

On the isotropic electron temperatures in the turbulent polar E-region with EISCAT CP data

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It is generally accepted that Strong electron temperature enhancements in the polar E-region is due to electrostatic waves excited by the modified two-stream instability, or Farley-Buneman instability. Solving the energy balance equation for electrons, we have estimated the effective collision frequencies between electrons and waves. The results show that they can be of the order of MHz.

We have compared electron temperatures measured from two directions. The results show that electron temperatures are isotropic, not anisotropic, in contrast to the expectation that they would be anisotropic since irregularities measured by coherent radars tend to be field-aligned.

Strong electron temperature enhancements in the polar E-region have been reported by many authors. Now it is generally accepted that it is due to electrostatic waves excited by the modified two-stream instability, or Farley-Buneman instability. When the relative drift velocity between electrons and ions exceeds the local ion acoustic speed, the instability gets excited and grow exponentially until its growth is limited by non-linear processes. Such waves scatter electrons and deflect their drifts away from the ExB direction to the E direction. Solving the energy balance equation for electrons, we have estimated the effective collision frequencies (known as anomalous collision frequencies) between electrons and waves. The results show that they can be of the order of MHz.

From coherent radar measurements, it is known that irregularities tend to be field-aligned. Such field-aligned waves would scatter electrons within a plane perpendicular to the magnetic field, resulting in the situation that field-perpendicular electron temperatures would be higher than field-parallel. Since the anomalous collision frequencies are much larger than classical electron-neutral collision frequencies, the latter are too infrequent to distribute the thermal energy isotropically in all directions. However, the observations show that electron temperatures are isotropic, not anisotropic, in contrast to this expectation above. The process that isotropizes the electrons is not clear, but we will suggest a probable explanation of our observation.

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