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Estimation of the long-term component of the variation in geomagnetic data

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The Dst index is widely used as a monitor of the temporal evolution of the magnetic storms. It has a long-term variation which is not associated with magnetic storms; that is, the quiet-time level of the Dst index is not constant but variable. However, the characteristics of the long-term variation has not necessarily been clarified.

We estimated the quiet-time level of the Dst under the assumption that the short-term variation due to magnetic storms is represented by an empirical dynamical model by Burton et al. (1975). The estimation was carried out by using the merging particle filter, which is a Monte-Carlo-based algorithm calculating the first and second moment of a probability density function (PDF) of a system state. This algorithm allows an on-line processing of a long sequence of the Dst data, which enables us to analyze the long-term variation.

The result suggests that the variation of the quiet-time level includes both a seasonal variation and an irregular variation. The irregular variation anti-correlates with a long-term (monthly or longer) variation of solar-wind parameters, especially the solar-wind dynamic pressure. In particular, the quiet-time level was unusually high around June 1999, when the solar-wind pressure was remarkably low. It is well-known that the solar-wind pressure make a positive effect on the short-term variations of the Dst index via the magnetopause current. The anti-correlation in the long-term variation implies that there exists another effect of the solar-wind pressure on the Dst index.