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# PERFORMANCE ASSESSMENT OF VARIABLE ORDER FLUX RECONSTRUCTION FOR IMPLICIT LARGE EDDY SIMULATION OF TURBULENT CHANNEL FLOW

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High-order methods have become increasingly useful and popular in recent years. Flux reconstruction (FR) [1] methods represent an arbitrarily high-order family of methods that employ unstructured body-fitted grids to enable simulations over and through complex geometries. Various studies have demonstrated that the inherent numerical dissipation associated with these schemes make flux reconstruction eligible for so-called implicit Large Eddy Simulation (ILES) [2]. This obviates the need for a subgrid-scale turbulence model. One of the main limitations of Large Eddy Simulation (LES) for practical aerodynamics problems featuring complex geometry turbulent flows is the need for a good near-wall model to keep the computational cost reasonable. By "good", this means accurate for attached and, more significantly, for separated flows. As a step in this direction, we are testing near-wall models for LES in the context of the arbitrarily high-order flux-reconstruction body-fitted unstructured grid method. An excellent recent study by Frẽre et. al. [3] demonstrated the use Discontinuous Galerkin (DG) method together with a simple algebraic equilibrium wall model based on the Reichardt law-of-the-wall for ILES of fully-developed turbulent channel flow at $Re_\tau = 5200$, which is the largest value available for quantitative comparison to DNS data. In the present study, the FR schems is used to carry out ILES of fully-developed turbulent channel flow to investigate the use of a "$p$-map" based approach where the element polynomial order is refined only in wall adjoining cells. These results are then compared against a more standard equilibrium wall modeling approach. The advantage of the $p-$map approach is that it avoids tuning parameters in a more complicated wall modeling approach. It is shown that a relatively low order $p = 3$ can be used away from the wall, while near the wall the order must be increased with increasing $Re_\tau$. While limiting the degrees of freedom, the time step becomes increasingly restrictive. Nevertheless, it is shown that our approach yields good results even though the first grid point is not within the $y^+ = 1$ rule.

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