Edge-plasma turbulence simulations with self-consistent profile evolution*

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Abstract

Fundamental understanding of plasma transport in the edge region of tokamaks is important to predict and optimize both the formation of edge transport barriers with the associated plasma pedestal and the strong plasma fluxes to material surfaces. Adequate performance of the edge plasma in these areas is crucial for the success of next-step fusion devices. The underlying plasma turbulence and profiles depend strongly on one another. To address this inter-dependency, 3D turbulence simulations with BOUT [1] are evolved together with the axisymmetric (2D) edge profiles. This is accomplished in two ways. In the first, the axisymmetric part of the 3D fields in BOUT is simply allowed to evolve. In the second, the axisymmetric parts of the BOUT fields are controlled: they are evolved on an independent timescale by a UEDGE[2]/BOUT code-coupling scheme. Because the axisymmetric fields evolve on a longer timescale than the 3D dynamics, the coupled scheme has potential for a significant gain in computational efficiency for simulations on the transport timescale. Our initial results on this coupling were reported in [3]. Here we report progress. It is shown that BOUT and UEDGE produce nearly identical 2D plasma profiles for a simple model transport problem, with any differences likely due to variation in the finite-difference approximations. We extend earlier results by including more plasma variables in the coupling. The effect of spatially dependent neutrals as a particle source for the pedestal has been added to BOUT via an analytic neutral source; neutrals are included in UEDGE via a self-consistent fluid neutral component (benchmarked with Monte Carlo). We aim to present multi-field turbulent steady-states with self-consistent radial profiles.

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