ULTIMA Magnetic Power Spectral Density and its Radial Diffusion Coefficients for Relativistic Electron Enhancement

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Pc 5 magnetic pulsations with frequencies between 1.67 and 6.67 mHz, are believed to contribute to the Relativistic Electron Enhancement (REE) in the outer radiation belt during magnetic storms. Ground-based observations suggested that high-speed solar wind and large-amplitude Pc 5 waves with a long duration during the storm recovery phase are closely associated with the production of relativistic electrons [Baker et al., 1998; Rostoker et al., 1998; Mathie and Mann, 2000; O'Brien et al., 2001, 2003]. On the other hand, many relativistic electron acceleration mechanisms have been proposed theoretically. They are separated roughly into two themes: in situ acceleration at L lower than 6.6 by wave particle interactions (as internal source acceleration mechanisms) [Liu et al., 1999; Summers et al., 1999; Summers and Ma, 2000] and acceleration by radial diffusion to transport and accelerate a source population of electrons from the outer to the inner magnetosphere (as external source acceleration mechanisms) [Elkington et al., 1999, 2003; Hudson et al., 2000; Kim et al., 2001]. One possible external source acceleration mechanism is the resonant interaction with ULF toroidal and poloidal waves.

In order to verify which of the two mechanisms is more effective for the REE, we have to examine the time variation of electron phase space density. Electron phase space density is not directly measured, but we can estimate radial diffusion coefficients using observational electric and magnetic data. The goal of this paper is to get more reliable radial diffusion coefficient from ground-based observational magnetic field and to show reasonability of it for radial diffusion model.

We use the global magnetometer data obtained from ULTIMA (Ultra Large Terrestrial International Magnetic Array, see http://www.serc.kyushu-u.ac.jp/ultima/ultima.html) stations, to precisely define the radial diffusion timescales. The ULTIMA includes McMAC, CARISAM, 210MM and MAGDAS/CPMN magnetometer arrays. The radial diffusion coefficient can be given from the magnetic field power spectral density as a function of L, frequency (f) and m-number (m) in the Pc 5 frequency range during the REE related magnetic storms [see Brautigam et al., 2005]. We can fit Pc 5 power spectral density (L, f, m) using the ULTIMA data. The m-number of global Pc 5 pulsation on the ground is found to be almost less than 5. This is consistent with m-number required in the radial diffusion theory by Elkington et al. [1999, 2003]. We will compare the observationally-estimated diffusion coefficient with theoretical diffusion coefficient [e.g. Elkington et al., 2006], and discuss adequacy of our diffusion coefficient.