Effects of neutral winds variation on induced Sq currents

Keiko Kawano[1], Saburo Miyahara[2]

[1] Earth and Planetary Sci., Kyushu Univ., [2] Earth and Planetary Sci. Kyushu Univ.

Sq, which stands for observed relatively periodic (ca. 1day cycle) geomagnetic variations with small scale amplitudes, are resulting from ionospheric dynamo currents, called Sq currents, originated in the interaction between earth's main magnetic field and neutral winds associated with tides in the lower thermosphere, where atmosphere is weakly ionized by solar ultraviolet rays.

It is well known since a long time ago that Sq shows significant day-to-day variations having no clear relations to the solar activity. It is natural that those day-to-day variations should depend on day-to-day variations of neutral winds in the lower thermosphere.

For the purpose of investigating the effects of neutral winds variations on variable Sq currents, numerical Sq currents simulations were carried out using neutral winds obtained from Middle Atmosphere Circulation Model at Kyushu University (MACMKU) and assuming a steady (having a diurnal cycle but no day-to-day variation) conductivity in the lower thermosphere. MACMKU is a general circulation model of the middle atmosphere covering from the ground through the lower thermosphere (ca. 150km). In this model, the solar radiation processes having a diurnal cycle are taken into account. Amplitudes of zonal winds fluctuations generated by such heat processes reach several ten [m/s] in the lower atmosphere, which fairly agree with real atmosphere in their behavior. They also involve seasonal, day-to-day or time-to-time variations. Conductivity used here is calculated using International Reference Ionosphere 1990 and 1-month averaged every universal time to get rid of involving day-to-day variation. In this study, we use a two-dimensional dynamo model to calculate the height-integrated non-divergent dynamo currents induced by the winds and conductivity symmetric with respect to the geomagnetic equator.

Results of simulations show that there actually exit significant day-to-day Sq currents variations due to variations included only in neutral winds.

As a next step, we sought the features of a neutral winds variation that could be most effective on Sq currents variation on the basis of the idea similar to Green function; instead of calculating dynamo currents induced by the neutral winds obtained from MACMKU, we calculated the dynamo currents induced by the neutral winds put on arbitrary two points symmetric with respect to the geomagnetic equator with the magnitude of just 1.0[m/s], changing the locations of the points where winds were given and directions of wind vectors. Currents induced by such slight winds put on specified points correspond to the currents variation when neutral winds blowing there change slightly, for ionospheric dynamo current can be expressed by a linear equation of neutral wind. This examination suggests that the variation in zonal components of neutral winds at midlatitudes or lowlatitudes occurred around noon should have a greater effect on the variation of induced dynamo currents than that of meridional components, or the variation at highlatitudes or occurred in nighttime.

Then we confirmed that day-to-day neutral winds variations simulated by MACMKU that satisfied the conditions to be effective on dynamo currents variations suggested above could indeed have great contributions to corresponding simulated day-to-day Sq currents variations.