Improved LPS-POD-ROM for convection-dominated flows SMAI 2017 (MS: Réduction de Modèles : Algorithmes, Analyses et Applications)

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In this work, we introduce improved Reduced Order Models (ROM) for convection-dominated flows. These closure models are inspired from successful numerical stabilization techniques used in Large Eddy Simulation (LES) of turbulent flows, such as Local Projection Stabilization (LPS), which may be cast in the Variational Multi-Scale (VMS) framework [2], and constitutes low-cost, accurate solvers (of optimal error order) for incompressible flows, despite being only weakly consistent [1].

We propose to apply a Streamline Derivative-based (SD-based) LPS finite element method to standard ROM created by Proper Orthogonal Decomposition (POD) of flows with Galerkin projection, to improve the numerical stability as well as the physical accuracy of the POD-ROM approximation.

Although LPS-POD closure model is being developed to derive a low-order approximation of complex non-isothermal turbulent flows [3], as first step we analyse it for convection-dominated convection-diffusion-reaction equations [4], by mainly deriving the corresponding error estimates.

Preliminary numerical simulations and results of convection-dominated flows confirm the increased numerical stability and physical accuracy of the new LPS-POD-ROM over the standard one. The computational efficiency of the proposed model is also showcased.

Références

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