Weekly CEAFM Seminar: Spring 2016

Date: Friday, March 25, 2016
Time: 11:00 AM
Location: Gilman Hall # 50
Speaker: Dr. Richard J.A.M. Stevens (University of Twente)
Title: “Challenging the Large Eddy Simulation Technique for Turbulent Wall-Bounded Flow with Advanced a Posteriori Tests”

Abstract

The logarithmic law for the mean velocity in turbulent boundary layers has long provided a valuable and robust reference for comparison with theories, models and large-eddy simulations (LES) of wall-bounded turbulence. More recently, analysis of high-Reynolds-number experimental boundary-layer data has shown that also the variance and higher-order moments of the streamwise velocity fluctuations $u'\overline{c}$ display logarithmic laws. Such experimental observations motivate the question whether LES can accurately reproduce the variance and the higher-order moments, in particular their logarithmic dependency on distance to the wall. In this study we perform LES of very high-Reynolds-number wall-modelled channel flow and focus on profiles of variance and higher-order moments of the streamwise velocity fluctuations. In agreement with the experimental data, we observe an approximately logarithmic law for the variance in the LES, with a ‘Townsend–Perry’ constant of $A_{1} \approx 1.25$. The LES also yields approximate logarithmic laws for the higher-order moments of the streamwise velocity. Good agreement is found between $A_{p}$, the generalized ‘Townsend–Perry’ constants for moments of order $2p$, from experiments and simulations. Both are indicative of sub-Gaussian behavior of the streamwise velocity fluctuations. The near-wall behavior of the variance, the ranges of validity of the logarithmic law and in particular possible dependencies on characteristic length scales such as the roughness length $z_{0}$, the LES grid scale $\delta$, and subgrid scale mixing length $C_{s}\delta$ are examined. We also present LES results on moments of spanwise and wall-normal fluctuations of velocity.