Analysis of DC electric fields and ELF waves observed by SS-520-2 sounding rocket in the polar region

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SS-520-2 sounding rocket was launched from Norway at Dec. 4, 2000 to observe plasma acceleration and heating in the low altitude polar region. In this region, the ion acceleration heating processes are considered to be related to low frequency electrostatic waves, especially oxygen ion cyclotron waves are expected to play an important role in ion heating processes. In addition, it is natural that DC electric field accelerate ions in this region. To identify these ion heating and acceleration mechanisms, we developed EFD (Electric Field Detector) onboard SS-520-2 rocket. EFD is a subsystem of PWA (Plasma Wave Analyser), and is designed to observe DC electric fields and ELF plasma waves with frequencies of 0–50Hz. During this rocket experiment, EFD worked properly and succeeded to obtain clear electric field data. We have been analyzing these EFD data to identify DC electric fields and ELF plasma waves.

In the rocket experiments in the polar region, observed DC electric fields contain a strong inductive electric field component ($\boldsymbol{V} \times \boldsymbol{B}$). We removed this inductive $\boldsymbol{E}$ field component and extract real DC electric fields. With some assumpitions, the existence of DC electric fields are confirmed around the apogee of rocket trajectory. The amplitudes of these DC electric fields are up to 50mV/m, and their directions are almost south-west. Since these DC electric fields are very weak to accelerate heavy ions, such as oxygen ions, we consider these are the convection electric fields in the polar region. Corresponding $\boldsymbol{E} \times \boldsymbol{B}$ drift velocities are almost 1500m/s, and their directions are south-east as shown in Figure 1. We are going to investigate relations between DC electric fields and accelerated ions by comparing these DC electric fields and ESA/ISA particle observations,

During all the observation time, on the other hand, no clear ELF waves are observed in EFD data. This is because SS-520-2 rocket straied from the cusp region, where the ion heating phenomena are frequently observed. In almost all the EFD data, however, strong harmonics of spiky pulses are observed. These pulses are due to the photoelectron emissions, and this photoelectron emission is strongly influenced by the local plasma environment, especially electron temperature and density.

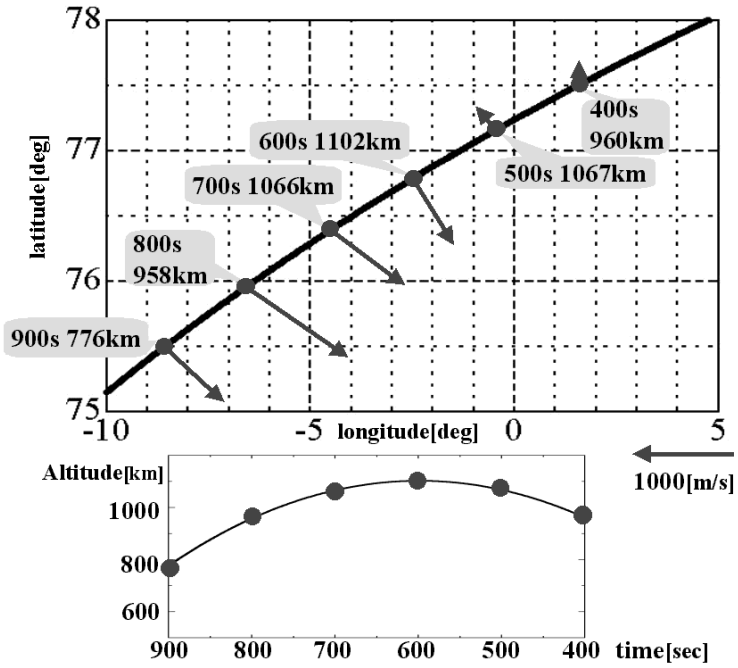

Figure 1: The transition of $\boldsymbol{E} \times \boldsymbol{B}$ drift velocities