Solar wind structures driving the greatest radiation belt storms

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One of the most important problems for space weather study is to understand how to predict the extreme flux enhancement of relativistic electrons in the Van Allen radiation belts. Some extreme events are associated with magnetosphere compression during super storms driven by coronal mass ejections (CMEs). In this paper, we suggest a new mechanism of extreme flux enhancement at geosynchronous orbit (GEO) due to the magnetosphere inflation during the storm recovery phase associated with the combination of CMEs and high-speed solar wind stream originated from coronal holes, based on the observations of July 2004 storms. In order to test the double inflation mechanism, we report average profiles of the solar wind and outer radiation belt during the extreme flux enhancement of relativistic electrons at GEO. It is found that seven of top ten extreme events at GEO during solar cycle 23 are associated with the magnetosphere inflation during the storm recovery phase as caused by the large-scale solar wind structure of very low dynamic pressure (less than 1.0 nPa) during rapid speed decrease from very high (more than 650 km/s) to typical (400-500 km/s) in a few days. For the seven events, the solar wind parameters, geomagnetic activity indices, and relativistic electron flux and geomagnetic field at GEO are superposed at the local noon period of GOES satellites to investigate the physical cause. The average profiles support the double inflation mechanism that the rarefaction of the solar wind and subsequent magnetosphere inflation are one of the best conditions to produce the extreme flux enhancement at GEO because of the excellent magnetic confinement of relativistic electrons by reducing the drift loss of trapped electrons at dayside magnetopause. The predictability of the extreme events will also be discussed.

References:

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