Coordinated in situ and remote sensing measurements of neutral temperature in the high-latitude lower thermosphere

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The dissipation of electromagnetic energy originating in the magnetosphere plays an important role in the energy budget controlling the neutral temperature of the high-latitude lower thermosphere. The electromagnetic energy transfer rate is described as the sum of the Joule heating rate and the mechanical energy transfer rate, and the Joule heating contributes to neutral temperature enhancements. These quantities can be estimated by observations using incoherent scatter radars. However, correspondence of the Joule heating rates to the resulting neutral temperature is presently not well investigated due to the lack of precise measurements of neutral temperature.

This paper reports on comparison of neutral temperatures observed by a sounding rocket and ground-based Fabry-Perot Interferometers (FPIs) and quantitative estimation of the Joule heating rate from the European Incoherent Scatter (EISCAT) radar during the Dynamics and Energetics of the Lower Thermosphere in Aurora (DELTA) campaign. The S-310-35 sounding rocket was launched from Andoya Rocket Range in Norway at 0:33 UT on 13 December 2004, and rotational temperatures of molecular nitrogen at altitudes of 100-140 km were measured by the N_2 temperature instrument (NTV) onboard the rocket. The observed rotational temperature, which is expected to be equal to the kinetic temperature in the lower thermosphere, is 70-140 K higher than neutral temperature from the MSIS model above 110 km. Neutral temperatures were also observed using the auroral green line at 557.7 nm by the two FPIs at Skibotn and Kiruna. The neutral temperatures derived from the look directions closest to the rocket correspond to the rotational temperature measured at an altitude of 120 km. In addition, a combination of the all-sky camera images at 557.7nm observed at two stations, Kilpisjarvi and Muonio, suggest that the most optimum altitude of the aurora arc at the time of the launch is about 120 km. The observed neutral temperature is consistent with the observed rotational temperature at 120 km rather than the MSIS model profile. On the other hand, the result from the EISCAT observation suggests the presence of strong Joule heating at 110-130 km altitudes about 30 minutes before the

rocket launch. Quantitative estimation of the temperature enhancement by the Joule heating is compared with the observed rotational temperature profile and the MSIS model profile.