Consistency of the full and reduced order models for evolve-filter-relax regularization of convection-dominated, marginally-resolved flows

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Numerical stabilization is often used to alleviate the spurious oscillations generally produced by full order models (FOMs) in under-resolved or marginally-resolved simulations of convection-dominated flows modelled by the incompressible Navier-Stokes equations. However, when dealing with reduced order models (ROMs) of convection-dominated, marginally-resolved flows, the role of numerical stabilization is still not well understood. In this presentation, based on [1], we investigate the FOM-ROM consistency, i.e., whether the numerical stabilization is beneficial both at the FOM and the ROM level. As a numerical stabilization strategy, we focus on the evolve-filter-relax (EFR) regularization algorithm, which centers around spatial filtering. To investigate the FOM-ROM consistency, we consider two ROM strategies: (i) the EFR-ROM, in which the EFR stabilization is used at the FOM level, but not at the ROM level; and (ii) the EFR-EFRROM, in which the EFR stabilization is used both at the FOM and at the ROM level.

Simulation of a 2D flow past a circular cylinder in the convection-dominated, marginally-resolved regime will be employed in both parts for the validation of the methodology.

This work is in collaboration with Maria Strazzullo (Politecnico di Torino), Traian Iliescu (Virginia Tech), Michele Girfoglio and Gianluigi Rozza (SISSA Trieste).

References:

[1] Maria Strazzullo, Michele Girfoglio, Francesco Ballarin, Traian Iliescu, and Gianluigi Rozza. Consistency of the full and reduced order models for evolve-filter-relax regularization of convection-dominated, marginally-resolved flows. International Journal for Numerical Methods in Engineering, 123(14):3148-3178, 2022. arXiv:2110.05093, doi:10.1002/nme.6942.