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ADVANCED MESH STRATEGIES FOR UNSTEADY FLOWS WITH MOVING GEOMETRIES

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ABSTRACT

Computational fluid dynamics (CFD) has become an essential tool throughout the industrial product lifecycle, from preliminary design and optimization to performance assessment and post-production analysis. Across these stages, computational efficiency is crucial, particularly for unsteady problems, whose experimental investigation may be costly or difficult. Many industrial applications involve moving bodies and large boundary deformations, posing additional challenges in terms of numerical accuracy, robustness, and computational cost.

For body-fitted unstructured discretizations, moving boundaries require the computational mesh to evolve while preserving adequate mesh quality, even under large deformations. At the same time, unsteady flows often feature localized structures that evolve throughout the computational domain, making mesh adaptation an effective strategy to concentrate computational resources where they are most needed. Efficient mesh deformation and adaptation techniques are therefore key ingredients for reliable and affordable unsteady CFD simulations.

This invited session will discuss recent advances in mesh deformation and adaptation for complex unsteady CFD applications, with particular emphasis on unstructured grids and moving geometries. Topics include robust mesh-motion algorithms, local and global adaptation, error- and feature-based criteria, predictive and data-driven strategies, conservative solution transfer, and their integration into CFD solvers. Particular attention will be devoted to approaches that improve computational efficiency while retaining the accuracy and robustness required by industrial applications involving moving and deforming geometries and strongly evolving flow features.