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Electron hybrid simulation of nonlinear wave growth of whistler-mode waves in an inhomogeneous magnetic field

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We have proposed the nonlinear wave growth theory for the generation mechanism of whistler-mode chorus emissions, based on the theoretical consideration and the analyses of the simulation result [Omura et al., 2008; Katoh et al., 2008]. The nonlinear growth theory suggests that the frequency sweep-rate of a chorus element is related to the wave amplitude of coherent chorus elements in the region close to the magnetic equator. We have confirmed this prediction by performing simulations with different initial number densities of energetic electrons and have shown that the frequency sweep-rates of reproduced chorus vary depending on the variation of the wave amplitude of each chorus element. We have also found that the theoretically estimated frequency sweep-rates are consistent with the simultion results, validating the accurary of the nonlinear growth theory. We expect that the nonlinear wave growth theory can be applied for the generation process of VLF triggered emissions.
We have conducted numerical experiments of the nonlinear wave particle interactions in an inhomogeneous magnetic field by using an originally developed electron hybrid code. The electron hybrid code is a simulation code based on the model which treats background cold electrons as a fluid and hot electrons as relativistic particles by PIC method. We solve the evolution of electromagnetic waves propagating along a reference magnetic field line by Maxwell's equations with computing the bounce motion of energetic electrons in the non-uniform magnetic field. In the present study we discuss the details of the nonlinear wave particle interaction in the generation process of chorus emissions and triggered emissions by analyzing the simulation results.