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Are measurements of fluctuating wall-shear stress with flush-mounted cavity hot-wires possible? RAMIS ÖRLÜ, ADALBERTO PEREZ, ALEX ALVISI, SimEx/FLOW, KTH Engineering Mechanics, ALESSANDRO TALAMELLI, University of Bologna, PHILIPP SCHLATTER, SimEx/FLOW, KTH Engineering Mechanics — Flush-mounted cavity hot-wire probes have been around since two decades, but have typically not been applied as often compared to the traditional wall hot-wires mounted several wire diameters above the surface. The former is believed to significantly enhance the frequency response of the sensor. The recent work using a cavity hot-wire by Gubian et al. (Phys. Rev. Fluids 2019) came to the surprising conclusion that the magnitude of the fluctuating wall-shear stress $\tau^+_{w,rms}$ reaches an asymptotic value of 0.44 beyond the friction Reynolds number $Re_\tau \sim 600$. In an effort to explain this result, which is at odds with the majority of the literature, the present work combines direct numerical simulations (DNS) of a turbulent channel flow with a cavity modelled using the immersed boundary method, and an experimental replication of the study of Gubian et al. in a turbulent boundary layer. It is shown that the measurements of Gubian et al. can be replicated qualitatively as a result of measurement issues. Based on our results, we will discuss why cavity hot-wire probes should neither be used for quantitative nor qualitative measurements of wall-bounded flows, and that several experimental shortcomings can interact to sometimes falsely yield seemingly correct results.

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