Four Dimensional Observation Impact on the US Navy's Atmospheric Analyses and Forecasts

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Abstract

One of the most important components of any operational numerical weather prediction (NWP) effort is the data assimilation system that provides the best available analysis as the initial condition for the NWP model. One of the main components of any data assimilation system is the observations themselves that are used to improve the analysis. There are clearly needs to have an objective way to assess the observations' impact on analysis and forecast, or the sensitivity of the analysis and forecast to the observations. The theory of the adjoint of a data assimilation system was introduced by Baker (2000) and Baker and Daley (2000), which laid the theoretical foundation on using the adjoint of the associated variational data assimilation system to extend the sensitivity of forecast error from the analysis (initial condition) to the observations themselves. Based on the adjoint theory, Langland and Baker (2004) developed and tested the first adjoint of an operational three dimensional variational (3D-Var) system – NAVDAS (NRL Atmospheric Variational Data Assimilation System). The adjoint of NAVDAS has been routinely used to monitor the observational impact on forecast and to diagnose issues of "bad" observations.
An observation space weak constraint four dimensional variational (4D-Var) data assimilation system - NAVDAS-AR (NRL Atmospheric Variational Data Assimilation System - Accelerated Representer) has recently been developed at NRL (Xu et al. 2005 and Rosmond and Xu 2006). As part of the 4D-Var effort, the adjoint of NAVDAS-AR has also been developed. The newly developed adjoint system further enhanced our ability to monitor and examine the four dimensional nature of the observation impact on both the analysis and forecast. In this presentation we will briefly describe the formulation, implementation, and validation of the adjoint of NAVDAS-AR. We will show the application of examining the sensitivity of the US Navy's global NWP errors to the observations using the adjoint of NAVDAS-AR.