Two-dimensional electromagnetic particle simulation of whistler-mode triggered emissions

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We perform two-dimensional electromagnetic particle simulations to study basic characteristics of whistler-mode wave particle interaction involved in chorus emissions propagating oblique to the static magnetic field. We assume a simple periodic (x, y) system with the magnetic field taken in the x-direction. Assuming energetic electrons with an anisotropic bi-Maxwellian velocity distribution function, we first test the linear whistler-mode instability driven by temperature anisotropy to confirm the numerical property of the simulation code. With the electrostatic components parallel to the magnetic field, which have been neglected in the previous simulation studies on chorus emissions, we find the linear phase of the instability is much affected by the Electrostatic thermal fluctuations.
It is necessary to put many super-particles in a grid cell to suppress the thermal fluctuation. With 30,000 particles per cell, we have confirmed a good agreement of the wave growth in the parallel direction with the linear growth rate. We next put an array of antennas with obliquely aligned to uniform magnetic field, and oscillate the antenna current with a variable frequency below the electron cyclotron frequency to excite a large amplitude whistler-mode wave obliquely propagating to the static magnetic field. In addition to the nonlinear trapping of energetic electrons through the cyclotron resonance, another nonlinear trapping of electrons by the Landau resonance takes place. Structures of the nonlinear trapping potentials changes with a varying frequency, affecting the efficiency of energy transfer between the wave and energetic electrons. We study nonlinear evolution of the wave packet, and competing processes of both resonances in accelerating the energetic electrons to higher energies.