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Analysis of velocity and thermal structures in a transitionally rough turbulent boundary layer ALI DOOSTTALAB, SURANGA DHARMARATHNE, Texas Tech University, GUILLERMO ARAYA, Mechanical Engineering Department, University of Puerto Rico - Mayaguez, MURAT TUTKUN, Institute for Energy Technology (IFE), Department of Process and Fluid Flow Technology, Norway, RONALD ADRIAN, Arizona State University, LUCIANO CASTILLO, Texas Tech University — A zero pressure gradient turbulent boundary layer flowing over a transitionally rough surface (24-grit sandpaper) with $k^+ = 11$ and Reynolds numbers based on momentum thickness of around 2400 is studied using direct numerical simulation (DNS). Heat transfer between the isothermal rough surface and the turbulent flow with molecular Prandtl number $Pr = 0.71$ is simulated. The dynamic multi-scale approach developed by Araya et al. (2011) is employed to prescribe realistic time-dependent thermal inflow boundary conditions. Above the roughness sub-layer (3 - $5k$) it is found that statistics of the temperature field, including higher order moments and conditional averages, are the same for the smooth and rough surface flow, showing that the Townsend's Reynolds number similarity hypothesis applies for the thermal field as well as the velocity field for the Reynolds number and k^+ considered in this study. Also the velocity and thermal structures of the developing boundary layer were studied by means of multi-point correlations and POD analysis.

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