relationship between variations in neutral winds and induced Sq currents, we carry out three-dimensional simulations of the ionospheric dynamo currents by a quasi three-dimensional ionospheric dynamo model using neutral winds in the general circulation model of the middle atmosphere at Kyushu University, which have seasonal, day-to-day, and time-to-time variations.

The quasi three-dimensional ionospheric dynamo model is constructed based upon the method introduced in Takeda and Maeda (1980), assuming an infinite parallel conductivity in the ionosphere. This assumption makes a three-dimensional ionospheric dynamo equation to a two-dimensional partial differential equation with variable coefficients. In this study, only the symmetric winds in dynamo action is taken into account. The simulations are conducted for the September condition with universal time fixed at 4.5 UT and succeed in simulating both the global Sq current system and the equatorial electrojet.

The results show an interesting vertically stratified double layer structure at 30N in the monthly averaged east-west current density, which mainly consists of the westward-wind-driven westward Hall current at altitude higher than 110km associated with the dominant semidiurnal tidal wind and the polarization-field-driven eastward Hall current at lower altitude (90km-110km). But the eastward current at lower altitude is not seen in the average over the last 10 days (21-30) of September and the stratified structure disappears. Comparison with the first 10 days (01-10) average, which shows the stratified structure clearly, reveals that the difference between them results from a variation of the wind-driven east-west Hall current associated with the diurnal east-west wind component with zonal wavenumber 1 at the altitude lower than 105km. It is consistent with the fact that the diurnal tidal winds are more variable than the semidiural tide. On the other hand, the current components driven by the polarization field do not show a remarkable difference through the month, since the polarization field is determined globally by a numerical solution of the boudary value problem and it is not susceptible to the local variation of the neutral wind.

The variation in the vertical structure significantly affects the vertically integrated global Sq current system as a variation of the focus position. It is also confirmed that the day-to-day variations of the neutral winds can vary not only the three-dimensional structure of the ionospheric currents but also the vertically integrated global Sq current system. The equatorial electrojet, however, does not vary so much since it generally consists of the polarization-field-driven current components.