Estimation of F-region neutral temperature from ion temperatures measured by two EISCAT radar beams with different aspect angles

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A steady-state ion energy equation is written by the balance between ion-neutral heat exchange and ion frictional heating, neglecting viscous heating, heat conduction and heat advection. In the presence of strong dc electric fields, the F-region ion velocity distribution is anisotropic, and is approximated by bi-Maxwellian for the electric field below about 50 mV/m. The neutral temperature is related to the ion temperatures parallel and perpendicular to the geomagnetic filed as

$$Tipara = Tn + BparaMn (V - U)2/(2kB) \quad (1)$$
$$Tiperp = Tn + BperpMn (V - U)2/(2kB) \quad (2)$$

The line-of-sight ion temperature TiX measured by the beam with the aspect angle X is give by

$$TiX = Tipara\ cos2(X) + Tiperp\ sin2(X) \quad (3)$$

A simultaneous measurement by the EISCAT-UHF radar at Tromsoe (UHF radar) and the Svalbard radar at Longyearbyen (ESR) was performed in July 09-10, 2001. In this experiment, the beams with the elevation angle of 30 deg of the UHF radar and the ESR measured the ion temperatures in the regions close each other at about 330 km height. The geographic latitudes of the two scattering volumes were almost the same and the geographic longitudes were different by about 3.2 deg. The horizontal distance in the zonal direction is about 120 km. By assuming that the ion and neutral temperatures were uniform in the zonal distance of about 100 km, the parallel and perpendicular ion temperatures are derived by using equation (3). The aspect angles of the beams of the UHF radar and the ESR were 72.8 deg and 51.6 deg, respectively.

In this paper, the neutral temperature and the ion frictional heating are also derived by using the parallel and perpendicular ion temperatures with equations (1) and (2). The partition coefficients Bpara and Bperp are assumed to be 0.3 and 0.85, respectively. The variations of the derived parameters as a function of the geomagnetic local time are discussed.