An anomalous effect of the dynamo layer ion-to-electron overheating as a function of the altitude and ionospheric E-field strength

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About two thousands of coordinated STARE-EISCAT measurements stored during the ERRRIS campaign are analysed. The data covering the E-layer 90-130 km altitude range provide average altitude and temporal resolutions of about 3 km and 90s, respectively. The analysed ion and electron temperatures are averaged over altitude layers having characteristic scale from 3 till 20 km. The ionospheric E-field strengths are averaged in 5 mV/m bins covering 0-40 mV/m range; the azimuthes are averaged and 30 degree bins, respectively.
From analysis of the average altitude profiles of ion and electron temperature difference (Ti - Te)(h) it is shown that:
1) Systematic ion-to electron overheating there exist in small (under FB-threshold) E-fields within about 102-117 km altitudes. Maximum of the phenomenon is observed in about 10 km width layer centered at about 110 km altitude. Maximal average value of the overheating (about 50 Kelvin) take place for the minimum E-field bin (0-5 mV/m).
2) The altitude of about 117 km plays a role of a separatrix subdividing ranges with the opposite sign of the temperature difference for E-fields less than 10 mV/m: Ti<Te for h>~117 km and Ti>Te for lower altitudes.
3) For greater E-fields the ion-to-electron overheating (Ti>Te) dominates already everywhere within the E-layer altitudes. Moreover, the second Ti-Te maximum appears around 120 km altitude beginning from about 20 mV/m E-fields.
4) However, the behaviour of the mean altitude profile undergoes dramatical change just as the E-field exceeds the threshold value of about 30-35 mV/m. In particular, just above the threshold a new maximum of the opposite (electron-to-ion) overheating primarily appears within rather narrow (of about 2.5 km width) layer centered at 110 km altitude. For greater E-fields such well known the FB-heating (Te>Ti) dominates everywhere within about 107-117 km altitude range.
In course of the interpretation it is concluded that Joule heating of the E-layer ions seems to be most probable physical cause of the anomalous effect (Ti > Te). The conclusion is confirmed by rather simple quantitative modeling of the Pedersen ion current heating rates estimated for several altitudes of the E-layer made in the discussion part of the paper.