6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11 – 15 June 2018, Glasgow, UK

VALIDATION OF ALGEBRAIC MODELS FOR VPG AND DISSIPATION TERMS IN RANS AND FANS EQUATIONS

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Key Words: *Statistical Closures, Turbulence Modelling*

Efforts to find relationships between various terms in transport equations of turbulent flows and present them in a form of algebraic expressions have a long history. If such relationships exist, they reflect important aspects of energy transfer in turbulent flows. They can also be used to minimize a number of unknown terms in the equations.

In our previous works [1-2], we found that velocity/pressure-gradient (VPG) correlations in incompressible planar wall-bounder turbulent flows can be modelled as linear functions of the terms describing turbulence production due to the mean velocity gradient, molecular and turbulent diffusions. The models were deduced through the analysis of data of direct numerical simulation (DNS). The analysis revealed in particular that VPG correlations in the transport equation for one Reynolds stress may depend on terms in the transport equations for the other Reynolds stresses. This finding is outside conventional wisdom and requires further understanding.

Values of model coefficients are always of concern. In the proposed VPG models, they were found to remain constant when the models were validated using DNS data in various incompressible planar wall-bounded flows, with and without separation, in a relatively large range of the Reynolds number [2].

The current study specifies values of model coefficients more accurately, proposes models for VPG correlations in the transport equation for the Reynolds stress in the spanwise flow direction and for the components of the second-rank dissipation tensor, and validate the models with DNS data in several incompressible planar wall-bounded flows. Validity of the models in a compressible flow is also investigated using DNS data for the budget terms in the Favre-averaged Navier-Stokes (FANS) equations in a compressible planar channel flow.

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