Monitoring of Ionosphere-Atmosphere Electrodynamic Coupling by Network Geomagnetic Fields

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Geomagnetic disturbances observed on the ground include various information of magnetospheric phenomena. A extraction method to separate various components is needed to be developed from network data. In this study, a possibility of monitoring of ionosphere-atmosphere electrodynamic coupling is investigated by using geomagnetic fields data obtained from network observations. We establish a new separation method by applying the Principal Component Analysis (PCA). This technique is useful to extract fundamental components of magnetic variation from the network data obtained from Circum-pan Pacific Magnetometer Network (CPMN).

The PCA is a statistical technique to transform a number of correlated variables into a smaller number of uncorrelated variables called principal components. By applying the PCA to datasets of geomagnetically quiet days of past about 13 years, we obtained the orthogonal basis functions making up variations on geomagnetically quiet day. Geomagnetic variations are decomposed into fundamental and higher order components. Basically, the fundamental component reflects a daily variation factor of geomagnetic disturbances, and the higher order components describe magnetospheric disturbances or higher order components of daily variations originated from atmospheric tide.

Our results suggest that the first principal component reflects a global Sq current structure. The second principal component may correspond to a current system driven by atmospheric wind propagating from polar region. The third principal component shows two currents vortices enhanced in the summer hemisphere, of which shapes are similar to the current structure generated by semidiurnal tidal wind. Network observations of geomagnetic disturbances may enable us to monitor an electrodynamic coupling between ionosphere and atmosphere through the tidal wind.