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HDG vs FV: Turbulent incompressible flows HASHIM ELZAABALAWY, GANBO DENG, Centrale Nantes, LHEEA , LUS EA, Department of Mechanical Engineering, Tcnico Lisboa, Universidade de Lisboa, MICHEL VISONNEAU, Centrale Nantes, LHEEA — Solving the Reynolds averaged Navier-Stokes equations using high-order methods is known to be challenging due to their high stiffness. Strategies to overcome this problem under the hybridizable discontinuous Galerkin framework are presented for the Wilcox 98, TNT, BSL, and SST $k-\omega$ models. Special treatment of ω near the wall to fit the high-order polynomial approximation is proposed. Moreover, scaling limiters are introduced to preserve the positivity as well as the high-order accuracy of the turbulence variables. The turbulence model is coupled with the pointwise divergence-free hybridizable discontinuous Galerkin solver for incompressible flows and solved implicitly. The method of manufactured solution is employed to assess the formulation and the treatment of each equation separately. Further, the formulation is tested on the 2D channel flow, the zero pressure gradient flat plate, and the NACA 0012 airfoil test cases. Preliminary results show significant improvements regarding the error magnitudes and number of iterations compared to finite volume based solvers. Additionally, optimal convergence rates are obtained. Finally, the possibilities and limitations for the high-order methods in RANS simulations are discussed and compared with finite volume approach.

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