The effect of ion-scale dynamics on electron-temperature-gradient turbulence

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Abstract. This work reports on numerical studies of small-scale electron-temperature-gradient (ETG) turbulence embedded in large-scale turbulence driven by both ion-temperature-gradient (ITG) modes and trapped-electron modes (TEM). To begin with, we find that the simplified adiabatic-ion model of ETG turbulence does not always saturate nonlinearly, suggesting that corrections to the purely adiabatic ion response are required for robust saturation. Our results also qualitatively confirm a prediction of Holland and Diamond that the back-reaction of ETG on ITG turbulence is insignificant. For the parameters studied, we find that ETG turbulence levels are reduced as ion driving gradients are increased. This result is at least partially explained by linear physics. An important practical result of this work is the finding that most of the electron energy transport arises from ion scales ($k_\theta \rho_i < 1$) in cases for which ion-scale instabilities are not suppressed. Specifically, for the Cyclone base case parameters, only 16% of the energy diffusivity, χ_e, arises from the spectral region $k_\theta \rho_i > 1.0$.

PACS numbers:

Submitted to: *PPCF*