Data assimilation approach for estimating unknown factors in a kinetic ring current model

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The magnetospheric ring current during magnetic storms has been modeled by various simulation studies. However, since our knowledge on the inner magnetosphere remains limited, such simulation studies adopt many uncertain assumptions which may cause uncertainties or inaccuracies in the simulation outputs. One method to resolve such uncertainties is to incorporate observed data into a model, a procedure referred to as data assimilation. There is a difficulty in this assimilation because the effect of external forcings on a ring current state is not immediate but with a delay and the estimation of states at former times is important. However, the use of an algorithm based on the particle filter/smoother allows us to estimate states at former times with relatively low computational cost.

We assimilated ENA data from the IMAGE satellite into a kinetic ring current model (CRCM) by Fok et al. (2001). It was assumed that the electric potential distribution, plasmasheet ion density, and plasmasheet ion temperature were uncertain, and they were estimated through the data assimilation process. The trend of those temporal variations were assumed to be linear to time and updated every hour of simulation time. On the basis of the estimates of those parameters, the ring current ion distribution in the inner-magnetosphere was consequently estimated. Using this technique, we investigated the temporal variation of the ring current during a magnetic storm. We discuss the relationship between the variation of the storm-time ring current and the electric field variation in the inner magnetosphere.