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Rapid flux losses of the outer belt electrons due to the magnetopause shadowing effect: THEMIS observations

Chiemi Matsumura[1*], Yoshizumi Miyoshi[1], Kanako Seki[1], Shinji Saito[1], Vassilis Angelopoulos[2], J. P. McFadden[3], D. Larson[3], J. Koller[4]

[1]Solar-Terrestrial Environment Laboratory, [2]UCLA/ IGPP, USA, [3]UCB/ SSL, USA, [4]Los Alamos National Laboratory, USA

Relativistic electrons of the outer radiation belt show dynamical variations associated with solar wind disturbances. These variations caused due to the complicated balance between acceleration and losses. One of the potential loss mechanisms is the magnetopause shadowing effect (MPS), according to which the electron drift orbits of the outer belt intersect the magnetopause, allowing electron escapes outside the magnetosphere. Therefore MPS has been proposed as possible loss process, but there have been only few observational studies to examine this process.

This study focuses on rapid electron loss of the outer radiation belt, by using GOES and THEMIS observations. We detect rapid electron loss at geosynchronous orbit, and separate these loss events using the movements of the outer edge of the outer radiation belt. Using the value of 20% of the peak flux as a proxy of the outer edge of the outer belt, we examined a relationship between the outer edge and the solar wind parameters as well as the magnetopause standoff distance. As a result, we find that the magnetopause standoff distance has a good correlation with the solar wind dynamic pressure, the IMF Bz, and the magnetopause standoff distance. Comparing with the GEMSIS-RB simulation, which includes only the MPS loss process, we can explain the observed losses are due to the MPS. In order to investigate the possibility of the outward radial diffusion after the MPS, we specifically studied the radial diffusion coefficient using the THEMIS data. The estimated radial diffusion coefficients have the same order as the empirical radial diffusion coefficients of Brautingam and Albert [2000], and are seems to be consistent with the outward radial diffusion hypothesis. The results are consistent with the scenario that the MPS causes the rapid depletion of the electron flux at the outer portion of the outer belt, while subsequent outward radial diffusion causes global loss of the outer belt.

Keywords: radiation belt, loss, inner magnetosphere, particle acceleration, solar wind - radiation belt interaction