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On new symmetry-generated RANS models[1] DARIO KLINGENBERG, Graduate School of Excellence Computational Engineering, TU Darmstadt, MARTIN OBERLACK, DOMINIK PLUEMACHER, Chair of Fluid Dynamics, TU Darmstadt — We apply new insights into turbulent statistics obtained through Lie-symmetry analysis to the problem of RANS modeling. Symmetries mirror key physical principles from governing equations. The symmetries of the infinite hierarchy of multi-point correlation equations fall into two categories: Symmetries of classical mechanics, which have direct counterparts in the unaveraged Navier-Stokes equations, and statistical ones, which only arise when adopting a statistical view on turbulence. It was shown that those of the latter type encode crucial phenomena, in particular intermittency and non-Gaussianity (Waclawczyk 2014). In a modeling context, symmetries provide constraints on the model equations, because unless the model equations contain precisely the same symmetries as the exact equations, the model is prone to exhibiting nonphysical behavior. We therefore present a new modeling framework that allows algorithmically generating turbulence models based on symmetries. We apply this method to obtain a prototype RANS model that is agreement with not only the classical, but also the statistical symmetries, which existing models fail to accomplish. It turns out to be necessary to introduce as a new model variable an additional velocity field with specific advantageous symmetry properties.

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