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Ensemble/Variational Estimation (EnVE) and its application to canonical turbulent flow realizations CHRISTOPHER COLBURN, JOSEPH CESSNA, THOMAS BEWLEY, UC San Diego — The recently-developed hybrid EnVE method for data assimilation incorporates successive adjoint optimizations to update the initial conditions of a flow model, over various horizons of interest, in order to reconcile this model with recent measurements. Such adjoint optimizations typically require the trajectory to be saved over the entire interval over which the optimization is performed; in high-dimensional systems, this can lead to significant storage problems, which can be partially alleviated via checkpointing. In the EnVE framework, this requirement is eliminated, and supplanted by a requirement to march the state of the system backward in time simultaneously with the adjoint. If the system is derived from a PDE with a diffusive component, this backward-in-time state march is ill conditioned, and requires regularization/smoothing to prevent errors from accumulating rapidly at the small scales. The present talk focuses on this peculiar requirement of the EnVE algorithm. As the forecasting problem may itself be considered as a smoothing problem, it is, in fact, expected to find a "smoothing" ingredient at the heart of an algorithm of this sort. Various strategies are proposed and tested for accomplishing the required smoothing in the EnVE setting, and are tested on both a chaotic 1D PDE (the Kuramoto-Sivashinsky equation) as well as our in-house spectral 3D DNS/LES code, diablo.

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