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Streamwise Development of Turbulent Boundary Layer Drag Reduction with Polymer Injection[1] GODFREY MUNGAL, YONGXI HOU, VIJAY SOMANDEPALLI, Stanford University — Zero pressure gradient turbulent boundary layer drag reduction by polymer injection has been studied with PIV from low to maximum drag reduction. A previously developed technique - the (1-y/δ) fit to the total shear stress profile - is used to evaluate the skin friction, drag reduction and polymer stress. The mean velocity is seen to respond quickly to the suddenly reduced wall shear stress due to polymer injection, unlike the entire Reynolds shear stress profile. The Reynolds shear stress profiles (in wall units) can be greater than unity and this unique feature is used to judge if the flow is in equilibrium. Downstream drag reduction magnitude is used to categorize the flow into three zones: development, steady-state and depletion regions. The polymer stress is found to be proportional to drag reduction in the depletion region but not necessarily so in the other two regions. The dynamical contributions of the various stresses in the boundary layer to the overall stress balance shows that the polymer stresses can sometimes account for up to 25% of the wall shear stress.

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