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Experimental Manipulation of Wall-Bounded Turbulence

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The potential gains in efficiency across a range of applications associated with successful control of wall- bounded turbulence are well-known, as are the many challenges this interdisciplinary problem encompasses. Further, while there have been recent developments in fundamental wall turbulence research, including description of the characteristics of coherent structures (e.g. Adrian, 2007) and the very large scale motions (e.g. Mathis *et al*, 2009), many fundamental questions remain, in particular with respect to scaling behavior as the Reynolds number is increased to practically important values. Progress can be made in both understanding the response of canonical flows to forcing at the wall and isolating mechanisms important to the unperturbed flows using open-loop forcing. To this end, recent work has shown how small amplitude perturbations to surface roughness designed to isolate individual spatial and temporal scales (a "dynamic roughness") can be used to manipulate the characteristics of wall turbulence. This talk will describe the experimental manipulation of a turbulent boundary layer using dynamic roughness and the connection to the spatio-temporal (spectral) information traditionally reported in turbulence studies. The development of tools from earlier work on directional amplification of the Navier-Stokes operator into simple models by which to interpret the coupling between the wall motion and the flow will be described, and some examples of the understanding of structure and Reynolds number trends in the canonical (unperturbed) flow that emerge from the perturbed case will be given. The contribution of students and collaborators, in particular Dr. Ati Sharma (University of Sheffield, U.K.) and Ian Jacobi (Caltech), to this work and the support of AFOSR (grant FA #9550-09-1-0701, program manager John Schmisseur) are gratefully acknowledged.