Adaptive Multiscale Methods for Flow Problems: Recent Developments

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Abstract The concept of the new fully adaptive flow solver Quadflow has been developed within the SFB 401 over the past 12 years. Its primary novelty lies in the integration of new and advanced mathematical tools in a unified environment. This means that the core ingredients of the finite volume solver, the grid adaptation and grid generation are adapted to each others needs rather than putting them together as independent black boxes. In this paper we shall present recent developments and demonstrate their efficiency by numerical experiments for some representative basic configurations.

1 Introduction

The work performed in the SFB 401 was motivated by two central questions arising from engineering applications, namely, (i) how to influence wake vortices generated by a lift-producing aircraft in order to reduce takeoff and landing frequencies at airports, and (ii) of better understanding the interaction of structural dynamics and aerodynamics to design new concepts for supporting wing structures. The accurate and reliable simulation of such processes pose challenging questions near or even beyond current simulation capabilities. The development of concepts that reduce computational complexity already on the level of mathematical algorithmic design appears to be indispensible. This has been the core objective of the new adaptive and parallel solver Quadflow [6, 7]. In order to exploit synergy effects, this solver has been designed as an integrated tool where the core ingredients, namely, (i) the flow solver concept based on a finite volume discretization, (ii) the grid adaptation concept based on wavelet techniques, and (iii) the grid generator based on B-spline mappings are adapted to each others needs, see Figure 1. In particular, the three tools

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