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# Global 3D Two-Fluid Simulations of Turbulent Transport in the Tokamak Edge Region: Turbulence, Profile Evolution and Spontaneous $E \times B$ rotation[1]

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A new flux-driven global 3D two-fluid code, Global Drift Ballooning (GDB) model, based on the drift-reduced Braginskii equations [2] is developed to study the turbulent transport across the entire tokamak edge region: from plasma sources in the inner core to plasma sinks in the outer-most scrape-off layer (SOL). In this model, profiles of plasma density, electron and ion temperature, electric potential, magnetic flux and parallel flow are evolved self-consistently. As a first step, we carried out simulations with a shifted-circle magnetic configuration and realistic Alcator C-Mod inner wall limited (IWL) discharge parameters. Figure 1 shows a typical density profile snapshot of a quarter of the full simulation domain. In the L-mode regime, simulation indicates the predominant driver of edge turbulence is the resistive ballooning instability. The simulations show that, in agreement with experimental observations, as the simulation moves towards density limit regime by ramping up the density profile, the turbulent transport is enhanced; on the other hand, as the simulation approaches to the H-mode regime by ramping up the temperature profile, the turbulent transport is suppressed. (see Figure 2) These findings seem largely consistent with previous local flux-tube simulation results [3]. In all cases, spontaneous formation of the $E \times B$ drift in the electron diamagnetic drift direction is observed in the closed-flux region. (see Figure 3) We provide an explanation of this phenomenon based on the steady state ion continuity relation $\nabla \cdot n \vec{v}_i \approx 0$. We find the $E \times B$ rotation in the closed flux region mostly cancels the ion diamagnetic drift as H-mode-like regimes are approached, and exceeds it by a factor of roughly two or more at lower temperatures. More detailed results will be presented at the meeting.

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Figure 1 Typical snapshot of density profile (a quarter of full simulation domain) .

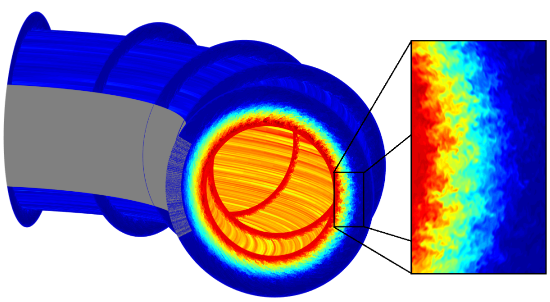


Figure 2 $\alpha_d-\alpha_{mhd}$ phase space diagram and time evolution (blue to red) of doubled density (squares), reference L-mode (crosses) and doubled temperature (circles) simulations.

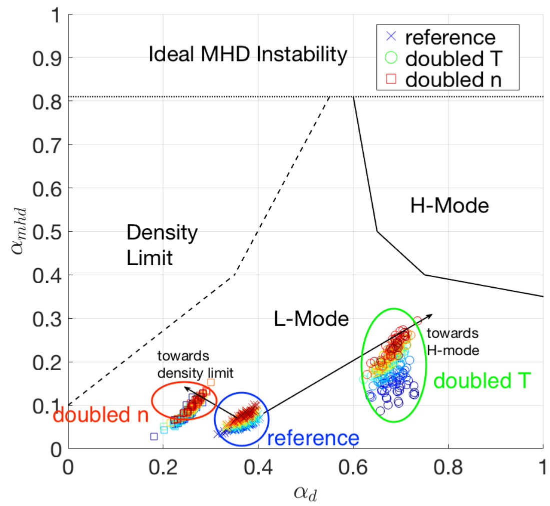
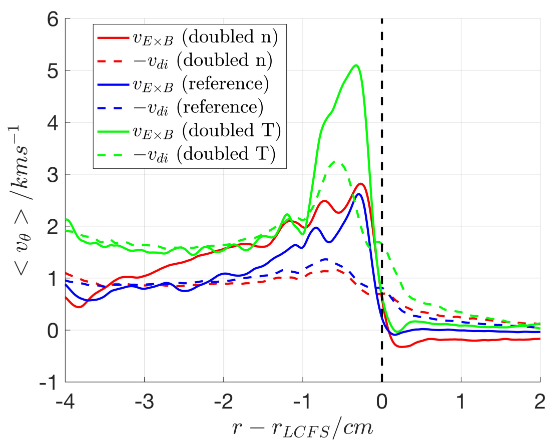



Figure 3 Poloidal $E{\times}B$ (solid) and ion diamagnetic (dashed) drifts of doubled density (red), reference L-mode (blue) and doubled temperature (green) simulations.




References

[1] B. Zhu, M. Francisquez and B. N. Rogers, Phys. Plasmas, 24, 055903 (2017)
[2] A. Zeiler, J. F. Drake and B. N. Rogers, Phys. Plasmas, 4, 2134 (1997)
[3] B. N. Rogers, J. F. Drake and A. Zeiler, Phys. Rev. Lett., 81,4396 (1998)