



Evaluation of the operational 4D-Var at the Meteorological Service of Canada

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The three-dimensional variational data assimilation (3D-Var) for the operational global forecasting system has been extended to 4D-Var. The new variational scheme is now composed of several additional and improved features. First guess at the appropriate time from the full-resolution model trajectory is used to calculate the misfit to the observations. The tangent-linear of the global environmental multi-scales (GEM) model and its adjoint are employed to propagate the analysis increment and the gradient of the cost function over the 6-h assimilation window. The analysis is obtained after two outer loops: 40 iterations with only the vertical diffusion as simplified linearized physics are first performed, then after updating the full-resolution trajectory, 30 more iterations are done with a set of simplified physical parameterizations which includes vertical diffusion, subgrid-scale orographic effects, large-scale precipitation and deep moist convection. The data selection process has been modified for all observation types except the surface reports. The 6-h assimilation window is divided into 9 time intervals (rather than one in 3D-Var). For each interval, the data are spatially thinned to retain the observation closest of the middle of the time interval. This has considerably increased the number of frequently reported data such as aircraft, satwind and profiler data. Finally, the resolution of the analysis increment (T108), background error statistics and the data quality control remain the same as in 3D-Var.

An extensive pre-implementation evaluation of 4D-Var against the operational 3D-Var was conducted. Results from two-month assimilation periods in winter 2003-2004 and summer 2004 show a consistent improvement in the northern hemisphere with 4D-Var, a neutral impact in the tropics, but nearly 6-h gain in predictability in the southern hemisphere. The contribution of each additional 4D-Var component to the improvement has been assessed and will be discussed in this presentation.