24P-1F-01

観測データ駆動シミュレーションによって再現されたホイッスラー･コーラス波動の散乱に伴う電子フラックス変動

Data-driven simulation of rapid flux enhancement of energetic electrons with an upper-band whistler burst

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The temporal variation of the energetic electron flux distribution caused by whistler mode chorus waves through the cyclotron resonant interaction provides crucial information on how electrons are accelerated in the Earth's inner magnetosphere. We have performed a data-driven test-particle simulation which demonstrates the temporal variation of electron flux distribution obtained from the Arase satellite. Figure 1 shows a dynamic frequency spectrum of magnetic fluctuations (the top panel) and electron flux distributions at four-time intervals (the bottom panels a, b, c, and d), which are obtained from the Arase satellite. The top panel shows that the magnetic wave burst appears for the time interval of about 30 seconds. Kurita *et al.* (2018) have shown that the observed waves are an upper-band whistler wave burst whose frequencies are above half the electron gyrofrequency f_{ce}. The temporal evolution of the flux distribution as shown in the bottom panels of figure 1 shows that a narrow peak around a pitch angle of ~75 degree at energies higher than ~18 keV appears during the wave burst is enhanced.

The data-driven test-particle simulation has been performed by using the wave spectrum of upper-band whistler chorus waves and the flux distribution before the burst is enhanced (figure 1(a)). Figure 2 shows pitch angle distributions at 20.5 and 24.5 keV obtained from the Arase satellite (blue dashed lines with error bar) and that calculated from the simulation (red solid lines) at corresponding time intervals. As shown in figure 2, the pitch angle distributions calculated from the test-particle simulation reproduce the observations well.

From the detail data analysis of our simulation, we found that the nonlinear scattering contributes to the flux enhancement of energetic electrons. Further we confirmed that a quasi-linear diffusion model, which has been used in general so far, cannot explain such a rapid flux enhancement. We conclude that the nonlinear scattering caused by the whistler burst plays an important role in the rapid flux enhancement of energetic electrons observed by the Arase satellite. Details of this study including the discussion of nonlinear scattering process is described in the published paper (Saito *et al.* (2021) JGR, doi: 10.1029/2020JA028979).

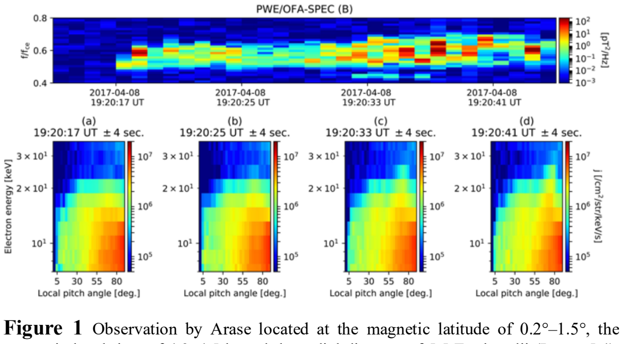

Figure 1 Observation by Arase located at the magnetic latitude of 0.2°–1.5°, the magnetic local time of 4.3–4.5 h, and the radial distance of 5.5 Earth radii (Lm ~ 5.4). (Top) Dynamic frequency spectrum of magnetic fluctuations obtained from Plasma Wave Experiment/Onboard Frequency Analyzer (PWE/OFA). (Bottom) Electron flux distributions as functions of pitch angle and energy obtained from MEP-e at time intervals at around 19:20:17, 19:20:25, 19:20:33, and 19:20:41 UT. Electrons responsible for each flux distribution are detected in the time range of ±4 s.

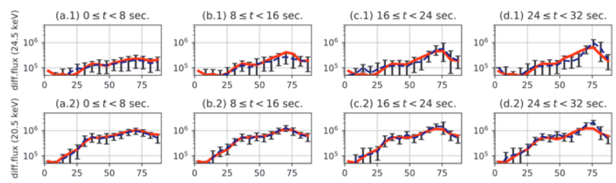

Figure 2 Pitch angle distributions at 20.5 and 24.5 keV. Blue lines are electron fluxes taken from the Medium Energy Particle Experiment-electron analyzer (MEP-e) onboard Arase averaged over 8 s, black error bars are the standard deviations of the fluxes obtained during the time interval, and red lines are calculated from the test-particle simulation.

Reference

Kurita *et al.* (2018). Deformation of electron pitch angle distributions caused by upper band chorus observed by the Arase satellite. *Geophysical Research Letters*, 45, 7996– 8004. https://doi.org/10.1029/2018GL079104