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Hemodynamic data assimilation using model order reduction and Kalman filter MILAD HABIBI, Northern Arizona University, ROSHAN DSOUZA, University of Wisconsin-Milwaukee, SCOTT DAWSON, Illinois Institute of Technology, AMIRHOSSEIN ARZANI, Northern Arizona University — Obtaining high-fidelity blood flow data is a challenging task. High-resolution patient-specific computational fluid dynamics (CFD) simulations are sensitive to uncertainty in boundary conditions and model parameters. On the other hand, imaging methods such as time resolved phase contrast magnetic resonance imaging (a.k.a 4D-Flow MRI) suffer from low spatio-temporal resolution and acquisition noise. To overcome these limitations, we propose a data assimilation method based on dynamic mode decomposition (DMD), reduced-order modeling (ROM), and Kalman filtering. Our method leverages DMD to build the predictor operator. Subsequently, a Kalman filter is used to merge CFD and 4D-Flow MRI observations. Our reduced-order approach improves prior ensemble Kalman filter models, which required several expensive ensemble simulations. To test our method, we generate synthetic 4D-Flow MRI data and consider CFD simulations with uncertainty in model parameters. We apply our method to different blood flow problems ranging from Womersley flow to blood flow in cerebral aneurysms. We demonstrate the accuracy of our model and improvement in quantifying hemodynamics.

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