Simulation study of the dependence of the whistler-mode chorus generation on properties of energetic electrons in the Earth's inner magnetosphere

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By a series of self-consistent electron hybrid code simulations, we study the dependence of the generation process of whistler-mode chorus emissions on the properties of the velocity distribution function of energetic electrons. In particular, in the present study, we focus on the temperature anisotropy and density of energetic electrons in the Earth's inner magnetosphere. We use the same magnetic field gradient in the simulation system and different temperature anisotropy A_T for the initial distribution of energetic electrons at the magnetic equator. We conduct 6 sets of simulations for different A_T from 4 to 9, changing the initial number density N_h of energetic electrons at the equator in each set of simulations. By analyzing the spectra obtained in the simulation results, we identify chorus elements with rising tones in the results for higher N_h but no distinct chorus in smaller N_h. We compare the simulation results with estimations of the threshold and optimum amplitude proposed by the nonlinear wave growth theory. We find that the chorus generation processes reproduced in the simulation results are consistently explained by the theoretical estimates. We also compare the simulation results with linear growth rates for all simulation runs. We find clear disagreement between the spectral characteristics of reproduced chorus and the predictions by the linear theory. The present study clarifies that the spectra of chorus are essentially different from those predicted by the linear theory and are determined fully by nonlinear processes of wave-particle interactions in the chorus generation region.

Keywords: whistler-mode chorus, numerical experiments, inner magnetosphere