Effect of ECH waves on pitch angle scattering of energetic electrons

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Electrostatic Cyclotron Harmonic (ECH) waves are electrostatic emissions observed in bands between the harmonics in the electron gyrofrequency, f_{ce}, which were first reported by Kennel et al. [1970] based on the OGO-5 observations. The amplitudes of ECH waves reported from the OGO-5 data are very large, typically between 1-10mV/m and sometimes as large as 100 mV/m [Kennel et al., 1970]. The wave amplitudes are large enough to cause the strong pitch angle diffusion for electrons in the energy range of a few hundreds eV to several keV, suggesting that the ECH waves could be responsible for diffuse auroras [Lyons, 1974]. Subsequently, Belmont et al. [1983] showed that such large amplitude (greater than 1 mV/m) ECH waves were rarely (lower than 2%) observed by GEOS-2 and concluded that the ECH wave activity is more modest. Recent theoretical and modeling studies by Thorne et al. [2010] concluded that whistler mode chorus waves rather than ECH waves play a dominant role in electron scattering in the velocity space in the inner magnetosphere. While, correlation analyses of auroral intensities and ECH wave amplitudes suggest that electron scattering by the ECH waves results in diffuse auroras [e.g., Nishimura et al., 2010; Liang et al., 2010]. In this study, using the plasma wave and electron data obtained from the THEMIS spacecraft, we examine whether ECH waves can contribute to electron scattering in the velocity space or not. Since contours of an electron velocity distribution function (VDF) follow the diffusion curves of whistler mode when whistler mode waves are active [Cully et al., 2011], the diffusion curve of whistler mode can be used as a marker to identify changes of VDFs due to wave-particle interactions. We compared the contours of VDF when ECH waves were active following the inactivation of whistler mode waves with the diffusion curves of whistler mode. It is found that the contours deviated from the diffusion curves in the pitch angle range below ~20 degrees when ECH waves were active. The calculation of quasi-linear pitch angle diffusion rates for ECH waves shows that scattering by ECH waves are most effective in the pitch angle range below ~30 degrees [e.g., Lyons, 1974; Ni et al., 2011], which is roughly consistent with the pitch angle range where the deviations between the contours and the diffusion curves are observed. We suggest that the result is an observational evidence of electron scattering driven by ECH waves and that ECH waves can contribute to the generation of diffuse auroras.