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A Model of the Saturation of Multi-scale Turbulence by Zonal Flow Mixing[1] G.M. STAEBLER, J. CANDY, General Atomics, C. HOLLAND, UCSD, N. HOWARD, MIT PSFC — Analysis of the spectrum of the saturated electric potential fluctuations from multi-scale (both ion and electron scales) gyrokinetic turbulence simulations, in tokamak geometry, reveals that fluctuating zonal (axisymmetric) ExB flows couple the ion and electron scales. The zonal flows are driven by the ion-scale instabilities but strongly regulate the amplitude of the electron-scale turbulence. The electron-scale turbulence can grow to large amplitude when the linear growth rate of the ETG modes exceeds the zonal flow mixing rate due to advection of the ETG modes. The model of the zonal flow mixing is shown to capture the suppression of electron-scale turbulence by ion-scale turbulence and the threshold for the increase in electron-scale turbulence when the ion-scale turbulence is reduced. The nonlinear upshift of the effective critical ion temperature gradient (Dimits shift) is also captured by the new model. Prediction of the core plasma fusion performance of ITER with TGLF using the new saturation model yields a 19% increase in fusion power for hybrid regime operation.

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