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Retrograde Estimation and Forecasting of Chaotic Systems. Part 3: Adaptive Observation and Covariance Update Strategies THOMAS BEWLEY, JOSEPH CESSNA, CHRISTOPHER COLBURN, University of California-San Diego — The variational (i.e., adjoint-based) strategies discussed in Parts 1 and 2 of this presentation do not attempt to model the variance or covariance of the estimation error, as done in the Kalman and extended Kalman filters. In the low-dimensional setting, when the system evolves slowly as compared with the computational model, it is straightforward to extend the idea of covariance modeling to the retrograde, or backwards-in-time, setting. The key idea of this extension is to "undo" the covariance update based on the linearization of the system around the previous estimator trajectory, then "redo" the covariance update based on the linearization of the system around the updated estimator trajectory. In the high-dimensional setting [as encountered when using high-fidelity computational models of fluid systems], low-rank approximations of the covariance may be used, as with Kalman filtering, in this retrograde framework. A consistent model of the spatial and temporal dynamics of the error covariance (that is, of the system uncertainty) may then be used to drive an adaptive observation algorithm in order to coordinate the motion of a swarm of mobile sensors, such as UAVs equipped with GPS and MEMS-based detectors of contaminants, in order to maximize the accuracy of the forecast.

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