Validation of reduced-order turbulence modelling in the tokamak L-mode near-edge

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The turbulent transport properties of the L-mode near-edge region (ρ = 0.85-1.0) play a significant role in determining the discharge performance in tokamak plasmas. Optimising scenario confinement in a predictive manner, e.g. through q-profile tailoring during plasma current ramp-up simulations, demands reduced-order turbulence models that accurately capture the transport physics in this key region. We present an extensive L-mode near-edge validation study of the current state-of-the-art reduced-order turbulence models. QuaLiKiz [1] and TGLF [2] are validated using both gyrokinetic and integrated modelling simulations. A range of plasma conditions seen in NBI-heated JET-ILW discharges [3] are considered. The impact of several magnetic geometry model assumptions, sensitivity to impurities and limited uncertainty quantification are included. Comparison against linear gyrokinetic simulations with GENE [4] shows that the predicted dominant turbulent instabilities at low collisionality match with the ITG/TEM/ETG regime embodied in QuaLiKiz and TGLF. At high collisionality in the pedestal-forming region, the turbulence found with linear gyrokinetics has a drift-resistive character, consistent with previous work [5][6]. Such resistive modes are currently not included in the reduced-order models part of this study. The correlation between accurate scenario predictions and the prevalence of the resistive modes in the pedestal-forming region is tested with integrated modelling. For several discharges, the plasma density and temperature profiles predicted with both QuaLiKiz and TGLF in the JINTRAC suite [7] are compared against experimental measurements.

References

[1] C Bourdelle et al. *Plasma Physics and Controlled Fusion*, 58:014036, 2016.
[2] G M Staebler et al. *Physics of Plasmas* 14**:** 055909, 2007.
[3] P Vincenzi et al. *4th Asia Pacific Conference on Plasma Physics of AAPS DPP*, 2020.
[4] F Jenko et al. *Physics of Plasmas*, 7:8, 2000.
[5] G De Dominici et al. *Nuclear Fusion 59:126019***,** 2019.
[6] N Bonanomi et al. *Nuclear Fusion*, 59:126025, 2019.
[7] M Romanelli et al. *Plasma and Fusion Research*, 9:3403023, 2014.