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NEAR-WALL REYNOLDS STRESS MODELLING BASED ON ELLIPTIC BLENDING: PHYSICAL RATIONALE AND APPLICATION TO SEPARATED FLOWS

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The Reynolds stress models (RSM), based on the solutions of the equations governing the Reynolds stress field $\overline{u_i u_j}$, certainly represent the highest level of turbulence modeling within the RANS (Reynolds-averaged Navier-Stokes) computational framework. They are inherently capable of treating a number of phenomena that are characteristic of the flows, the structure of which deviates significantly from the conditions underlying the fully-developed, wall-parallel flows. These phenomena relate to the effects of differently varying pressure gradients and the streamline curvature, complying with the configuration geometry, but also with the flow separation as well as with the swirling and rotating flows. It can be generally said that all three-dimensional flow configurations strongly deviate from the conditions the logarithmic law for the velocity field is based on. In contrast to the eddy viscosity-based RANS models, which do not carry the information about the turbulence anisotropy into the momentum equation, the Reynolds stress models can naturally differentiate between the strengthened wall-related viscous effects and the kinematic wall blocking, with the latter representing the basis of the Reynolds stress anisotropy.

The present activity is concerned with a new version of the near-wall Reynolds stress model by Jakirlic and Maduta (2015, *Int. J. Heat and Fluid Flow* 51) based on the homogeneous part of the specific dissipation rate ω^h $(= \varepsilon^h/k)$, in which the pressure-distribution term is introduced in accordance with the elliptic-blending approach by Manceau and Hanjalic (2002; *Physics of Fluids* 14). Accordingly, the quadratic formulation (expressed as a function of the Reynolds stress anisotropy tensor) proposed by Speziale et al. (1991; *J. Fluid Mech.* 227) is adopted in the core-flow region. This is appropriately blended with its adequately modelled wall-related counterpart that fulfills the exact asymptotic behavior. The model coefficients do not have to be expressed as relevant functional dependencies, but can be specified as constants. Another important model detail is a correspondingly modified turbulent diffusion coefficient in both the Reynolds stress and the length scale-determining equation. This avoids the need to include some additional, mostly ad-hoc modelled, source terms that address the well-known anomaly of the backward curvature of the mean dividing streamline at the reattachment point in separated flows. Moreover, a special form of coupling of the velocity and Reynolds stress fields is included in the RANS equation of motion. Accordingly, a variably formulated part (maximally up to 25% in the region very far from the wall, but vanishingly small in the immediate vicinity of the wall) of the Reynolds stress tensor originating from the Boussinesq correlation is introduced. The numerical robustness of the model is thus significantly improved. The model is extensively validated in a broad range of attached and separated, two-dimensional and three-dimensional flow configurations over a range of Reynolds numbers, with results showing a high degree of agreement with available experimental and reference DNS and LES data.