Revisiting hybrid 3D-Var error covariance for IAU-based assimilation systems and exploiting extensions to weak-constraint 4D-EnVar

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As a first step toward weak-constraint 4D-Var/4D-EnsVar, the Global Modeling and Assimilation Office (GMAO) is revisiting its 3D-Var formulation using the Incremental Analysis Update (IAU) procedure of Bloom et al. (1996). Typical applications of IAU to 3D-Var are inconsistent in that the variational procedure assumes the model to be unbiased and seeks for a correction to the initial condition, while IAU leaves the initial condition untouched and requires a constant forcing (tendency) term to be applied to the model during a 6-hour filtering period as if the model were biased within this period. The benefits from the filtering properties of IAU are undeniable, but the structures of the tendency forcing terms provided to the model by the 3D-Var solutions appear suspiciously large and are not quite consistent with typical model dynamical tendencies. The spatial structures of the 3D-Var solutions are implied by the intrinsic structures of its underlying background error covariance matrix. With IAU, it seems more natural to base the error covariance structures of 3D-Var on model tendency differences (e.g., Trémolet 2007) instead of forecast differences as currently done.

This work will show results from replacing the current error covariance formulation of the GMAO hybrid 3D-Var with the tendency-based estimates derived in a companion paper presented at this Symposium (see El Akkraoui & Todling). Results reformulating both the climatological (static) and ensemble estimates of the hybrid Grid-point Statistical Interpolation analysis system will be presented, as well as a preliminary evaluation of extensions to 4D-EnsVar.

References

[1] Bloom, S. C., L. L. Takacs, A. M. da Silva, and D. Ledvina, 1996: Data assimilation using incremental analysis updates. Mon. Wea. Rev., 124, 1256-1271.

[2] Trémolet, Y., 2007: Model error estimation in 4D-Var, Q. J. R. Meteorol. Soc., 133, 1267-1280.