Abstract

The Earth's radiation belts consist of the inner and outer radiation belts, and these regions are composed of highly energetic electrons. Especially in the outer radiation belt, the energetic electron fluxes are highly variable during magnetic storms. Energetic electrons in the radiation belts sometimes cause satellite charging, resulting in gradual degradation of instruments and devices onboard satellites. Therefore, it is important to understand basic physics of the energetic electron variation in the outer radiation belt from the space weather point of view. It has been considered that the drastic change of the outer radiation belt is controlled by the dedicate balance between transport, acceleration and loss processes. However, each process has complex physical mechanisms and there remain still much outstanding questions.

In this study, we particularly focused on the loss processes. As a possible loss process, (i)precipitation to the atmosphere , (ii)Dst-effect and (iii)direct loss from the magnetopause (magnetopause shadowing) have been considered. According to the recent study, it is reported that a rapid depression of outer belt electrons is caused by the sudden inward shift of the magnetopause and subsequent enhancement of outward radial diffusion (*Turner et al.*, 2012). The relationship between the magnetopause location and the outer boundary of the outer radiation belt was studied by *Matsumura et al.* [2011]. However, the regions where electrons escape and how the magnetopause shadowing effect reaches smaller L-value are still open questions.

In order to understand the effect of magnetopause shadowing, we used the concept of the drift shell splitting. Due to the asymmetric configuration of Earth's magnetosphere, charged particles which have different pitch angles drift along the different drift shells. On the dayside, particles whose pitch angles are closer to 90 degrees have drift shells closer to the magnetopause. It is expected that the pitch angle distribution will be the butterfly distribution, as a result of magnetopause shadowing. To confirm this hypothesis, we used Solid State Telescope (SST) onboard THEMIS satellite and analyzed pitch angle distributions. The butterfly distribution is usually seen on the night side during geomagnetically quite periods. Our result shows inward shift of dominant region of butterfly distribution when the magnetopause is compressed. We consider that this change is caused by the effect of inward shift of the magnetopause. However, the correlation coefficient between magnetopause distance and the shadowing region (the region where the effect of magnetopause shadowing is expected) is relatively low. It is because the effect of drift shell expansion due to the enhancement of the ring current. We, then, calculate the a largest L* which has closed drift shell, L^*_{max} [*Koller and Zaharia*, 2011] and compared with shadowing regions. Result shows good correlation. This facts support the scenario that the electron loss is caused by the magnetopause shadowing.

However, our result also shows a little difference between loss and shadowing region. It means that the other loss processes are necessary to explain the total loss of outer belt electrons. We, then, investigate this difference of the two by calculating 1D Fokker Plank Diffusion model. Result support the *Turner*'s scenario, magnetopause shadowing and subsequent enhancement of outward radial diffusion, however, it need a strong diffusion.

We also consider the loss to the atmosphere by using POES. POES can detects a strong precipitation events. However, these precipitation events are not detected for all the events, there are some events which we can rarely detect a strong precipitation. Thus, it is suggested that precipitation loss is not the main cause of loss but just the subsequent loss. However, we should note that if precipitation loss is localized in a limited region, the satellites cannot always detect these phenomenon. We need to investigate further about precipitation loss.