Time-dependent Transport Simulations of JET H-mode Plasmas

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Abstract

A drift wave based transport model is used to self-consistently predict the time evolution of temperature and density profiles in JET H-mode tokamak discharges. It is found that the same theoretically derived gyro-Bohm transport model previously used to simulate systematic scans of L-mode discharges is equally successful in modeling JET ELMy H-mode plasmas, implying that core transport is not intrinsically different from L-mode confinement. The only difference between the L-mode and H-mode simulations results from the boundary conditions (i.e., density and temperature pedestals), which are taken from experimental data in both cases. Here, standardized experimental data from 16 JET H-mode discharges in the ITER Profile Database is used including dimensionless parameter scans in relative gyro-radius ρ_*, collisionality ν, and plasma β. Imperfections in dimensionless similarity for three pairs of scans in relative gyro-radius cause a purely gyro-Bohm transport model to exhibit worse than gyro-Bohm confinement. For the β scan, the model indicates a somewhat stronger β dependence than that observed with a thermal energy confinement scaling of $B\tau \propto \beta^{-0.7}$. More than half of the β scaling is found to result from finite β effects in model. The model demonstrates a collisionality scaling of $B\tau \propto \nu_*^{-0.3}$ with some unfavorable dependence arising from neoclassical transport in the plasma core region. The overall goodness-of-fit obtained when comparing the global and local predictions results in a root-mean-square error averaging less than 13% for the total stored energy and averaging less than 9% for the density and temperature profiles relative to the maximum experimental values. When $E \times B$ shear effects are added to the model, the resulting change in the mean RMS error for the temperature profiles is less than 4%.

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