Abstract Submitted
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Resolvent-based estimation of turbulent channel flow[1] FILIPE AMARAL, ANDRE CAVALIERI, Instituto Tecnologico de Aeronautica, EDUARDO MARTINI, PETER JORDAN, Institut Pprime, CNRS Universite de Poitiers ENSMA, AARON TOWNE, University of Michigan, DAN HENNINGSON, Royal Institute of Technology (KTH) — We employ a resolvent-based methodology to estimate time-domain velocity and pressure fluctuations within turbulent channel flows at friction Reynolds numbers of 550 and 1000 using only measurements of shear stress and pressure at the wall. The resolvent-based estimation method recovers fluctuations in the time domain by convolving the measurements with a transfer function formulated in terms of the resolvent operator obtained from the linearized Navier-Stokes equations as well as coloured statistics of the nonlinear terms, which are computed from DNS data. The estimation of buffer-layer structures is very accurate, with normalized correlation between the estimated flow and DNS fields higher than 0.95 for all variables. The accuracy is lower when log layer fluctuations are estimated from the wall; however, large-scale structures are still well estimated, and the normalized correlation between estimation and DNS is approximately 0.6 at $y^+ = 200$. The energy spectra and variance of the filtered DNS and the estimated flow also exhibit good agreement. The use of coloured forcing statistics is crucial for obtaining accurate estimates; if white-noise forcing is considered, buffer-layer structures can still be estimated accurately, but the errors in the log layer become significant.

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Filipe Amaral
Instituto Tecnologico de Aeronautica

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