Subannual variation in the Dst index and its relationship with solar-wind parameters

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It has been well known that the temporal variations in the Dst index are mostly controlled by the solar-wind north-south magnetic field. The Dst index decreases when the solar-wind magnetic field is directed southward. And the solar-wind magnetic field is directed northward, the Dst index recovers to nearly zero. On the basis of this knowledge, Burton et al. (1975) have proposed an empirical model of the temporal evolution of the Dst index and their model can successfully represents short-term variations of the Dst index. However, this empirical model often fails to reproduce the long-term variations (longer than one month). This fact suggests that the long-term variation in the Dst index would be controlled by mechanisms which were not taken into account in this empirical model.

We decomposed the Dst variation into the long-term component and the short-term component by using state space modeling and the particle filter algorithm. We then compared the estimated long-term component with various solar parameters, such as solar-wind density, solar radiation, and sunspot number. It was found that the long-term variation of the Dst index is negatively correlated with the solar-wind dynamic pressure. (Note that the short-term Dst variation is positively correlated with the solar-wind dynamic pressure.) As the Dst index is not available after 2003, we examined geomagnetic data from 2004 to 2008 for each of four observatories which are used for deriving the Dst index. The negative correlation was found for all of the four observatories. One possible reason of this negative correlation is the effect of the solar-wind pressure on the ion density of the plasmasheet. If high solar-wind dynamic pressure is maintained for a long time, the density of the plasmasheet would be enhanced, which could cause the intense ring current and tail current. The enhancements of the ring current and tail current would cause the decrease in the Dst index during the high solar-wind dynamic pressure conditions. However, there is a room for discussion with the mechanism which causes the negative correlation.