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Unscented Kalman filter (UKF) based nonlinear parameter estimation for a turbulent boundary layer:a data assimilation framework ZHAO PAN, University of Waterloo, YANG ZHANG, JONAS GUSTAVSSON, Florida State University, JEAN-PIERRE HICKEY, University of Waterloo, LOUIS CATTAFESTA, Florida State University, UWATERLOO COLLABORATION, FSU COLLABORATION — A turbulent boundary layer is an essential flow case of fundamental and applied fluid mechanics. However, accurate measurements of turbulent boundary layer parameters (e.g., friction velocity u_τ and wall shear τ_w), are challenging, especially for high speed flows. Many direct and/or indirect diagnostic techniques have been developed to measure wall shear stress. However, based on different principles, these techniques usually give different results with different uncertainties. The current study introduces a nonlinear data assimilation framework based on the Unscented Kalman Filter that can fuse information from i) noisy and gappy measurements from Stereo Particle Image Velocimetry, a Preston tube, and a MEMS shear stress sensor, as well as ii) the uncertainties of the measurements to estimate the parameters of a turbulent boundary layer. A direct numerical simulation of a fully developed turbulent boundary layer flow at Mach 0.3 is used first to validate the data assimilation algorithm. The algorithm is then applied to experimental data of a flow at Mach 0.3, which are obtained in a blowdown wind tunnel facility. The UKF-based data assimilation algorithm is robust to uncertain and gappy experimental data and is abl

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