Sergey Utyuzhnikov, J Appl Mech Eng 2017, 6:5(Suppl)
DOI: 10.4172/2168-9873-C1-011

Near-wall domain decomposition in turbulence modeling: Current state of the art and perspectives

Sergey Utyuzhnikov
University of Manchester, UK

It is well recognized that the near-wall turbulence modeling is computationally a very expensive problem. The talk addresses a novel approach based on non-overlapping domain decomposition. To realize the domain decomposition, the computational domain is split into the inner region nearby the wall and the outer region. The governing equations in the inner region are reduced to the parabolized Navier-Stokes equations. Thereby, the domain decomposition appears to be approximate although the simplification of the governing equations in the region is mostly justified. As a result, there is a trade-off between the accuracy and computational time. The approach has proven its efficiency for industrial applications. It was shown that the computational time can be saved as much as one order of magnitude whilst the error does not exceed a few percent. The key element of the domain decomposition is the boundary condition at the interface boundary. The interface boundary conditions are achieved via the transfer of the boundary condition from the wall to an interface boundary. If the governing equations in the inner domain are reduced to the parabolized Navier-Stokes equations, then the interface boundary conditions prove to be of Robin type. If the interface boundary is far enough from the wall, the computational time is reduced by one order of magnitude. However, the near-wall turbulence effects might not be well-resolved. In turn, if the interface boundary tends to the wall, then the solution completely coincides with the original low-Reynolds- number-model solution but the effect from domain decomposition vanishes. In the talk, the computational efficiency of the proposed domain decomposition approach is confirmed via the convergence analysis. Possible approaches to the exact domain decomposition are also analyzed. In addition, the extension of the technique to unsteady problems is considered with some examples.

Biography

Sergey Utyuzhnikov is an expert in numerical methods and their applications in fluid dynamics. He is Professor in Computational Mathematics (Russian Ministry of Education) since 1999. He has fundamental results in the numerical modeling of hypersonic flows, non-overlapping domain decomposition for turbulence modeling, active sound control and multi objective optimization. He has provided consultancy work for industrial companies such as Daimler-Benz, ABB, ALSTOM and EDF. He has given invited talks at Los Alamos National Laboratory (USA), Isaac Newton Institute (Cambridge), Henri Poincare Institute (Paris), Schlumberger (Cambridge), EDF/CNRS (Paris), ALSTOM Technology Centre (Zurich), ABB (Zurich), CARDC and many international conferences. He has been the author or co-author of over 100 peer reviewed journal publications and many conference papers. Currently, he is Reader in Computational Mechanics at the University of Manchester.

s.utyuzhnikov@manchester.ac.uk

Notes: