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Disentangling turbulence, transport and blobs in the periphery of double-null tokamak configurations

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A non-field aligned coordinate system was recently implemented in GBS, a three-dimensional drift-reduced Braginskii fluid code to simulate turbulence in the plasma periphery of tokamaks. This avoids the singularity present in field-aligned coordinates at the X-point, thus allowing the simulation of any toroidally symmetric magnetic field configuration, with no separation between equilibrium and fluctuating quantities, therefore evolving self-consistently the formation of the plasma profiles. Simulations are carried out in the single-null and double-null configurations and first simulations in innovative exhaust configurations (such as the snowflake) are being performed. The talk will focus on the double-null configuration, which is of interest as a possible heat exhaust solution and for advanced heating schemes. The new insights obtained in the double-null configuration from the GBS simulations will be presented and thoroughly analysed. The different nature of the plasma dynamics in the low- and high-field sides will be pointed out, showing that turbulence is driven by a Kelvin-Helmholtz instability on the high-field side, and by an interchange instability on the low-field side. On the low-field side, a structure with two scale lengths forms. The wave-like nature of turbulence across the last closed-flux surface will be discussed and estimates of the narrow pressure scale length in this region will be given. It will be shown that blobs are generated across the last-closed flux surface, being responsible for the convective nature of the transport in the far SOL. The blob generation rate, size, and speed will be estimated, allowing the prediction of the far SOL width. Comparisons of the simulation results with previous and new analytical results will be presented, as well as with experimental results. Generalisation to other tokamak configurations will also be discussed.