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A local anisotropic adaptive algorithm to solve time-dependent dominated convection problems

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Abstract

In this work we present a local, anisotropic adaptive algorithm useful to solve scientific and engineering time-dependent problems encompassing multiple scales. The algorithm is derived in the context of semi-Lagrangian schemes within a finite element framework, being suitable for higher-order finite elements. Convection-dominated equations, like those present in Fluid Dymanics, are ideal to employ anisotropic refinement due to the 'directional features' present in flows such jets, mixing layers, vortices... The size, shape and orientation of the anisotropic elements which define the optimal triangulation are provided by a metric tensor based on an a posteriori error indicator of the local or truncated error incurred at each time step.

We illustrate the good performance of the algorithm with a convection-dominated problem taken from the Combustion field of knowledge. Simulation in 2D and 3D is also considered to address the interaction between a diffusion flame and a vortex generated by a turbulent flow. Finally, we include a comparison with actual experimental data.

Key words: Semi-Lagrangian schemes, finite element method, a posteriori error indicator, local anisotropic refinement, combustion problems.