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Evaluation of Leray, LANS and Verstappen regularizations in LES, without and with added SGS modeling G. WINCKELMANS, N. BOURGEOIS, Y. COLLET, M. DUPONCHEEL, UCL — Regularization approaches (Leray, LANS and Verstappen) for the "restriction in the production of small-scales" in turbulence simulations have regained some interest in the LES community, because of their potentially appealing properties due to filtering. Their potential is here investigated using the best possible numerics (dealiased pseudo-spectral code) and on simple problems: transition of the Taylor-Green vortex (TGV) and its ensuing turbulence, developed homogeneous isotropic turbulence (HIT). The filtered velocity field is obtained using discrete filters, also of various orders (2 and 6). Diagnostics include energy, enstrophy, and spectra. The performance of the regularizations on the TGV is first evaluated in inviscid mode (96^3 Euler), then in viscous mode at $Re = 1600$ (256^3 DNS and 48^3 LES). Although they delay the production of small scales, none of the regularizations can perform LES when the flow has become turbulent: the small scales are still too energized, and thus added subgrid-scale (SGS) modeling is 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. In particular, it is found that the regularization helps increase a bit the true inertial subrange obtained with the RVM model.

G. Winckelmans
UCL

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