ong-term variation of geomagnetic activity from the data at Kakioka

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Geomagnetic field changes with various frequencies: One end is secular variation produced by dynamo in the outer core and the other end is a very short-frequency variation caused by geomagnetic disturbances. Its frequency range extends thirteen figures in log scale when reversal of the dipole field is taken into consideration. We have several kinds of indexes that measure intensity of geomagnetic disturbances at different frequencies which are produced by causes in the outer space; Sq for daily variation, K-index for three-hour variation after removing Sq, Dst that is used as a scale of magnetic storm, and AR that evaluates magnetic disturbance associating substorms. Although these indexes are to evaluate magnetic variations of frequencies from several hours to a few days according to their object phenomena, they can also be used to examine long-term change of geomagnetic activities. For example, Kp that can be regarded as a kind of a global mean of K-indexes, or aa that is a mean of three-hour variation at two observatories in the northern and southern hemispheres, are often used to discuss a long-term change in the intensity of geomagnetic disturbances. In particularly, using the aa index whose values since 1868 could be obtained, it was proposed that velocity of the solar wind or intensity of IMF might have been doubled during the last century (Feynman and Crooker, 1978; Lockwood et al., 1999). However, a counterargument based on IHV analysis has been presented by Svalgaard (2003).

In this paper we investigate characteristics of seasonal variation, annual variation, 11-year and 22-year variations associated with the solar activity cycle, and secular variation, using the geomagnetic data at Kakioka and the Tokyo data (Toya et al., 2004).

As above-described K-index or IHV which measures three-hour variation are often used to discuss long-term change in geomagnetic disturbances. However, it is pointed out that a monthly mean of daily amplitude of Sq in calm days exhibits a variation at the period of the solar activity cycle (Kakioka magnetic observatory, 2002), and it is shown that numbers of ssc and si have a good correlation with numbers of the solar spot (Yoshida et al., 2004). These correlations can be understood if we note that a daily amplitude of Sq is related to the intensity of ultraviolet radiation from the sun and ssc is produced by CME, i.e., both of them are caused by solar activities. On the other hand, number of storms with gradual commencement does not show a clear variation of the 11-year period (Yoshida et al., 2004). A reason that the solar activity cycle is not clear in the change of K-index is considered that K-index includes variations due to storms with gradual commencement. K-index data at Kakioka exist from 1932. But the value was shifted in March 1978 when the reading scale was changed (Uesugi et al., 2005). Here, we examine change in the intensity of geomagnetic disturbance of relatively short periods from Meiji era on the basis of IHV. In addition to that we discuss long-term changes of the seasonal variation and the variations of 11-year and 22-year periods using monthly mean and annual mean values. The seasonal variation is affected by the crossing angles between the dipole field of the earth and solar wind velocity or IMF. We should keep it in mind when we try to estimate variations of solar activity (solar wind velocity, CME or IMF) from change in geomagnetic disturbances.