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A COLLOCATED MODEL ORDER REDUCTION FOR ADVECTIVE-DOMINANT PDEs: HYPER-REDUCTION OF ADER SCHEME ON EVOLVING CHIMERA MESHES

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ABSTRACT

Model Order Reduction (MOR) involves seeking the solution to a partial differential equation (PDE) in a vector space of small dimension compared to the high-fidelity problem. This search is typically performed using the residual of the underlying numerical model associated with the solution of the PDE. In this work, this operation is achieved by minimizing the residual in the sense of Finite Volumes according to the Arbitrary High-Order Derivatives (ADER) scheme. In particular, a hyper-reduction step is performed in order to compute the residuals on a modest number of discretization points. We will demonstrate an approach that departs from this now-classic method for advective-dominant or purely advective problems and relies solely on the ADER scheme, while conducting this operation with an extremely reduced number of the Chimera mesh points. These points are obtained through an empirical numerical quadrature technique, even for evolving domains or evolving overset grids. In addition, the possibility to track either the evolution of the mesh (due to an internal boundary evolving by an unknown geometrical parameter) or local features of the solutions (e.g., solving purely advective or nonlinear equations) through a moving Chimera mesh allows to sensitively minimize the Kolmogorov N-width. As a consequence, the numerical method needs a smaller number of components for the employed truncated reduced basis with respect to classical MORs at the same relative loss of accuracy compared with the high-fidelity solution.