Observation sensitivity calculations using the adjoint of the gridpoint statistical interpolation (GSI) analysis scheme

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With an adjoint of the analysis component of a data assimilation system, sensitivities of aspects of either forecasts or the analyses themselves can be efficiently estimated. These sensitivities can be determined with respect to observational data, background fields or assimilation parameters, all computed simultaneously in one pass of the adjoint system. This permits arbitrary aggregation of the sensitivities, e.g., by data type, data channel or data location. It also allows for estimation of the impacts of any subset of data on standard forecast measures and represents a powerful approach for monitoring observation quality, diagnosing system behavior, etc.

The NASA Global Modeling and Assimilation Office (GMAO) is developing the adjoint of the Gridpoint Statistical Interpolation (GSI) analysis scheme developed at the National Centers for Environmental Prediction (NCEP). The GSI is expected to become the operational analysis scheme at both NCEP and GMAO in the near future. In this presentation, we discuss the development of the adjoint of GSI and show observation sensitivity results for a pre-operational version of the system. The adjoint is derived from a line-by-line tangent linear version of GSI, analogous to the approach often used to derive the adjoint of an atmospheric model. Availability of the tangent linear scheme provides an explicit means of assessing not only the fidelity of the adjoint, but also the effects of nonlinear processes in the GSI itself. Results indicate that the GSI adjoint provides accurate assessments of sensitivities with respect to observations of wind, temperature, satellite radiances and, to a lesser extent, moisture. Sensitivities with respect to ozone observations are quite linear for the ozone fields

themselves, but highly nonlinear for other variables. The accuracy of observation sensitivities in the presence of highly nonlinear penalty terms for negative moisture and super saturation are also assessed.