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Application of a Machine Learning Turbulent and Non-turbulent Classification Method to Wall Modeled LES of Transitional Channel Flows[1] GHANESH NARASIMHAN, CHARLES MENEVEAU, TAMER ZAKI, Johns Hopkins University — While wall-resolved large eddy simulation (LES) can predict laminar-to-turbulence transition, further reduction in computational cost by wall modeling compromises the ability to accurately capture the transition process. This issue arises, in part, because the wall model assumes the flow is in a statistically stationary turbulent state and hence incorrectly prescribes turbulent wall stresses in laminar regions. We retain the application of the wall model within the turbulent regions of transitional channel flow where even nascent spots exhibit high-Reynolds number characteristics, and we exclude the model from laminar regions. The distinction is performed using a self-organizing map (Wu et al, PRF 2019), an unsupervised machine-learning classifier. We discuss the capability of WMLES with turbulent/non-turbulent classification (WMSOM) in predicting both natural and bypass transitions in channel flow. Predictions of bypass transition agree well with DNS, while for natural transition both K- and H-type are predicted with only a slight delay in the transition time. In addition, the approach offers a significant reduction in computational cost.

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