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Transition from drift wave turbulence to coherent zonal structures using a flux-balanced fluid model for plasma edge turbulence DI QI, ANDREW MAJDA, ANTOINE CERFON, New York University — We investigate the drift wave zonal flow interaction mechanism in plasma edge turbulence using the recent two-field flux-balanced Hasegawa-Wakatani model, whose particularity is an improved treatment of the electron response on magnetic flux surfaces. A sharp transition is observed from a turbulence dominated regime to a zonal jet dominated regime. The robust zonal jets are further enhanced with multi-scale dynamics when the numerical domain is elongated in the radial direction. We analyze the generation and stability of the zonal state based on the selective decay principle and the secondary instability analysis. The generation of zonal jets is displayed from the secondary instability analysis via nonlinear interactions with a linearly unstable drift base mode, while stabilizing damping effect is shown from a zonal flow base state. The selective decay process can be characterized by transient visits to several metastable states, then final convergence to a purely zonal state. We rely on detailed statistical analysis of our numerical experiments to highlight the energy transfer mechanisms. The insights gained from investigating the properties of our simple model can lead to guidelines for the development of model reduction methods for more complicated systems.

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