Vertical profiles of neutral temperature and Joule heating rate during the DELTA campaign

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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 polar 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. The relation between these terms can be estimated by observations using incoherent scatter radars. However, correspondence of the vertical distribution of the Joule heating rates to the resulting temperature structure is presently not well investigated due to the lack of neutral temperature observations.

This paper reports on the comparison between the neutral temperature profile observed by a sounding rocket and the vertical distribution of the Joule heating rate observed 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 N2 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. On the other hand, the result from the EISCAT observation suggests the presence of a strong Joule heating at 110-130 km altitudes about 30 minutes before the rocket launch. Quantative estimation of the temperature enhancement by the Joule heating is compared with the observed neutral temperature profiles.