Data-based study of Lagrangian coherence and mixing in turbulent flows

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Abstract

Transport and mixing processes in fluid flows are crucially influenced by coherent structures. The characterisation of these Lagrangian objects has been a topic of intense research over the last three decades. More recently, computational methods have been proposed to identify coherent sets directly from an ensemble of trajectories. Among these approaches are Lagrangian flow networks, where trajectories serve as network nodes and the links are weighted according to spatio-temporal distances between trajectories. Spectral clustering as well as simple network measures such as node degrees or clustering coefficients can be used to identify flow regions of different dynamical behavior [1, 2]. In this talk, we propose some extensions to the network-based framework that allow us to study the long-term dynamics of coherent sets in turbulent flows and their role in global transport processes. We demonstrate the applicability of these methods in a number of example systems, including turbulent convection [3, 4].

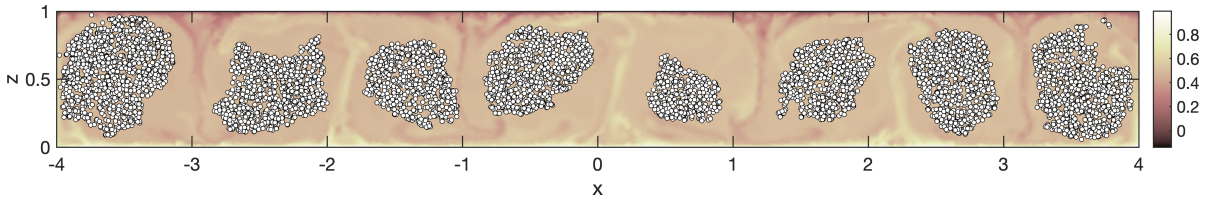

Figure 1: Extracted coherent sets in a two-dimensional turbulent Rayleigh–Bénard convection flow. The instantaneous temperature field is plotted in the background. Coherent sets play a crucial role in the global heat transport (figure taken from [3]).

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References

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