Spectrally accurate global-local gyrokinetic simulations of turbulence in tokamak plasmas

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We develop a novel approach to gyrokinetics where multiple flux-tube simulations are coupled together in a way that consistently incorporates global profile variation while allow- ing the use of Fourier basis functions, thus retaining spectral accuracy. By doing so, the need for Dirichlet boundary conditions typically employed in global gyrokinetic simulation, where fluctuations are nullified at the simulation boundaries, is obviated. This results in a smooth convergence to the local periodic limit as $\rho * \rightarrow 0$. In addition, our scale-separated approach allows the use of transport-averaged sources and sinks. Having implemented this approach in the flux-tube code stella [1], we study the role of transport barriers and avalanche formation in the transition region between the quiescent core and the turbulent pedestal, as well as the efficacy of intrinsic momentum generation by radial profile variation. Finally, we show that near-marginal plasmas can exhibit a radially localized Dimits shift [2], where strong coherent zonal flows give way to flows which are more turbulent and smaller scale.
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