Abstract Submitted
for the DFD13 Meeting of
The American Physical Society

Model-based analysis of the effect of spanwise wall oscillations on drag reduction at high Reynolds numbers ARMIN ZARE, University of Minnesota, RASHAD MOARREF, Caltech, MIHAILO JOVANOVIC, University of Minnesota — Experiments and numerical simulations have shown that drag-reducing ability of spanwise wall oscillations in turbulent channels deteriorates as the Reynolds number increases. Recent work by Moarref and Jovanovic (J. Fluid Mech., vol. 707, 2012) has demonstrated the predictive power of a model-based approach for controlling turbulent flows. In the present study, we use a linearized stochastically-forced model to reveal the Reynolds number independent effects of wall oscillations on drag reduction. This allows us to extend the predictive capability of our simulation-free approach to high Reynolds numbers. We show that the influence of wall oscillations at low Reynolds numbers is confined to the streamwise and spanwise wavelengths that correspond to the universal inner-scaled eddies in wall turbulence. Since wall oscillations do not suppress large scale eddies, which are responsible for increased drag in the uncontrolled flow, we conclude that wall oscillations have weaker influence on drag reduction at higher Reynolds numbers. In addition, our observations enable predictions of drag reduction trends at high Reynolds numbers.

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Date submitted: 31 Jul 2013 Electronic form version 1.4