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Estimating the State of Aerodynamic Flows in the Presence of Modeling Errors[1] ANDRE F. C. DA SILVA[2], TIM COLONIUS[3], California Institute of Technology — The ensemble Kalman filter (EnKF) has been proven to be successful in fields such as meteorology, in which high-dimensional nonlinear systems render classical estimation techniques impractical. When the model used to forecast state evolution misrepresents important aspects of the true dynamics, estimator performance may degrade. In this work, parametrization and state augmentation are used to track misspecified boundary conditions (e.g., free stream perturbations). The resolution error is modeled as a Gaussian-distributed random variable with the mean (bias) and variance to be determined. The dynamics of the flow past a NACA 0009 airfoil at high angles of attack and moderate Reynolds number is represented by a Navier-Stokes equations solver with immersed boundaries capabilities. The pressure distribution on the airfoil or the velocity field in the wake, both randomized by synthetic noise, are sampled as measurement data and incorporated into the estimated state and bias following Kalman's analysis scheme. Insights about how to specify the modeling error covariance matrix and its impact on the estimator performance are conveyed.

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