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Evaluation of Leray and Verstappen regularizations in LES, without and with added SGS modeling G. WINCKELMANS, N. BOURGEOIS, Y. COLLET, M. DUPONCHEEL, Universite catholique de Louvain (UCL) - Institute of Mechanics, Materials and Civil Engineering (iMMC) — Regularization approaches (Leray and Verstappen) for the "restriction in the rate of production of small-scales" in turbulence simulations have regained some interest in the LES community. Their potential is here investigated using the best numerics (dealiased pseudo-spectral code) and on two cases: transition of the Taylor-Green vortex (TGV) and its ensuing turbulence, decaying homogeneous isotropic turbulence (HIT). The filtered velocity fields are obtained using discrete filters, also of various orders. Diagnostics include energy, enstrophy and spectra. The performance of the regularizations is first evaluated on the TGV in inviscid mode (96^3); then in viscous mode: 256^3 DNS at $Re = 1600$, 128^3 LES at $Re = 5000$ (compared to 1024^3 DNS). Although they indeed delay the rate of production of small scales, they cannot sustain LES when the flow has become turbulent: the small scales are still too energized. Added subgrid-scale (SGS) modeling is thus required. The combination of regularization and SGS modeling (here using the RVM multiscale model) is then also evaluated. Finally, 128^3 LES of fully developed HIT at very high Re is also investigated, providing the asymptotic behavior. The regularizations help increase the true inertial subrange obtained with the RVM model.

Gregoire Winckelmans
Universite catholique de Louvain (UCL) - Institute of Mechanics,
Materials and Civil Engineering (iMMC)

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