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Moving horizon estimation of turbulent velocity fields in the atmospheric boundary layer using lidar measurements and large eddy simulations[1] PIETER BAUWERAERTS, JOHAN MEYERS, KU Leuven — Pulsed lidar sensors measure the line-of-sight (LOS) projected wind velocity in the atmospheric boundary layer at a range of locations along the LOS spanning several kilometres. Despite the vast amount of measurement information, the data remains sparse and unidirectional. To reconstruct a full 3D velocity field, we employ a non-linear moving horizon estimation (or 4D-Var) approach, using large-eddy simulations (LES) as a state space model. The cost function, which represents the relative probability of the state space trajectories, is comprised of two terms, the first term regularizes the optimization based on prior statistical knowledge of the velocity field fluctuations embedded in the 2-point covariance tensor of the atmospheric boundary layer. To this end, the covariance tensor is averaged offline over a sufficiently long time window, to ensure statistical convergence. The second part penalizes the difference between the LES and real observations over the time horizon. Instead of using experimental data, we use a fine-grid LES simulation as a virtual reality, creating a controlled and flexible testing environment. The methodology is demonstrated on two measurement setups, a standard plan-position indicator scanning mode and a 3D trajectory based on a Lissajous curve.

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