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Supporting Information for

Quantifying extremely rapid flux enhancements of radiation belt relativistic electrons associated with radial diffusion

Si Liu[1,2], Qi Yan[3], Chang Yang[1], Qinghua Zhou[1], Zhaoguo He[2,4], Yihua He[1], Zhonglei Gao[1], Fuliang Xiao[1]

[1]School of Physics and Electronic Sciences, Changsha University of Science and Technology, Changsha, China, [2]William B. Hanson Center for Space Sciences, Department of Physics, University of Texas at Dallas, Richardson, Texas, USA, [3]Lunar and Planetary Science Laboratory, Macau University of Science and Technology, Macau, China, [4]Harbin Institute of Technology Shenzhen Graduate School, Shenzhen, China

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Introduction

The supporting information contains additional details of our modeling methods and results for the potentially new scenarios that we present in the main paper. We provide the details of electron phase space density (PSD) calculation used for this study (Text S1). We also provide the wave spectral fitting and diffusion coefficients of THEMIS observed chorus in Figure S1, to model the local acceleration process at high L-shell (Figure 4). The entire profile of radial diffusion simulation results of PSD around L^*=3.5-9 is shown in Figure S2, which are the details of Figure 5. Figure S3 shows the inferred chorus wave intensities at L=5 by using POES 30-110 keV channel electron data for 16:00-24:00 UT on October 2, 2013, used to estimate the relatively weak chorus activities during the period of interest.

Text S1.

The ECT team has provided the magnetic ephemeris data services, which include the second and third adiabatic invariants as functions of satellite positions and pitch angle in different magnetic field models. Consequently, pitch angle $\boldsymbol{\alpha}$ can be obtained by interpolating and kinetic energy $\boldsymbol{E_k}$ can be derived through the relation:

$$\boldsymbol{\mu = E_k(E_k + 2E_0)\sin^2\alpha / 2BE_0} \quad (1)$$

where $\boldsymbol{B}$ is the local magnetic field and $\boldsymbol{E_0}$ denotes electron rest mass energy (~ 0.512 MeV). The corresponding differential flux $\boldsymbol{j(E_k, \alpha)}$ can be obtained by interpolating between neighboring energy channels of REPT flux data with an exponentially decaying energy spectrum [Ni et al., 2011]. Finally, $\boldsymbol{j}$ can be directly converted into PSD $\boldsymbol{f_t}$ by the following relation [Chen et al., 2005, 2007]:

$$\boldsymbol{f_t = 3.325\times10^{-8} \times j / (E_k(E_k + 2E_0))} \quad (2)$$

where $\boldsymbol{f_t}$ is in units of $(c/MeV/cm)^3$, $\boldsymbol{j}$ is in units of $cm^{-2}s^{-1}sr^{-1}keV^{-1}$ and $\boldsymbol{E_k}$ is in a unit of MeV.

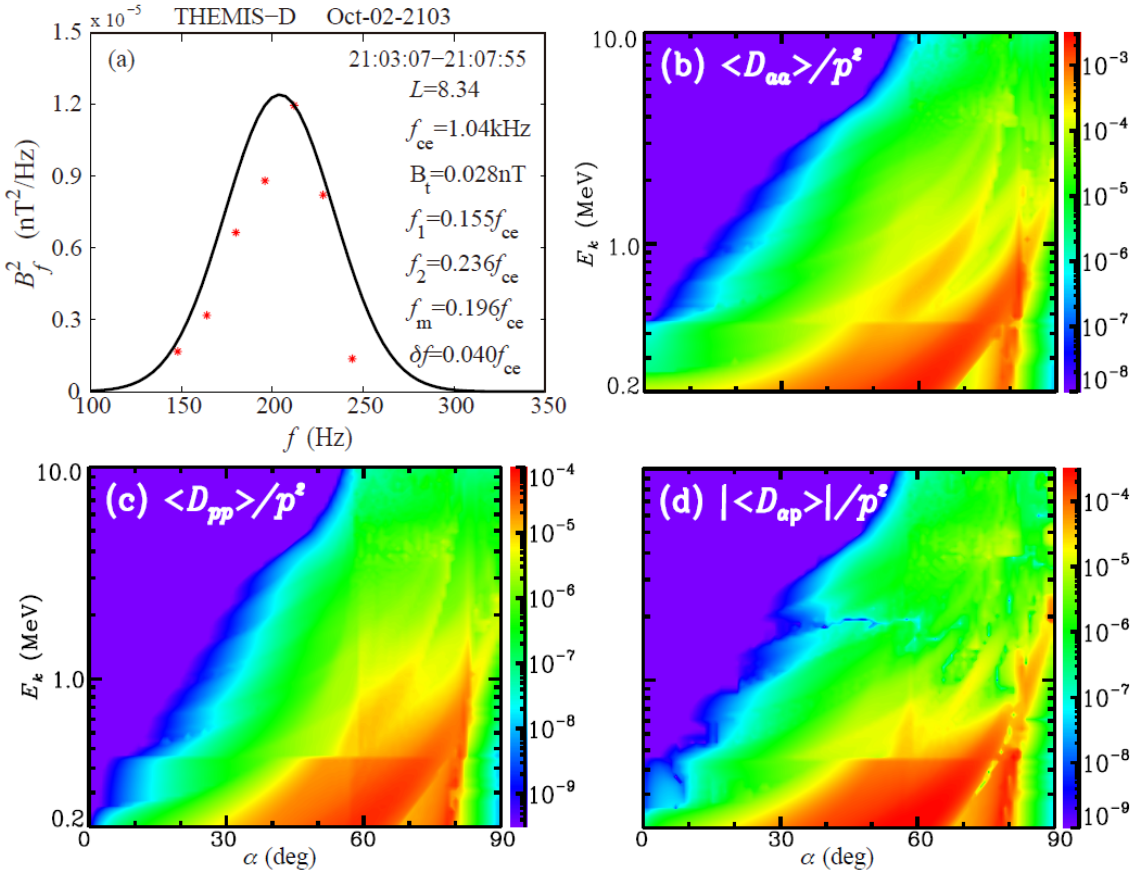

Figure S1. (a) The Gaussian distribution (solid) fit to the weight-averaged THEMIS wave data (asterisk) for the selected interval together with the corresponding fitting wave parameters (shown). (b-d) The bounce-averaged diffusion coefficients of (b) pitch angle, (c) momentum and (d) cross terms in units of s^{-1}, as a function of equatorial pitch angle α and kinetic energy E_k based on the aforementioned fitting parameters.

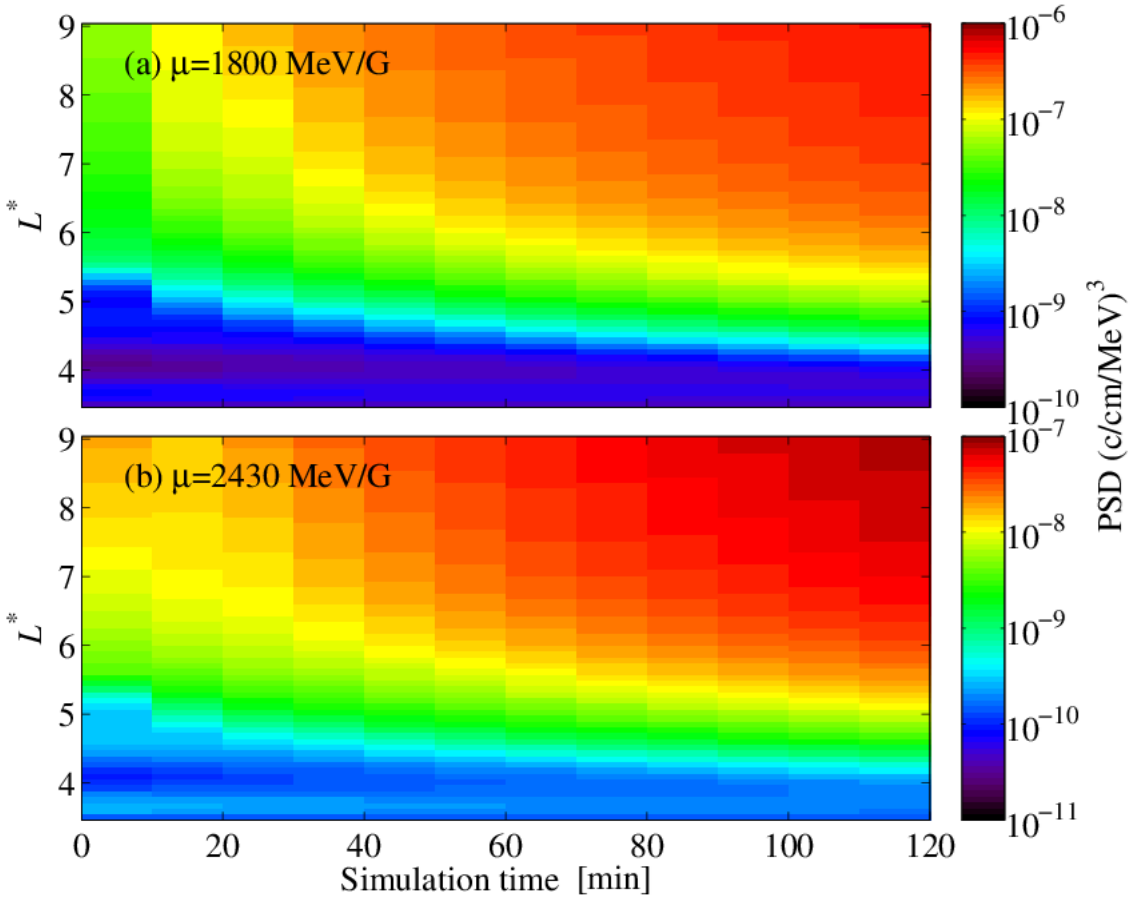

Figure S2. The entire profile of radial diffusion simulation results of PSD with $K=0.11\ R_E G^{1/2}$ around L^*=3.5-9 during the 2-hour simulation with the time resolution 10 minutes.

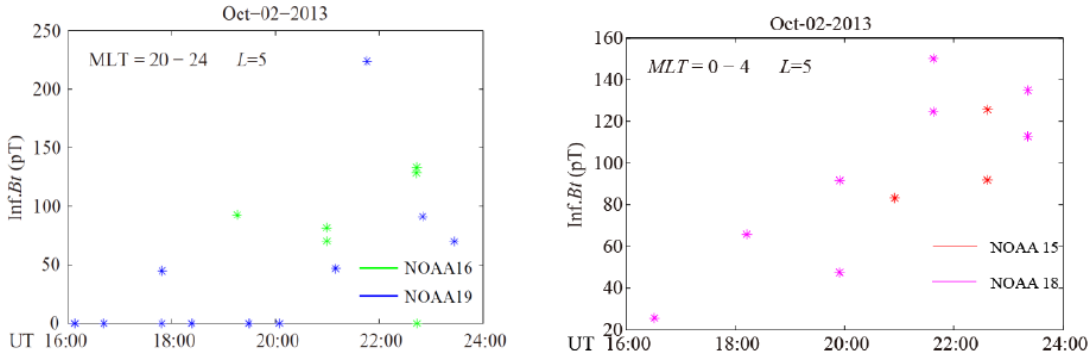

Figure S3. The inferred chorus wave intensity based on the POES 30–100 keV channel electron data at L=5 for 16:00-24:00 UT on October 2, 2013. (left) MLT=20-24. (right) MLT=0-4.