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Development of the NRL 4D-Var data assimilation adjoint system

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The adjoint of an observation-space four-dimensional variational atmospheric data assimilation system, NAVDAS-AR[**?**], is under development at NRL in Monterey, CA, USA. NAVDAS-AR, where AR stands for accelerated representer, is a four-dimensional extension of the current US Navy three-dimensional operational data assimilation system - NAVDAS[**?**]. Using a numerical weather prediction (NWP) model as a dynamic constraint, NAVDAS-AR minimizes a generalized nonlinear cost function that combines the errors in the initial background, forecast model, and observations within a given data assimilation window. The minimization is equivalent to solving a nonlinear coupled Euler-Lagrange (EL) system. Instead of directly solving the nonlinear EL system, we use an iterative method to partially account for the nonlinearities in both the NWP model and observation operators by solving a sequence of coupled linear EL systems that are decoupled using the representer method.

The adjoint of NAVDAS has proven to be very useful in estimating the impact of observations on the short-range forecast error in NWP. Due to the limitations of NAVDAS itself, however, the NAVDAS adjoint does not properly take into account of the temporal distribution of the observations. On the other hand, the adjoint of NAVDAS-AR enables us to monitor the observation in both space and time. The new capability of estimating the temporal aspect of the impact of observations is likely to become much more important in the near future when asynoptic observations become more dominant. In this presentation, we start with some background material to the development of the NAVDAS-AR adjoint and give a brief description of the basic design and formulation. We will present the key procedures for implementing the adjoint system. Preliminary results of monitoring observation impact using the four-dimensional adjoint system will also presented.