Fast Langmuir Probe observation of the electron temperature in the DELTA

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The "Dynamics and Energetics of the Lower Thermosphere in Aurora" (DELTA) rocket was successfully launched from Andøya Rocket Range in Norway at 0033 UT on December 13, 2004. The objective of DELTA campaign is to study the upper atmospheric dynamics and energetics associated with the auroral energy input. The instruments onboard the rocket successfully made in-situ measurements of neutral atmospheric temperature and density as well as auroral emission rate, electron density and temperature. The Fast Langmuir Probe (FLP) is one of the eight instruments onboard, and its main objective is to measure the electron density and electron temperature from the current – voltage relationship of the cylinder Langmuir probe in the low altitude ionospheric F region. The measured density and temperature variations are used for a comparison with the neutral temperature and wind as well as the electron temperature and density derived from the EISCAT observations for a study of the dynamics and energetics in the lower thermosphere.

The probe is a cylindrical shape with a length of 14 cm and a diameter of 3 mm. The stainless probe was baked at the temperature of 200ºC for about 24 hours to get outgas from the probe surface, and subsequently the probe is glass-sealed. The glass was cut and removed during the rocket flight (approximately at the altitude of 70 km) so that the probe could start measuring with a clean surface. After that, the probe was deployed in the direction vertical to the rocket spin axis to measure the electron/ion current outside of the rocket sheath.

The probe was directly biased by a triangular voltage with amplitude of 3 V with respect to the rocket potential in order to provide the incident current – voltage relationship. The electron current incident to the probe was amplified and subsequently transferred to the telemeter. Three levels of the current gain; low, middle, high, were prepared so that the probe could measure in a wide range of the electron density. In order to measure the ion current as well as the electron current, the amplifier has an offset voltage of +1 V; a positive (larger than 1 V) voltage means the electron current while a negative one does the ion current. The calibration signal was obtained by switching the input from the probe to the resistance.

During the rocket flight, the FLP started detecting thermal electrons and ions after being deployed from the payload section. The preliminary analysis of the FLP data shows that the electron temperatures are in the range from 600 K to 900 K at 100-140 km altitudes. In particular, the electron temperatures observed during the descending phase represent a remarkable increase in the altitude region from 108 to 118 km. This temperature structure may be related to the electron heating caused by particle precipitation in the polar ionosphere. We present a result of the further analysis on such a characteristic structure of the electron temperature as well as a possible comparison with other observations.