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HOW MUCH SLIP IS NEEDED TO COUNTERBALANCE THE NEAR-WALL PRODUCTION OF UNRESOLVED SCALES IN A WALL-MODELED LARGE-EDDY SIMULATION?

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Large-eddy simulation (LES) seeks to predict the dynamics of the larger eddies in turbulent flow by applying a spatial filter to the Navier-Stokes equations and by modeling the resulting commutator of the filter and the non-linear term. Thus the (explicit) calculation of all small-scale turbulence - for which numerical resolution is not available - can be avoided. In boundary layers, however, the required resolution is still too high, particularly at high Reynolds numbers, i.e., in many applications. Wall-modeling approaches are particularly interesting as they allow to reduce the resolution in the boundary layer. As shown in the recent review of Larsson et al. [1], numerous wall models have been developed. These models are mostly based on an assumed behavior of the wall-stress, and the spatial filter is not or hardly involved. The dynamic slip condition that is recently proposed by Bose & Moin [2] is based differently; it is consistent with a filter approach to the Navier-Stokes equations and does not require any tuning of parameters. In the present paper the dynamic slip condition is analyzed in detail. In particularly, the minimum amount of slip is determined in such a way that the production of too small scales by the boundary condition is counteracted. This slip-production balance is worked out with the help of Poincaré's inequality as in Rozema [3] and Verstappen [4] and it is tested for turbulent channel flow.

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