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Effective Solar Wind Structures for the Evolution of the Ring Current and Radiation Belts

YOSHIZUMI MIYOSHI[1], RYUHO KATAOKA[1]

[1]*STEL, Nagoya University, Japan*

The dynamics of the ring current protons and radiation belt electrons are important subjects for the space weather study because such energetic particles do considerable harm to human being activities in the space. It has been well known that the southward IMF is a primary parameter to control the ring current evolution, while it has been believed that the solar wind speed is a primary parameter for the radiation belt evolution. However, the solar wind speed and IMF are not independent but related via inherent plasma properties of the solar wind structures such as CMEs and CIRs. Therefore the dependence on solar wind structure is essential to understand the relationship between the solar wind and energetic particles in the inner magnetosphere. In this paper, we show the relationship between the solar wind structure causing the magnetic storms and the dynamics of the energetic electrons [Miyoshi and Kataoka, 2005, GRL, Kataoka and Miyoshi, 2006, SW]. Using the OMNI2 database, all of the storms with Dst<-100 nT during solar cycle 23 are categorized into different groups considering the nature of the solar wind driver, e.g., CME-driven, or CIR-driven. The energetic particle data from GOES and NOAA satellites are used to examine the dynamics of both ring current ions and radiation belt electrons. As a result, it is revealed that the energetic particles at inner and outer parts of the inner magnetosphere are sensitive to different solar wind structures. CIRs are significantly more effective for the evolution of the outer belt than CMEs. A series of particle injections contribute for the evolution of the outer belt, which are driven by Alfvenic magnetic field fluctuations within the fast coronal hole stream following the CIR. High-speed CMEs is not effective for the flux enhancement of the outer belt, indicating that only the fast solar wind speed is not a sufficient condition for the flux enhancement. On the other hand, the flux enhancements of radiation belt electrons and ring current ions at L<3.0 largely depend on the strength of storms; only particular CMEs with a huge motional electric field and large dynamic pressure are effective to increase radiation belt electrons and ring current ions at L<3.0.