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Flux enhancement of the outer radiation belt associated with high-speed coronal hole streams

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High-speed coronal hole streams are responsible for flux enhancements in the outer belt, and the solar wind speed has been thought as a primary parameter for the flux enhancement. However, our statistical study about the flux variation of the radiation belts during geomagnetic storms revealed that only high speed solar wind is not sufficient for the flux evolution in the outer belt. In this study, we examine the response of the outer belt to the stream interface crossing regardless of magnetic storms in order to seek the control parameters for the flux enhancement associated with high speed coronal hole streams.

We identify stream interface events from 1995 to 2005, and the response of the outer belt is examined using the data from the GOES and NOAA satellites. We classify the stream interface events into two groups, considering the difference of the IMF sector polarity of coronal hole streams: (A) the sector polarity follows so-called Spring toward Fall away (STFA) law, and (B) vice versa. Comparing Groups A and B, by superposing about the stream interface, only IMF Bz dependence can be obtained because all the other solar wind parameters change in the same manner. As a result, the greatest flux enhancement after the stream interface crossing is found in the high speed coronal hole streams in group (A) in which there is a southward offset of IMF. We obtain an evident parameter dependence of both the solar wind speed and the IMF Bz within coronal hole streams for the flux enhancement.

Further, as a case study, we compare the flux evolution in the outer belt and related phenomena between two CIR-driven storms using comprehensive data sets of in-situ particles and plasma waves in the inner magnetosphere, the solar wind data, and solar observations. The sector polarity of two storms was different from each other. The recovery phase of one storm that follows the STFA law is associated with the prolonged substorm activity; continuous injections of hot and sub-relativistic electrons, and enhanced chorus wave activity which can accelerate sub-relativistic electrons to MeV energies by means of wave-particle interactions. In contrast, the recovery phase of another storm is associated with reduced substorm activity; weak injections of hot and sub-relativistic electrons, and low chorus wave activity. These results indicate that only the solar wind speed is not a sufficient condition and the southward IMF is important for flux enhancements in the outer belt.