

Observation of electron temperatures in the polar lower thermosphere by Langmuir probe during the DELTA campaign

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The sounding rocket S-310-35 was launched at 00:33:00 UT on 13 December 2004 from Andoya Rocket Range in Norway, during the DELTA (Dynamics and Energetics of the Lower Thermosphere in Aurora) campaign. On the sounding rocket, the payload zone was separated into two stage; upper and lower stages to avoid a possible influence of positive charging due to electron beam emission by the NTV (Neutral Temperature of Vibration) instrument. The FLP (Fast Langmuir Probe) was installed on the lower stage while the NTV being on the upper stage.

The FLP was developed to measure the electron temperature and number density in the lower ionosphere. During the rocket flight, the FLP successfully measured the voltage versus current relationship of the probe.

The electron temperatures were estimated by evaluating the relationship between the probe current versus voltage. In the rocket's wake region, the temperature tends to be overestimated because of a distortion of the probe characteristics. Such high temperatures are not considered, when discussing the general trend of the temperatures. Altitude profile of the electron temperature indicates the local increase by several hundreds K at 106 km -110 km during the rocket's ascent. A possible influence of the NTV on the Langmuir probe measurement was considered if it is responsible for the temperature enhancement. However, it is possibly less than predicted because the variation of the rocket potential at the time of the rocket separation is insignificant. Heating due to precipitating electrons may cause the local increase of temperature. In fact, the region where the local increase of the electron temperature was observed is in good agreement with that of bright auroral emission identified by all-sky imager, and moreover an enhancement of the precipitating electron energy flux was simultaneously observed by APD (Aurora Particle Detector). However, in general, the precipitating electron heating is unlikely responsible for the temperature increase in such a low-altitude region.

When the rocket was descending, the electron temperature was observed to slightly increase at an altitude between 114 km and 118 km. It is not appropriate to explain the increase by heating due to precipitating electrons, because no auroral emission was observed in the corresponding region by all-sky imager and no electron fluxes were identified by APD. It should be considered if Joule heating can be responsible for the electron temperature increase by comparing with the electric field distribution near the rocket trajectory. Noticeable feature in the probe characteristics from which such temperature increases were obtained is that the probe current contains a high-frequency fluctuation, suggesting that a small scale density perturbation exists in this region.

In this presentation, we will discuss a possible cause of the local electron temperature variations in the polar lower ionosphere as well as its relationship with the all-sky imager data.