A "divide-and-conquer" spatial and temporal multiscale method for transient convection-diffusion-reaction equations

Abstract:
A multiscale method for the numerical solution of transient convection-diffusion-reaction equations is presented. Two main goals have led to the development of the present method: a desired independence of any heuristic parameter such as the stabilization parameter in stabilized methods and a desire for a consistent multiscale approach in space and time. The method is constituted by solution approaches on a coarse- and a fine-scale level and by interscale operators for data transfer between those two levels. A particular feature of the method is that no large matrix system has to be solved. The results from numerical test cases show that, for both problematic flow regimes, that is, the regime of dominant convection and the regime of dominant convection and absorption, the present method provides completely stable solutions, which are not achieved by standard stabilized methods, particularly for the later regime. For remedying a still to be noted shortcoming of the proposed method, that is, a
too smooth resolution of sharp-gradient regions in the solution field, considerable improvement
can be provided by the use of cubic spline interpolation as the spatial reconstruction (i.e., the
spatial coarse-to-fine inter-scale) operator.

**Stichworte:**
Computational fluid dynamics, transient convection-diffusion-reaction equation, finite element
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