Progress in GYRO Validation Studies of DIII-D H-mode Plasmas

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Abstract. The need for a validated predictive capability of turbulent transport in ITER is now widely recognized. However, to date most validation studies of nonlinear codes such as GYRO [J. Candy and R. E. Waltz, J. Comput. Phys. **186**, 545 (2003)] have focused upon low power L-mode discharges, which have significant differences in key dimensionless parameters such as $\rho^* = \rho_S / a$ from more ITER-relevant H-mode discharges. In order to begin addressing this gap, comparisons of the turbulent transport and fluctuations predicted by nonlinear GYRO simulations for a number of DIII-D [J.L. Luxon, Nucl. Fusion **42**, 614 (2002)] H-mode discharges to power balance analyses and experimental measurements are presented. The results of two H-mode studies are presented in this paper, this first of which investigates the importance of nonlocality at typical DIII-D H-mode ρ^* values. Electrostatic global GYRO simulations of H-mode discharges at low and high rotation are shown to predict turbulence and transport levels lower than corresponding local simulations, and which are consistent with or slightly above experimental measurements and power balance analyses, even at "near-edge" radii where gyrofluid and gyrokinetic models systematically underpredict turbulence and transport levels. The second study addresses the stabilizing effect of a significant density of energetic particles on turbulent transport. The results of local GYRO simulations of low-density QH-mode plasmas are presented, which model the fast beam ion population as a separate, dynamic ion species. The simulations show a significant reduction of transport with this fast ion treatment, which helps to understand previously reported results [C. Holland *et al*, Phys. Plasmas **18** 056113 (2011)] in which GYRO simulations without this treatment significantly overpredicted (by a factor of 10 or more) power balance calculations. These results are contrasted with simulations of a high density, low fast ion fraction QH-mode discharge, which predict transport levels consistent with power balance, regardless of the fast ion treatment.

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