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Ring current decay time model: Forecasting the recovery phase of magnetic storms

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Abstract

Magnetic storms are caused by changes in the currents flowing near the Earth, particularly by the enhanced ring current. One important thing related to storms development is to know how, how much and how long the energy injected into the inner magnetosphere enhancing the ring current during the main phase will be available there before to be fully dissipated during the recovery phase.

The ring current dynamics is described through the energy balance equation, where a key role is played by the decay time parameter τ. Two kind of models depending on diverse geophysical parameters have been introduced for this important function. One of them, based on the generally observed dependence on Dst, and the other depending on the energy input related to the electric field vB_S, where v is the solar wind velocity and B_S is the southward component of the interplanetary magnetic field.

In this work we analyze the recovery phase of storms comparing the two kind of models through diverse study cases from the OMNI database. We assume that the decay time depends on Dst and Dst-peak during the recovery of storms because during that phase the energy injection, usually considered as proportional to vB_S, ceases. We show that the observed data during the early recovery is better described by the model based on Dst, but during the late recovery it is necessary to include, as a fastener, an exponential model resulting from a constant or null injection. This indicates that the whole recovery phase of storms should be described by a two-step model which considers both approaches.