Frequency structure and polarization of MF/HF auroral radio emissions observed in the topside ionosphere

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Auroral radio emissions are generated at ionospheric F-region altitudes in the medium and high frequency bands (MF/HF) and propagate towards the ground and outward into space. Satellite-level MF/HF auroral radio emissions, which were termed terrestrial hectometric radiation (THR), are band-limited signals like ground-level auroral roar. We report on the statistical properties of frequency structure and polarization of THR emissions using a long-term data set obtained from the Plasma Waves and Sounder (PWS) experiment mounted on the Akebono satellite in the polarization (PL) mode operation. The PL mode observation provides the power spectra of right- and left-handed polarized components (I_R and I_L), whose rotation is viewed from the normal direction of the antenna plane. We analyzed multi events where THR emissions appeared simultaneously in two discrete frequency ranges (THR-L and THR-H). THR-H was about twice the frequency of THR-L, as in the case of minor ground-level event of simultaneous $2f_{ce}$ and $4f_{ce}$ roars. The sign of axial ratio $(I_L - I_R)/(I_L + I_R)$ of THR-L was opposite to that of the simultaneously detected THR-H. The axial ratio is applied to identify the propagation mode of the electromagnetic waves with the assumption that the source of the waves is in an altitude region lower than the satellite position in the night-side auroral latitude. The observed axial ratio is consistent with the hypothesis that THR-L and THR-H respectively correspond to O- and X-mode electromagnetic waves. The observed harmonic frequency structure and polarization feature support the idea that O-mode THR-L results from linear conversion of upper hybrid waves generated under the condition of $f_{UH} \sim 2f_{ce}$, and harmonic X-mode THR-H is attributed to the nonlinear wave-wave coalescence of two upper hybrid waves generated under the same matching condition. However, we also found that the upper limit frequency of THR-H was slightly higher than twice the upper limit frequency of THR-L, and the normalized frequency bandwidth of THR ($\Delta f/f$) was often more than 0.1, unlike ground-level auroral roar. The explanation of these observed features should involve other factors related to the excitation of upper hybrid waves and mode conversion processes.

