Implementation and application of two synthetic diagnostics for validating simulations of core tokamak turbulence

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Abstract

The deployment of multiple high-resolution, spatially localized fluctuation diagnostics on the DIII-D tokamak [J. L. Luxon, Nucl. Fusion **42** 614 (2002)] opens the door to a new level of core turbulence model validation. Towards this end, the implementation of synthetic diagnostics that model physical beam emission spectroscopy (BES) and correlation electron cyclotron emission (CECE) diagnostics is presented. Initial results from their applications to local gyrokinetic simulations of two locations in a DIII-D L-mode discharge performed with the GYRO code [J. Candy and R. E. Waltz, J. Comp. Phys. **186** 545 (2003)] are also discussed. At normalized toroidal flux $\rho = 0.5$, we find very good agreement between experiment and simulation in both the energy flows and fluctuation levels measured by both diagnostics. However, at $\rho = 0.75$, GYRO underpredicts the observed energy flows by roughly a factor of 7, with RMS fluctuation levels underpredicted by a factor of 3. Interestingly, at both locations we find good agreement in the shapes of the radial and vertical density correlation functions, and in the shapes of the frequency power spectra. At both locations, the attenuation of the GYRO-predicted fluctuations due to the spatial averaging imposed by the diagnostics' spot sizes is significant, and its incorporation via the use of synthetic diagnostics is shown to be essential for quantitative comparisons such as these.

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