Fundamental variations of the outer radiation belt during solar cycle 21-23

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Flux enhancement of relativistic electrons of the outer radiation belt depends on the large-scale solar wind structures such as coronal mass ejections (CME) and coronal hole streams (CHS). Large flux enhancements at geosynchronous orbit tend to occur during CHS because of the prolonged Alfvenic fluctuations of the magnetic field embedded in the high-speed solar wind. Such a flux enhancement at the outer portion is observed regardless of the occurrence of magnetic storms, while another type of large flux enhancement tends to occur at the inner portion during great storms driven by CMEs. Here we show that the structure dependence plays an essential role in the long-term variations. Relativistic electrons of the outer belt shows the long-term variation associated with solar cycles. During the solar active period, the peak position of the outer belt moves inward toward the earth, and the large flux enhancement is observed at the inner portion. During the solar declining phase, the peak position of the outer belt moves outward, and the large flux enhancement tends to occur at the outer portion including the geosynchronous orbit. Consequently, the fundamental variations of the outer belt are consistent with the solar wind structure dependence since many CME-driven storms are observed during the solar active period, while CHS are frequently observed during the solar declining phase.