Global aspects of gyrokinetic turbulent transport

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The question of turbulence scale separation and locality of turbulent transport is a long standing issue. In that matter, it is quite important to assess the impact of mesoscale structures such as zonal flows, avalanches, or streamers. A related question is whether a local description of transport is appropriate. Some elements of answer to this question, based on recent gyrokinetic simulations run with the GYSELA code [1], will be presented. First, it will be shown that the poloidal velocity stays close to the neoclassical value, even for turbulent states. However the flow shear rate is different from the neoclassical prediction, due to mesoscale corrugations of the velocity profile [2]. These corrugations are related to steady zonal flows. Regarding flux driven simulations, it appears that the turbulence dynamics is governed by avalanche-like events, already reported in fluid simulations and in experiments. These bursts propagate at velocities of the order of the diamagnetic velocity on radial distances much larger than the turbulence Eulerian correlation length [3,4]. This behaviour has been observed in other global gyrokinetic codes. The avalanche propagation speed agrees with theoretical expectations. Their radial size is related to the corrugated zonal flow profile mentioned above, which forms an “ExB staircase” [4]. Temperature profiles are found to be stiff, i.e. gradients stay close to the stability threshold when the heat source increases. Toroidal momentum transport has also been investigated. Conservation laws have been verified with a high level of accuracy. It appears that momentum avalanches are also produced when a source of momentum is added. Hence profile relaxation is mediated by the excitation of avalanches, which thus appear as a manifestation of profile resilience.