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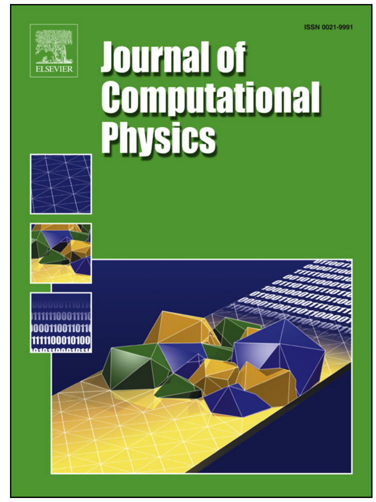

A spectral-element dynamic model for the Large-Eddy simulation of turbulent flows

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A Spectral-Element Dynamic Model for the Large-Eddy simulation of turbulent flows.

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Abstract

A spectral dynamic modeling procedure for Large-Eddy Simulation is introduced in the context of discontinuous finite element methods. The proposed sub-grid scale model depends on a turbulence sensor built from the computation of a polynomial energy spectrum in each of the discretization elements. The evaluation of the energy decay gives an estimation of the quality of the resolution in each element and allows for adapting the intensity of the sub-grid dissipation locally. This approach is simple, robust, efficient and it is shown that the sub-grid model adapts to the amount of numerical dissipation in order to provide an accurate representation of the true sub-grid stresses. The present approach is tested for the large-eddy simulation of transitional, fully-developed and wall-bounded turbulence. In particular, results are reported for the Taylor-Green vortex and periodic turbulent channel flows at moderate Reynolds number. For these configurations, the new model shows an accurate description of turbulent phenomena at relatively coarse resolutions.

Keywords: High-order methods, Spectral Difference method, Large-Eddy simulation, Dynamic models.

1. Introduction

The Large-Eddy Simulation (LES) technique has become a tool of paramount importance for the accurate prediction of high-Reynolds number turbulent flows. Due to its reduced cost compared to the Direct Numerical Simulation (DNS) and the persistent increase in the available computational power, the use of LES represents the most viable and sensible option to address configurations of academic and industrial interest where, on the one hand, DNS would be unfeasible and, on the other, Reynolds Averaged Navier-Stokes (RANS) simulation would fail (e.g., statistically unsteady or massively de-

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