TRANSPORT MODEL TESTING AND COMPARISONS USING THE ITER AND DIII-D PROFILE DATABASES*

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A fast steady-state transport code using experimental sources is used to test and compare several theory-based transport models including the IFS/PPPL [1], GLF23 [2], multi-mode [3], and Itoh-Itoh-Fukuyama (IIF) [4] models. The IFS/PPPL model and the more comprehensive GLF23 model are based upon gyrofluid simulations of the toroidal ion temperature gradient (ITG) mode in a 3D nonlinear ballooning mode representation with extrapolated trapped electron (TEM) physics. The multi-mode model combines the Weiland-Nordman “local” (2D) dispersion equations for ITG and TEM modes with contributions from resistive g-modes and kinetic ballooning modes. While its physics is not as rigorous as the gyro-Landau fluid models, it has been more extensively tested in a full time-dependent transport code including density profile evolution. The IIF model differs from the other models in that it is not a drift wave based transport model. It can be characterized as a current-diffusive model based upon one fluid electrostatic “inertial” MHD equations. The gyrofluid models are “stiff” tending to marginality to the ITG threshold and the multi-mode less stiff. The IIF model has no threshold.

We compare the predictions from these models against experimental data. Statistics for both local and global quantities as a ratio of model to experiment are computed to assess the performance of each model against a profile database comprised of more than 50 L– and H–mode discharges. These discharges, which include parameter scans in gyroradius, collisionality, beta, plasma current, density, and power, have been obtained from the ITER [5] and the DIII–D profile databases. Here, the experimentally analyzed sources and density profiles are assumed and only the electron and ion temperature profiles are predicted. We find that the Multi-mode model yields the best overall fit to these discharges with the average total stored energy ratio of 1.01 and an rms error of 17%. Other models have rms errors in excess of 20%. Many other fit figures of merit are given, but model ranking does not change.

We examine the sensitivity of the predicted profiles to variations in the boundary conditions and other quantities including E×B shear, magnetic shear, impurity content, and particle and heat sources. It has been proposed that E×B shear effects can lead to a reduction in transport and model enhanced core confinement in negative central shear core transport barriers [2], however, we observed that adding E×B shear improves the average stored energy ratio for the GLF23 and IFS/PPPL models, but does not lead to an overall improvement in the rms errors.

[1] M. Kotschenreuther, et al., Phys. Plasmas **2** (1995), 2381.
[2] R.E. Waltz, et al., Proc. 16th IAEA Conf., Montreal, Canada, 1996.
[3] J. Kinsey and G. Bateman, Phys. Plasmas **3** (1996) 3344.
[4] S.I. Itoh, et al., Phys. Rev Lett. **72** (1994) 1200.
[5] J.W. Connor, et al., Proc. 16th IAEA Conf., Montreal, Canada, 1996.

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