Abstract

We have studied some effects of electrostatic waves and turbulences on the plasma in the auroral both E and F regions both experimentally and theoretically.

In the E region, electron heating by Farley-Buneman waves are studied using the EISCAT CP-1 data. We find that electrons are strongly heated in the magnetic field-line direction during high electric field events. The remote site data show that the electron temperature increases almost the same amount as in the field-perpendicular direction, and that electron heating by E region plasma turbulence is isotropic. We discuss the implementations of our observation for the "plasmon"-electron as well as the wave Joule heating models of the anomalous electron heating in the E region. [St.-Maurice, 1987]'s model which shows that Farley-Buneman waves have an electric field component both perpendicular and parallel to **B** and effectively heat electrons can explain our results. We also suggest that if T_e enhancement is rather due to a direct scattering of electrons by wave fields not involving electron-neutral collisions, our observation implies that these waves should be isotropic.

Because the total energy is conserved, we argue that electrons must partly drift along the background electric field when the electron temperature is elevated above the background neutral temperature. We parameterize the effect of the waves by the anomalous (effective) electron collision frequency $\nu_e^\star$. We find that a rotation of the electron flow direction from a $\mathbf{E} \times \mathbf{B}$ direction can be up to $\sim 8°$. Although we could not confirm the rotation with the STARE data, we point out the possibility of using an optical instrument to test our results. We also discuss the importance of electron heating on the Magnetosphere-Ionosphere coupling.

By using the Kilpisjärvi IRIS data, we examine the nature of the anomalous (effective) electron collision frequency. We find that including $\nu_e^\star$ in the absorption model leads to overestimation of the cosmic noise absorption when compared with observation by the Kilpisjärvi IRIS. We find that $\nu_e^\star$ has a limited range of application.

In the F region, we have studied incoherent scatter spectra which are a scattering of electromagnetic waves by electrostatic ion acoustic waves and Langmuir waves. We have theoretically calculated incoherent scatter spectra for a plasma that consists of electrons with kappa distribution function and ions with Maxwellian neglecting the effects of the magnetic field and collisions.

The ion line spectra have a double-humped shape similar to those from a Maxwellian plasma. The electron temperatures are underestimated, however, by up to 40% when interpreted assuming Maxwellian distribution. Ion temperatures and electron densities are affected little. Accordingly, actual electron temperatures might be underestimated when energy input maintaining a high energy tail exists. We have also calculated plasma lines with the kappa distribution function. They are enhanced in total strength, and the peak frequencies appear to be slightly shifted to the transmitter frequency compared to the peak frequencies for a Maxwellian distribution. The damping rate depends on the electron temperature. For lower electron temperatures, plasma lines for electrons with a κ distribution function are more strongly damped than for a Maxwellian distribution. For higher electron temperatures, however, they have relatively sharp peaks.