

Comparison of turbulence simulation with experiment—issues and discussion

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Abstract

The status of turbulence simulation for realistic experimental cases is discussed. The author's opinions are presented and illustrated with examples. Discussion, argument, and even refutation are welcomed.

There have been great advances in understanding the basic mechanisms of turbulent transport, mediated by plasma flow shear. Transport models that incorporate this understanding are routinely and successfully used to interpret the evolution of experimental discharges. Advances in turbulence simulation have contributed strongly to this understanding and these models. Nevertheless, the correspondence of the simulated local transport fluxes and fluctuation levels to those observed in the experiments has not been quantitatively demonstrated.

In the author's experience with the nonlinear gyro-kinetic continuum code GS2,^{1,2} transport fluxes and density fluctuations in DIII-D and Alcator C-MOD are overestimated in the simulation by factors that are hard to reconcile with the observations, even with generous allowances for the error bars. This is true even in regions with small flow shear and lacking a transport barrier. The GS2 code takes account of the detailed plasma shaping and includes the relevant kinetic physics and the zonal flows. In particular, the effects of trapped and passing electrons, with collisions, are strongly destabilizing to the ion temperature gradient (ITG) modes. While most of our simulations are electrostatic, we have done some fully electromagnetic runs³ that do not mitigate these results.

Thus, we must investigate what is missing from the physics in the simulations that could provide additional stabilization.

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