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Multi-Rate and Multi-Fidelity Sensor Fusion for Wall-Bounded Turbulent Flow Reconstruction MENGYING WANG, University of Minnesota, C. VAMSI KRISHNA, MITUL LUHAR, University of Southern California, MAZIAR S. HEMATI, University of Minnesota — Experimental instrumentation is rarely able to resolve the breadth of spatial and temporal scales in turbulent flows of practical interest. In this study, we propose to fuse measurements from multi-rate and multi-fidelity sensors with predictions from a physics-based model to reconstruct a wall-bounded turbulent flow. A "fast" filter is used to fuse high-temporal low-spatial resolution measurements (e.g., hot-wire anemometers) with predictions from a model based on rapid distortion theory. Then, a "slow" filter updates these estimates to improve spatial fidelity each time a low-temporal high-spatial resolution measurement (e.g., particle image velocimetry) becomes available. Construction of the filter from first principles requires knowledge of modeling errors and noise statistics, which can be difficult to characterize. Here, we show that a covariance matching technique can be used to identify the proposed filters directly from the available sensor measurements, avoiding the need to model and quantify uncertainties a priori. We demonstrate the approach using direct numerical simulation of a turbulent channel flow from the Johns Hopkins Turbulence Database. The role of sensor placement on reconstruction performance is also investigated.

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