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Electron flux dynamics in the low-altitude inner belt during magnetic storms

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The dynamics of the radiation belts during magnetic storms has been studied in order to understand particle acceleration and loss processes in the geospace. It has been known that outer belt electrons show great variation during magnetic storms. On the other hand, inner belt electrons have been believed not to show dynamical variation during magnetic storms except for great magnetic storms. Therefore, little is studied about detailed characteristics and mechanisms of the inner belt dynamics response to general magnetic storms. The purpose of this study is to examine the dynamics of the inner belt with respect to general magnetic storms.

Electron flux (300 - 1100 keV) observed by NOAA has shown electron flux enhancements in the inner belt during the main phase of magnetic storms. We have clarified the observational characteristics of the electron flux enhancement. The main characteristics are summarized as follows:

1. Electron flux (300 - 1100 keV) in the inner belt increases by over one order of magnitude during the main phase of magnetic storms.
2. The duration of the enhancement is approximately 1 day.
3. The electron flux enhancement occurs at not only 300 keV but also other energy ranges.
4. During the event, the electron flux shows spectral hardening.
5. The flux enhancement shows some local time dependence with respect to the amount of flux, the start time and the duration of the enhancement.
6. The flux enhancement appears at lower L (~2) than the usual inner belt position (L ~2.2) observed by NOAA.
7. The flux enhancement does not depend on the size of magnetic storms.
8. The level of the flux enhancement depends on the solar activity.

We have examined some possible mechanisms explaining the electron flux enhancement.
Radial diffusion process is denied due to a long diffusion timescale. Since strong convectional electric fields are not detected in the inner belt during small and moderate storms used in the present study, radial transport process by convectional electric fields is also excluded from the possible mechanisms. We conclude that the electron flux enhancement event is caused by the pitch angle scattering through wave-particle interactions. Strong wave intensities of plasmaspheric hiss and LF whistler mode waves are observed by the PWS/Akebono in the inner belt region during the electron flux enhancement. The calculated diffusion coefficients point out that the resonance is not possible with plasmaspheric hiss but possible with LF whistler mode waves at the magnetic mid-latitude.

In order to discuss the scattering process quantitatively, we have calculated the time evolution of pitch angle distribution over one electron drift period. The estimated result is almost consistent with the observed result. The characteristics of the observed electron flux enhancement are qualitatively understood through the proposed process. The problem remains to be solved is the origin of free energy to generate LF whistler mode waves.

The results of our investigation will propose a new loss mechanism for a few hundred keV electrons in the inner belt, and claims that the inner belt during general storm is not in a stationary state, as was previously believed, but is variable in response to the magnetic activity.