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An algebraic non-equilibrium wall-stress model for LES by analytically integrating the TBLE[1] KAZUHIKO SUGA, TOMOKI SAKAMOTO, YUSUKE KUWATA, Osaka Prefecture University — An algebraic non-equilibrium wall-stress model for large eddy simulation is proposed. The ordinary differential equation (ODE) of the thin-layer approximated momentum equation including the temporal, convection, and pressure gradient terms is considered to form the wall-stress model. Applying the ideas of the analytical wall function for Reynolds averaged turbulence models, the profile of the sub-grid-scale eddy viscosity inside the wall adjacent cells is modeled as two-segment piecewise linear variations. This simplification makes it possible to analytically integrate the ODE near the wall to algebraically give the wall shear stress as the wall boundary condition for the momentum equation. By applying such integration to the wall-normal velocity component, the methodology to avoid the log-layer mismatch is also proposed. Coupled with the standard Smagorinsky model, the proposed model shows good performance in turbulent channel flows at $Re_\tau = 1000 - 5000$ irrespective of the grid resolutions. The proposed model is also confirmed to be superior to the traditional equilibrium wall stress model in a turbulent backward-facing step flow.

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