Relationship between the frequency sweep rates and the wave amplitude in the generation process of whistler-mode chorus emissions

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Based on the theoretical consideration and the analyses of the simulation result, the nonlinear wave growth theory has been proposed for the generation mechanism of whistler-mode chorus emissions [Omura et al., 2008]. The nonlinear growth theory predicts 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 performed simulations by assuming different initial number densities of energetic electrons and have found that the frequency sweep-rates of reproduced chorus vary depending on the variation of the wave amplitude of each chorus element. We have also confirmed that the theoretically estimated frequency sweep-rates are consistent with the simultion results, validating the accurary of the nonlinear growth theory.

Moreover, in the simulation results, we have found the existence of the threshold amplitude of coherent waves in the chorus generation process. The simulation results show that the coherent chorus elements appear after the wave amplitude of whistler-mode waves exceeds the certain level through the linear growth phase due to the instability driven by the temperature anisotropy of energetic electrons. The simulation results have also revealed that the generation of chorus terminates in the later stage of the simulation. These results suggest a possiblity that the relaxed velocity distribution of energetic electrons results in the decrease of the wave amplitude of whistler-mode waves not enough to generate chorus emissions. The result of the present study serves an important clue in understanding the generation mechanism of chorus emissions and validates the proposed nonlinear wave growth theory.