UNIVERSITY OF MARYLAND

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WALL-MODELED LES: NONEQUILIBRIUM FLOWS AND CONVERGENCE

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DeWalt Seminar Room
2164 Glenn L. Martin Hall

Speaker

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ABSTRACT

Predictive and affordable simulation of wall-bounded turbulent flows remains as a pacing item in CFD, and significant progress has been made over the past decade in near-wall models for large-eddy simulation (LES) to this end. In this talk, I will summarize the research conducted in my group on wall-modeled LES, focusing on the assessment of the state-of-the-art wall models in nonequilibrium flows, and establishing the notion of convergence in inherently under-resolved WMLES calculations.

Application of widely used wall models to two spatially developing three-dimensional turbulent boundary layers (3DTBL), with and without flow separation, reveals that the flow direction near the wall has separable contributions from the equilibrium and nonequilibrium parts, where the latter controls the accuracy of the near-wall flow direction in wall models. For pressure gradient flows, wall models accounting for more of the near-wall physics tend to perform better in the adverse pressure gradient (APG) region. However, in the favorable pressure gradient (FPG) region, an opposite trend (discussed rarely) is found with overshoot in the skin friction, which we show resulting from the erroneous response of a dynamic model to FPG. In general, the mean and turbulence quantities away from the wall are predicted equally well with different wall models. An on-going application of WMLES to a rough-wall boundary layer for simulation of atmospheric surface layer over a New Mexico sand dunes will be discussed, focusing on the internal boundary layer development from a smooth-to-rough transition. Lastly, numerical experiments that indicate the convergence rate of WMLES is controlled by the extent of the wall-modeled region will be presented, suggesting that one may converge WMLES at the desired grid resolution.

BIO

George Park is an Assistant Professor of Mechanical Engineering and Applied Mechanics at the University of Pennsylvania. He received his Ph.D. and M.S. in Mechanical Engineering (ME) from Stanford University in 2014 and 2011, respectively, and his B.S. in ME from Seoul National University, South Korea, in 2009. He worked as a postdoctoral fellow and an engineering research associate at the Center for Turbulence Research (Stanford) prior to joining UPenn as a faculty member. His research interests include high-fidelity numerical simulation of complex wall-bounded turbulent flows, computational methods with unstructured grids, non-equilibrium turbulent boundary layers, and fluid-structure interaction.

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