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Large eddy simulation of hydrodynamic and magnetohydrodynamic channel flows with a colocated finite-volume scheme and improved subgrid-scale modeling.

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Abstract

We study hydrodynamic and magnetohydrodynamic channel flows by means of Large Eddy Simulations (LES) on the basis of a second-order finite-volume scheme in collocated variable arrangement with a focus on the impact of numerical diffusion on the subgrid-scale (SGS) modeling. It is found that a mixed SGS model, which is based on the velocity increment tensor and an eddy viscosity model, performs best and is able to capture near-wall regions of energy backscatter from small to larger scales. Thereby, it improves the accuracy of the LES computations significantly. Our studies suggest that the mixed SGS model is thus applicable for a wide class for shear flow problems in liquid metal flows where finite-volume methods with collocated grids are applied.

Keywords: Large eddy simulation, Magnetohydrodynamic channel flow

1. Introduction

Accurate numerical simulations are an indispensable tool for an improved understanding of magnetohydrodynamic (MHD) turbulence, which plays a key role in a broad area of different research disciplines ranging from astro- and geophysical flows to industrial applications, where magnetohydrodynamic effects are used, for example, in the production process of steel. Flows considered in this manuscript are classified to the latter category. Here, external magnetic