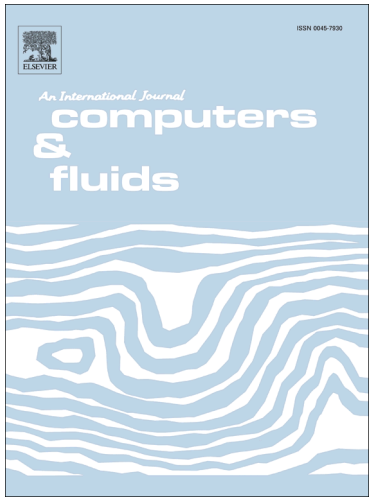

Large-eddy simulation of turbulent channel flow using relaxation filtering: resolution requirement and Reynolds number effects

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PII: S0045-7930(15)00099-7
DOI: http://dx.doi.org/10.1016/j.compfluid.2015.03.026
Reference: CAF 2845

To appear in: *Computers & Fluids*

Received Date: 28 March 2014
Revised Date: 12 March 2015
Accepted Date: 29 March 2015

Please cite this article as: Kremer, F., Bogey, C., Large-eddy simulation of turbulent channel flow using relaxation filtering: resolution requirement and Reynolds number effects, *Computers & Fluids* (2015), doi: http://dx.doi.org/10.1016/j.compfluid.2015.03.026

Large-eddy simulation of turbulent channel flow using relaxation filtering: resolution requirement and Reynolds number effects

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April 10, 2015

Abstract

Large-eddy simulations (LES) of fully developed channel flows are performed using relaxation filtering as a subgrid-scale model in order to investigate the performance of the LES methodology for wall-bounded flows. For this, LES are carried out using different spatial resolutions, and then for channels flows at different Reynolds numbers. The accuracy of the results is discussed both *a priori* and *a posteriori*, by examining the transfer function of the dissipation mechanisms associated with molecular viscosity and relaxation filtering in the wavenumber space, the quality of the discretization of the dominant turbulent scales based on velocity snapshots and integral length scales, the convergence of the velocity profiles with respect to the grid, and their consistency with data from Direct Numerical Simulation of the literature. In the first step, a channel flow at a friction-velocity-based Reynolds number $Re_\tau = 300$ is computed using fourteen grids with mesh spacings $15 \leq \Delta x^+ \leq 45$ in the streamwise direction, $0.5 \leq \Delta y^+ \leq 4$ at the wall in the wall-normal direction, and $5 \leq \Delta z^+ \leq 15$ in the spanwise directions, in wall units. A very good accuracy is obtained for $\Delta x^+ = 30$, $\Delta y^+ = 1$ and $\Delta z^+ = 10$. In the second step, three channel flows at Reynolds numbers $Re_\tau = 350$, 600 and 960 are simulated using grids with mesh spacings smaller than, or equal to the mesh spacings reported above. The results are shown to be reliable, and demonstrate that the Reynolds number effects are well captured in the present LES of wall-bounded turbulent flows.

Keywords : large-eddy simulation, relaxation filtering, channel flow, spatial resolution, Reynolds number

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