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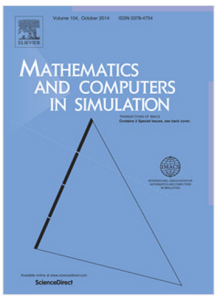

A two-step model order reduction method to simulate a compressible flow over an extended rough surface

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A two-step model order reduction method to simulate a compressible flow over an extended rough surface

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Abstract

In this paper the ideas presented in the article "Effective boundary conditions: a general strategy and application to compressible flows over rough boundaries", *Communications in Computational Physics*, **21(2)**, 358–400, 2017 to simulate efficiently a compressible flow over a rough surface are extended to a two-step model order reduction strategy. The first level consists in the formulation of effective boundary conditions, to take into account the effect of the roughness without resolving it. This requires the solution of a parameter-dependent cell problem on the micro-scale. To reduce its computational cost we add an additional step, where a second level of reduction is applied to the cell problem by means of the reduced basis method. Through numerical computations we verify the gain in efficiency of this strategy.

Keywords: Model order reduction, multiscale modeling, compressible flow.

1. Introduction

From nature it is well-known that microstructures on surfaces aligned in the streamwise direction of the flow, so-called riblets, can significantly reduce drag. For instance, the skin of a shark exhibits small-scale structures that makes the shark one of the fastest hunters in the ocean [35]. In oil channels experiments have been conducted to study biological surfaces, e.g., shark-skin replicas, hairy surfaces such as seal fur [9, 4, 22]. These have confirmed that drag can be reduced in the range of 10%. Engineers try to mimic this effect for economical and eco-

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