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Session:

An algebraic hybrid RANS-LES model with application to turbulent heat transfer

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Abstract

An algebraic hybrid RANS-LES model is proposed. The RANS mode employs a modified mixing-length approach near walls. Instead of using the magnitude of the resolved strain-rate tensor, the advanced spatial operator used by the WALE sgs model[1] is embedded into the formulation due to its better scaling properties for the turbulent/eddy-viscosity. The LES mode incorporates the well-known WALE sgs model to resolve flow in the rest of the domain. Similar to the robust, well-calibrated, low-cost, algebraic hybrid RANS-LES model (HYB0) by Peng[2] which combines simple mixing length-type RANS near wall with Smagorinsky sgs model away from wall, the same turbulent length-scale adaptation approach for the RANS-LES interface is utilized for proper interaction between the modes. In addition to correct near-wall behaviour, the use of the advanced WALE differential operator theoretically ensures smooth transition at the interface, detection of turbulent structures inside the eddies and better prediction of the log-layer velocity profile.

The proposed model (*m*HYB0) is implemented into the LES flow solver (*i*LES)[3] which is based on an implicit, non-dissipative, discrete kinetic energy conserving, low-Mach number DNS algorithm[4] to make it applicable to transitional/turbulent flows with heat transfer and buoyancy. Turbulent Rayleigh-Bénard problem is studied to examine the performance of the resulting algorithm without the Boussinesq approximation even at large temperature differences.

Fig.1 shows the *rms* of the temperature and the vertical velocity fluctuations. The turbulent heat flux distribution is also plotted in Fig.2. It can be seen from the figures that no issues were observed at the RANS-LES interface and correct scaling near wall was achieved. These preliminary results are satisfactorily compared with the previous experimental and numerical data. Further results and analyses will be included in the full manuscript.

Session:

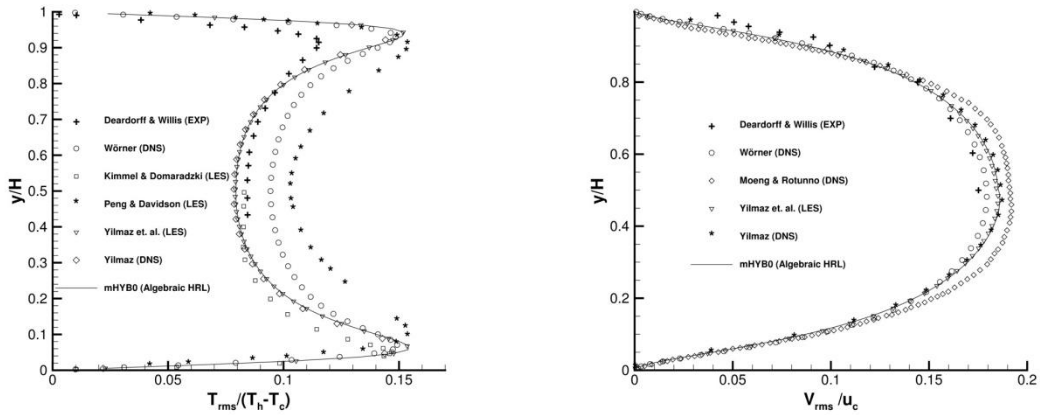

Fig. 1 Vertical distribution of *rms* of temperature (right) and vertical velocity fluctuations

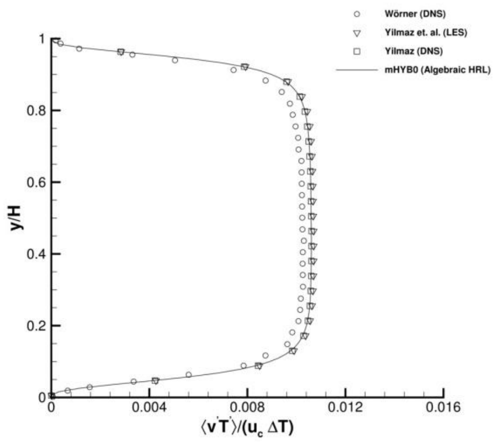

Fig. 2 Vertical distribution of turbulent heat flux

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