あけぼの太陽電池劣化に基づく放射線帯プロトン分布のモデル化

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Modeling L-shell distribution of the trapped protons from solar cell degradation of the Akebono satellite

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Output current of silicon solar cells of Akebono satellite orbiting in the inner magnetosphere decreased from 13 A in 1989 to about 7 A in 2009, due to accumulated damage by energetic particles. Annual decrease from the same month in the previous year shows a clear oscillation due to orbit precession correlated with trapped energetic proton flux up to 1996. Although phase of the oscillation in annual variation shows a clear correlation, the amplitude tends to be larger than that expected from a degradation model based on energetic proton distribution of the NASA's AP8 model. The larger amplitude of oscillation suggests that the proton radiation belt was more sharply localized than given by the AP8 model throughout the early half of 1990s.

We have been further working on modelling of the L-shell distribution of trapped energetic protons which provides best-fit for the degradation of solar cells. The results by assuming Gaussian distribution of proton flux for L value are as follows.

(1) If we assume a steady state before 1996, the best-fitted distribution has a peak around L=1.6 and a width of dL=0.2 (i.e., half width of 1/e decrease from the peak).

(2) If we employ a dynamic model with temporal variation and introduce a different distribution between April 1991 and June 1992, RMSE is further improved from the steady model. Modeled distribution has a peak around L=1.9, suggesting outward shift or expansion of the proton radiation belt during the interval.

Our modeling gives narrower distribution than given by the AP8 model, but is more consistent with the CRRES model based on the observation before November 1991 including the dynamic variation in 1991.