

The precipitation and diffusion of energetic particles induced by HF heating facility

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The ionospheric heating experiments between DEMETER and HF (high grequency) heating facilities on the ground have been carried out a lot of times during its operation time in 2004-2010, in which many perturbations in plasma parameters were detected in the topside ionosphere. However, as one of the major topic in ionospheric heating and magnetospheric physics, the real observations in energetic particle diffusion excited by HF heater have been rarely reported. In this paper, we collect all the SURA-DEMETER heating events, and exhibit a few cases with energetic particle perturbations over heating region.

Two typical events are identified with disturbances in high energy particles on May 12 2008 and Aug. 27 2009 respectively during SURA heating experiments. In our previous study, there occurred intensive plasma perturbations simutaneously. From Figure 1, the bumping waves from SURA falicity were detected on HF spectrum at 2.36MHz. and the energetic particles presented clear enhancement at energy band 70-100keV. With the HF heating process, perturbations in electric field were presented in broad frequency bands from 19Hz to 20kHz, and the intensive disturbances occurred below 600Hz in VLF spectrums in the middle panel of Figure 1. As for Relative to the HF wave intensity centers, perturbations in VLF and energetic particles exhibited a little drift to the south direction. The two events illustrated two facts: (1) the simultaneous electromagnetic emissions excited by HF heater; (2) only lower energy band of electrons precipitating over the same heating region. It demonstrates the direct relationship between HF heating and energetic particle precipitation.

In total 29 SURA-DEMETER experiments, only two passes observed the variations in pitch angle over SURA heater, along the orbit of 33262_1 on 18 Sep. 2010, and 33306_1 on 21 Sep. 2010. Over SURA heating region, the pitch angle of electrons decreased firstly, increased to reach a maximum, and then recovered to the normal ascending trend. The variation amplitude in pitch angle was about 0.03°. The pitch angle variations over the heating region were too small, but they can be easily distinguished under their smoothing background curves.

With the low orbiting satellite DEMETER which can measure wave and energetic particles and the multi times of experiments between SURA-DEMETER, it was possible to exhibit for the first time the in-situ electron precipitations and their pitch angle diffusion just over the heating region. Among different frequency band signals excited by HF heating process, the kHz whistler waves under the non-ducted propagation mode may be the major contributor to precipitated electrons, and the enhanced VLF transmitter signals play some roles in pitch angle modulation, while ULF/ELF electrostatic waves for direct effects on energetic particle scattering needs further study.



Figure 1. The energetic particle precipitation (left) and pitch angle diffusion (right) above SURA facility. **Acknowledgement**: This paper is supported by NSFC project (41674156).