Impact of Observation Location on Goodness of State Reconstruction Using Forward Sensitivity Data Assimilation Method (FSM)

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The present authors have recently developed an alternate approach to dynamic data assimilation based on knowledge of forward sensitivity of model solution to elements of control (initial conditions, boundary conditions, and physical/empirical parameters). The methodology exhibits duality with the 4D-Var method (four-dimensional variational method). Instead of using the linear adjoint equations to work backwards in time to find the gradient of the cost function as is done in 4D-Var, this method relies on knowledge of sensitivity function evolution. This evolution is found through solution to a linear time-varying system — essentially equivalent to the tangent linear system of the dynamical model. The model solution and its sensitivity contain a wealth of information that can be exploited in a variety of ways. Especially valuable is inherent information on optimal positioning of observations to minimize forecast error. Using a low order dynamical model of air mass modification over the Gulf of Mexico, we perform numerical experiments that demonstrate the advantages of dynamic data assimilation using the FSM.

Reference:

S. Lakshmivarahan and J. M. Lewis (2010) "Forward sensitivity approach to dynamic data assimilation" ***Advances in Meteorology*** -Special Issue: Advanced Data Assimilation and Predictability Studies on High-impact Weather and Climate (to appear in July 2010)