Statistical and case studies of MF/HF auroral radio emissions emanating from the topside ionosphere

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This is a brief report on polarization features and the source region of MF/HF auroral radio emissions emanating from the topside ionosphere. Data shown in this paper were obtained by the Plasma waves and sounder experiment (PWS) mounted on the Akebono satellite. The Akebono/PWS measurements show that band-limited natural radio emissions are often observed in a frequency range of 1-4.5 MHz when the satellite passed over the auroral latitudes during geomagnetic disturbances. These MF/HF auroral radio emissions are called “Terrestrial Hectometric Radiation (THR)” and regarded as a counterpart of auroral roar and MF burst which are observable from the ground. The PL mode observation of Akebono/PWS measures the spectra of right-handed and left-handed polarized components (I_R and I_L), whose rotation is viewed from the Z-axis of the satellite, which is perpendicular to the antenna plane and parallel to the spin axis.

The Akebono/PWS measurements show that THR typically occurs in either or both of two frequency bands near 1.5–2.0 MHz and 3.0–4.0 MHz. A multi-event study shows that the axial ratio $(I_L - I_R)/ (I_L + I_R)$ of the THR emissions show a clear difference between these two bands; the axial ratio of the lower band is positive in the night MLT sector and negative in the dawn and dusk MLT sectors, and the axial ratio of the upper band has opposite sign in each MLT sector. The axial ratios can be applied to identify the propagation mode of the THR esmissions with the assumption that the source of the waves is in an altitude region lower than that of the satellite position in the night-side auroral latitude, and the waves come from the positive direction of the satellite Z-axis. The assumption leads to the conclusion that the THR emissions in the lower and upper bands are L-O and R-X mode waves, respectively. The R-X mode, which has never been reported as auroral roar and MF burst, can be attributed to nonlinear coupling of two upper hybrid waves. The Akebono satellite can not only observe THR emissions away from their source regions, but also provide a rare opportunity for the in-situ measurement of the source regions. We present one particular THR event where the Akebono satellite crossed through the THR source region. This Akebono satellite observation shows THR emissions merge with upper hybrid waves in a frequency-time diagram under the matching condition $f_{UH} \sim 2f_{ce}$. This observation suggests that plasma instability enhances the upper hybrid waves under this condition, and then they are converted into electromagnetic THR emissions