Frequency and source height of MF/HF auroral radio emissions estimated from the results of EXOS-D/PWS sounder experiments

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The Earth’s auroral ionosphere is an abundant source region of radio emissions related to the auroral activity. A variety of auroral radio emissions (e.g., auroral hiss, MF burst and auroral roar) have been reported by previous ground-based radio observation [e.g., Sato et al., 2008]. Auroral roar is narrowband emissions observed in the MF/HF ranges and is believed to be generated through the mode conversion from electrostatic upper hybrid waves to LO-mode electromagnetic waves at an altitude where the condition that the local upper hybrid resonance frequency is equal to the integral multiple of the local electron cyclotron frequency ($f_{UHR}=nf_{ce}$, where n=2,3,4 and 5) is satisfied. Since the condition should be satisfied not only at the bottomside but also at the topside ionosphere, the mode conversion has been applied to the generation mechanism of Terrestrial Hectometric Radiation (THR) [Oya et al., 1985] radiated from the topside ionosphere to the space. Sato et al. [2010] analyzed radio emissions observed by Plasma Wave and Sounder experiments (PWS) of the AKEBONO (EXOS-D) satellite and reported an example of THR whose spectral characteristics is similar to auroral roar. Although previous studies suggested that THR is considered to be the counterpart of auroral roar, which was identified up to $5f_{ce}$ [LaBelle et al., 2012], THR has been reported only as $2f_{ce}$ emissions except for the RX-mode THR. The plasma environment of the source region of THR should be clarified so as to understand this difference.

In this study, we analyze data obtained from topside sounder experiments by PWS on board the AKEBONO satellite from March 19 to April 18, 2015. We analyze observed ionograms to obtain the height profiles of plasma density. Compared to empirical models such as the International Reference Ionosphere (IRI) model, the sounder experiments can provide more accurate plasma density profiles. The derived density profiles are converted to f_{UHR} profiles in order to estimate the possible frequency and source height of THR. We focus on data obtained in the region of latitude 50-80°N and longitude 50°W-50°E, while the simultaneous ground-based observation has been carried out at Svalbard (latitude 78.15°N, longitude 16.04°E) and Iceland (latitude 64.67°N, longitude 21.03°W). We have obtained 50 density profiles in the selected area and estimated that the expected frequency and the source height of THR corresponding to $2f_{ce}$ are 440-1090km and 1.9-2.5MHz, respectively. We have also found that the matching condition $f_{UHR}=3f_{ce}$ was satisfied in 2 cases out of 50 analyzed profiles, which suggests the possibility of the generation of THR corresponding to $3f_{ce}$. From that 2 cases, we have estimated that the expected frequency and the source height of THR corresponding to $3f_{ce}$ are 330-450km and 3.8-3.9MHz, respectively. In addition, we analyze radio emissions observed by PWS in the selected area during the analyzed period. We have identified 1 event which is considered to be THR corresponding to $2f_{ce}$, and have found that the emission frequency is within the frequency range estimated by the present study.

Keywords: auroral roar, Terrestrial Hectometric Radiation , AKEBONO satellite

