Observation of electron temperature in the polar cusp by SS-520-2 sounding rocket

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The high latitude ionosphere is known as a specific region where the geomagnetic field lines are open for the interplanetary space. It is generally accepted that the plasma existing in the high latitude region is essentially different in its dynamics from that in the low- and mid-latitude regions. Observations from the satellite and ground based radar have revealed that a great amount of ions are escaping from the polar ionosphere, and transported into the magnetosphere, which has been paid attention as a noticeable phenomenon. While light ion (H+ and He+) outflow was predicted by the classical polar wind theory, some additional mechanisms should play an important role in accelerating heavy ions to the escape velocity. Therefore, it is an important subject to study on this outflow process.

In December 2000, a sounding rocket experiment was carried out in Norwegian Spitzbergen Island to reveal this ion outflow mechanism. The present study has been based on the electron temperature data obtained in the vicinity of the dayside cusp from TEL (Temperature of ELectron) probe onboard SS-520-2 rocket. The electron temperature is one of the important parameters for studying on plasma acceleration and the heating processes. We have succeeded to estimate electron temperatures more accurately by data processing of the telemetry signal from the rocket, in particular by developing a method that corrects an influence of the plasma disturbance around the rocket on the probe signal. The electron temperature obtained by the present process shows characteristic feature of the thermal electrons in the polar ionosphere, and suggests that the temperature variation has small structures.

Main results of the present study are summarized as follows:

1) It is confirmed that the floating potential level, which is used to calculate the electron temperature, changes periodically depending on a spin phase of the rocket.

2) A method to correct the floating potential levels influenced by the rocket spin is proposed.

3) A general trend of the electron temperatures in the range of 2000-4000 K at altitudes of 300-1000 km is considered to be consistent with the average temperature in the polar ionosphere. However, the temperature variation with a small-scale structure is found to exist at altitudes of 500-800 km.

4) The electron temperature increase is observed to be in a good correlation with an increase in the downward flux of the low energy (several hundreds eV) electrons observed by the ESA (Electron Spectrum Analyzer).