Reduced transport models for a Tokamak flight simulator

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A tokamak flight simulator is a numerical tool which predicts the plasma behavior using the discharge program editor as input. It can ensure that either actuator trajectories or plasma parameters satisfy the experimental goals and reduces the probability of plasma disruptions and of exceeding operational limits. It is based on the interaction between control system, plasma equilibrium and transport. The transport models have to be physics based to be realistic, but also fast enough to be used as an inter-discharge prediction tool. This compromise can be reached employing analytical models which are derived from first principle theories. In this work an integrated model including every plasma region has been developed. The confined region is modeled in 1.5D, while the scrape-off-layer has a 0D structure. For the core region a physics-based analytical regression based on a set of TGLF [G. M. Staebler, Phys. Plasmas 12, 102508 (2005)] runs has been produced. For the H-mode regime, an average ELM model is applied in the pedestal region. In the SOL a 2-point model for electron temperature (exhaust) and a particle balance for the species density at the separatrix have been implemented. All the models have been first validated individually in standalone setting. Finally, a fully integrated simulation in Fenix flight simulator [F. Janky et al., Fusion Engineering and Design (2019), E. Fable et al., Plasma Physics and Controlled Fusion (2021)] framework including transients (ramp-up + flattop) has been performed, matching the experimental trajectories. A broader validation including more discharges and the ramp-down phase is planned for the near future and will be presented at the conference.