Near-Wall Turbulent Flows
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Recent Ideas and Developments in the Modeling of Wall Turbulence

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Abstract

The possiblitity of using the attached eddy hypothesis as first proposed by Townsend [1] and extended by Perry and Chong [2] and Perry, Henbest and Chong [3] in a closure scheme for computing the evolution of a turbulent boundary layer, was outlined recently by Perry , Li and Marusic [4]. Here it was assumed that certain properties of the attached eddies applicable in zero pressure gradient flow are preserved in favorable and adverse pressure gradient flows. In this keynote lecture, ways of incorporating the attached eddy hypothesis into the equations of motion are investigated. Use is made of the mean momentum (Reynolds Equation) and mean continuity equations for two-dimensional (mean) boundary-layer flow. It is found that a differential field method is inappropriate and an integral scheme is derived. The formulation uses the law of the wall and the law of the wake, and analytical expressions have been rigorously derived from the mean momentum equation which relates the shear stress profiles with the mean velocity profile parameters and their streamwise derivatives. This is combined with convolution integrals derived from the attached eddy hypothesis by Perry et al. [4] for obtaining closure.

The method is applied to favorable, zero and adverse pressure gradient flow cases to give the evolution of mean flow, shear stress profiles, skin friction coefficient and other parameters with streamwise Reynolds number. Although the method is still under development, the results look promising and should be applicable to a wide class of flows. Flow cases for which the method (in its present form) breaks down can be identified with internal consistency checks. Many of the important relations are in analytical form and were derived using *Mathematica*.

References

1 A. A. Townsend, The Structure of Turbulent Shear Flow, Cambridge University Press, Cambridge, UK, 1976.

2 A. E. Perry and M. S. Chong, J. Fluid Mech., 119 (1982) 173.

3 A. E. Perry, S. M. Henbest and S. M. Chong, J. Fluid Mech., 165 (1986) 163.

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