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Coupled Turbulence and Transport Evolution for Magnetized Edge Plasmas*

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Abstract

Turbulence and transport simulations for the edge-plasma region in magnetic fusion devices are generally performed by independent codes; the 3D turbulence codes (*e.g.*, Ref. [1]) typically use fixed plasma pressure profiles to evolve the fluctuations to a steady state, while 2D transport codes (*e.g.*, Ref. [2]) use fixed diffusion or convection coefficients to evolve the plasma profiles and flows. In real devices, these two processes can be tightly coupled. In order to have a predictive model of the key element of edge transport barrier and pedestal formation in tokamaks, the turbulence and transport (profile evolution) must be made self-consistent. Progress on coupling the fluid turbulence code BOUT [1] and the transport code UEDGE [2] is reported, where both codes simulate the full x-point geometry of diverted tokamaks from the top of the pedestal to the far scrape-off layer. Neutrals and impurities that can have a strong influence on the profiles are included in the transport code. A central issue is the stability of the coupling, where turbulence-induced fluxes are passed to the transport code, which returns the updated profiles. Stable algorithms have been demonstrated for a simpler fluid plasma system using a time-relaxed average of the fluxes and profiles over many coupling steps [3], where the turbulence and transport codes are evolved on their own characteristic times. This approach is extended to the 3D BOUT, 2D UEDGE coupling. The impact on the convergence properties of the implicit UEDGE and the degree of relaxation required appear quite acceptable using a model turbulent flux that depends on profile gradients and has substantial levels of random noise. The behavior of BOUT with the full poloidal profiles from UEDGE, including strong gradients in the divertor region, is analyzed. The status of the direct BOUT/UEDGE coupling is presented, and the role of kinetic corrections is discussed.

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