The partially integrated transport modeling method for continuous hybrid non-zonal RANS/LES simulations of turbulent flows

Bruno Chaouat*
ONERA , 92322 Châtillon, France

The basis of the partially integrated transport modeling (PITM) method was introduced in references [Schiestel and Dejoan, Theoretical Computational Fluid Dynamics, **18**,(2005)] and [Chaouat and Schiestel, Physics of Fluids, **17**, (2005)]. In regard with academic LES that requires refined grids, the PITM method allows to perform simulations of unsteady flows on relatively coarse grids when the spectral cutoff is located within or before the inertial zone. From a physical point of view, this method finds its basic foundation in the spectral space by considering the Fourier transform of the two-point fluctuating velocity correlation equations in homogeneous turbulence. The extension to non-homogeneous turbulence is developed within the approximate framework of the tangent homogeneous space. The main ingredient of the method is the new dissipation-rate equation that can be applied as a subfilter scale turbulence model. So that it becomes easy to convert almost any usual RANS transport model into a subfilter scale model. In particular, the method can be applied to two equation models and to stress transport models as well. This method has been successfully applied for simulating a large range of unsteady flows including various free flows as well as bounded flows with a sufficient accuracy for engineering computations. In particular, the turbulent flows over periodic hills at the Reynolds numbers $Re = 10,595$ and $Re = 37,000$ have been simulated on a very coarse grid and several medium grids with a relatively good agreement with the experimental data [Rapp and Manhart, Exp Fluids, **51**, (2011)].

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*Senior Scientist, Computational Fluid Dynamics Department.