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Resolving a convergence issue with local gyrokinetic simulations[1]

JUSTIN BALL, STEPHAN BRUNNER, AJAY C. J., Ecole Polytechnique Federale de Lausanne — Flux-tube gyrokinetic simulations are often used to model turbulence in toroidal plasmas. Their simulation domain follows a narrow bundle of field lines and typically extends one poloidal turn in length. However, this work and others show that such simulations may not be fully converged. In many parameter regimes, turbulent self-interaction can occur through the parallel boundary condition. This is not physical unless the flux-tube corresponds to a full flux surface, which is often computationally prohibitive. Symptoms of such self-interaction include flow shear layers at mode rational surfaces and staircase structures in the plasma profiles. We have observed such features with both kinetic and adiabatic electrons, ion and electron-scale turbulence, and toroidal and slab geometry. Ultimately, this self-interaction is observed to reduce the heat flux and can even cause non-convergence with respect to the size of the domain perpendicular to the magnetic field. To resolve these issues, we turn to a recommendation from the original paper on flux-tube boundary conditions [Beer et al. (1995)] - by increasing the parallel length of the domain to two or three poloidal turns, the self-interaction can be eliminated. This enables a small flux-tube to accurately model turbulence in tokamaks.

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