Development of a Use Case Database for Validation and Predictive Modeling in the AToM SciDAC Project

C. Holland
Center for Energy Research, University of California, San Diego

Computationally efficient verified and validated transport models are an essential building block for any practical whole device modeling capability. Towards this end, the AToM (Advanced Tokamak Modeling) integrated modeling SciDAC project [1] is developing a "use case" database to facilitate benchmarking, verification and validation studies of physics model components and workflows, with an initial focus on core turbulent transport. The first group of use cases included in this database correspond to high-fidelity magnetic equilibrium reconstructions, profile measurements, power balance analyses, and turbulence fluctuation data for a variety of plasma parameters and confinement modes in multiple tokamaks, with an emphasis on burning-plasma relevant discharges. This group of use cases provides the basis for systematic validation studies of turbulent transport models of varying complexity executed in isolation, as well as integrated predictions of core temperature, density, rotation, and fluctuation profiles. In addition to the validation use case group, a second group of use cases corresponding to a variety of planned or proposed future burning plasma experiments is included in the database. These predictive modeling use cases form the basis for comparing predictions of different transport models for the specific plasma parameters of interest in these future devices. Put together, the database allows assessment of current model fidelity to current-day burning plasma experiments, and systematic comparisons of model predictions for future plasmas of interest. A variety of initial applications will be shown, including comparisons of core profile predictions made using the TGLF "SAT-0" [2] and "SAT-1" [3] models. Future plans including gyrokinetic benchmarking studies, development of comprehensive validation metrics (including advanced uncertainty quantification techniques), and extensions of the database to support physics studies beyond core transport will be discussed.

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[1] https://scidac.github.io/atom/
[2] G. M. Staebler, J. Candy, N. T. Howard, and C. Holland, Phys. Plasmas **23** 0625108 (2016)
[3] G. M. Staebler, J. E. Kinsey, and R. E. Waltz, Phys. Plasmas **14** 055909 (2007)

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