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Cluster-based reduced-order modelling of a mixing layer[1] EURIKA KAISER, BERND R. NOACK, LAURENT CORDIER, ANDREAS SPOHN, Institute PPRIME, France, MARC SEGOND, MARKUS ABEL, Ambrosys GmbH, Germany, GUILLAUME DAVILLER, CERFACS, France, ROBERT K. NIVEN, ADFA/UNSW, Australia — We propose a novel cluster-based reduced-order modelling (CROM) strategy of unsteady flows. CROM builds on the pioneering works of Gunzburger's group in cluster analysis (Burkardt et al. 2006) and Eckhardt's group in transition matrix models (Schneider et al. 2008) and constitutes a potential alternative to POD models. This strategy processes a time-resolving sequence of flow snapshots in three steps. First, the snapshot data is clustered into a small number of representative states in the phase space. The states are sorted by probability and transition considerations. Secondly, the transitions between the states are dynamically modelled via a Markov process. Finally, physical mechanisms are distilled by a refined analysis of the Markov process. The resulting CROM is applied to the Lorenz attractor as illustrating example and velocity fields of the spatially evolving incompressible mixing layer. For these examples, CROM is shown to distill non-trivial quasi-attractors and transitions processes. CROM has numerous potential applications for the systematic identification of physical mechanisms of complex dynamics, for comparison of flow evolution models, and for the identification of precursors for desirable and undesirable events.

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