Abstract Submitted
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Resolvent-informed design of anisotropic permeable substrates for turbulence control[1] ANDREW CHAVARIN, University of Southern California, GARAZI GOMEZ-DE-SEGURA, RICARDO GARCIA-MAYORAL, University of Cambridge, MITUL LUHAR, University of Southern California — We utilize an extended version of the resolvent formulation to design anisotropic permeable substrates for passive turbulence control. The resolvent formulation interprets the Fourier transformed Navier-Stokes equations as a forcing-response system: the linear terms map the action of the nonlinear terms to a velocity and pressure response. A gain-based decomposition of the forcing-response transfer function (the resolvent operator) identifies flow features (resolvent modes) that reproduce important structural and statistical features of wall-bounded turbulent flows. One particular resolvent mode serves as a useful surrogate for the dynamically important near-wall cycle. The effect of permeable substrates is introduced in this framework using the Volume-Averaged Navier-Stokes equations. Substrates with high streamwise permeability and low wall-normal permeability are found to suppress the near-wall resolvent mode, which is consistent with conditions in which drag reduction has been observed in recent numerical simulations. Performance deteriorates when high-gain spanwise constant rollers resembling Kelvin-Helmholtz vortices emerge over the porous medium. A parametric study is used to identify permeability combinations that have drag reduction potential.

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Andrew Chavarin
University of Southern California

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