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OPENFOAM DNS FOR CONSTRUCTING A BOUNDARY LAYER DATABASE FOR THE PSEUDO-DNS MODEL

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Abstract. This paper presents advances in the development of pseudo-DNS, a new turbulence model based on pre- computed inertial stresses and a concurrent multiscale approach. The model relies on solving a "coarse" subproblem by computing, on a relatively coarse grid, the flow of a pseudofluid, using a database of sub-grid inertial stresses precomputed in separate "fine" subproblem simulations. These inertial stresses are assumed to depend only on a dimensionless tensor, namely Id, related to the kinematic viscosity of the real fluid and the local velocity gradient and local coarse mesh size. Databases are assembled using DNS simulations of a set of fine problems in hexahedral domains with structured meshes, using "jump" boundary conditions to impose the desired velocity gradients. Each fine subproblem is simulated until a statistically steady state is achieved. The results are post-processed to obtain time-mean inertial stresses averaged in a subdomain, called Representative Volume Element or RVE. The RVE simulation results are stored in the database. A distinction is made between a "boundary layer RVE" (or "wall RVE", characterized by having one of its faces in contact with a solid wall), and an "internal RVE" otherwise. Pseudo-DNS requires a database to be built for each one of these two types. For the wall RVE, fortunately, the tensorial Id may be reduced to a scalar one. The present work focuses on the construction of the wall RVE database, using DNS simulations of incompressible turbulent flow between parallel moving plates with null imposed pressure gradient. We present a mesh convergence analysis and the resulting wall RVE database for a range of Id numbers from 0 to 30000.