Sparse computations within LETKF: interpolating analyses vs. weights

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The idea of doing a sparse LETKF analysis (e.g., every other point) and interpolating the weights, rather than the analyses, was suggested by Brian Hunt to Jeff Whitaker as a way to reduce LETKFcomputational time. He was inspired by Neill Bowler's talk at UKMO, where they are doing this for their generation of initial ensemble perturbations.

Shu-Chih Yang tested this method with a QG model, several ways to interpolate (linear, splines, …), several levels of sparseness. She compared errors with the full resolution LETKF analysis and for interpolated weights, or interpolated analysis fields. Results with 3D-Var are also presented.

Method

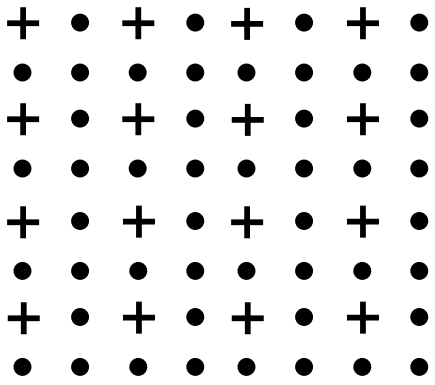
• The analysis is only performed at certain grid points (crosses) and the weighting coefficients ($\overline{w}_a, \mathbf{W}_a$) are interpolated to the non-analysis grid points (dots).

$$\overline{x}_a = \overline{x}_f + X_f \tilde{P}_a H^T R^{-1} d = \overline{x}_f + X_f \overline{w}_a$$

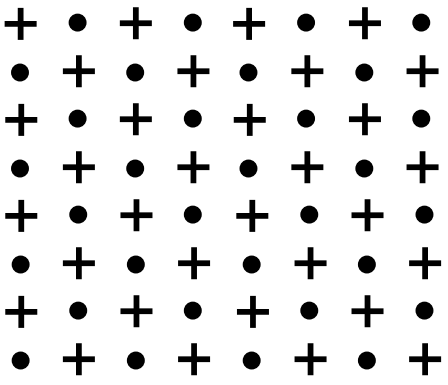
$$X_a = X_f [(K-1)\tilde{P}_a]^{1/2} = X_f W_a$$

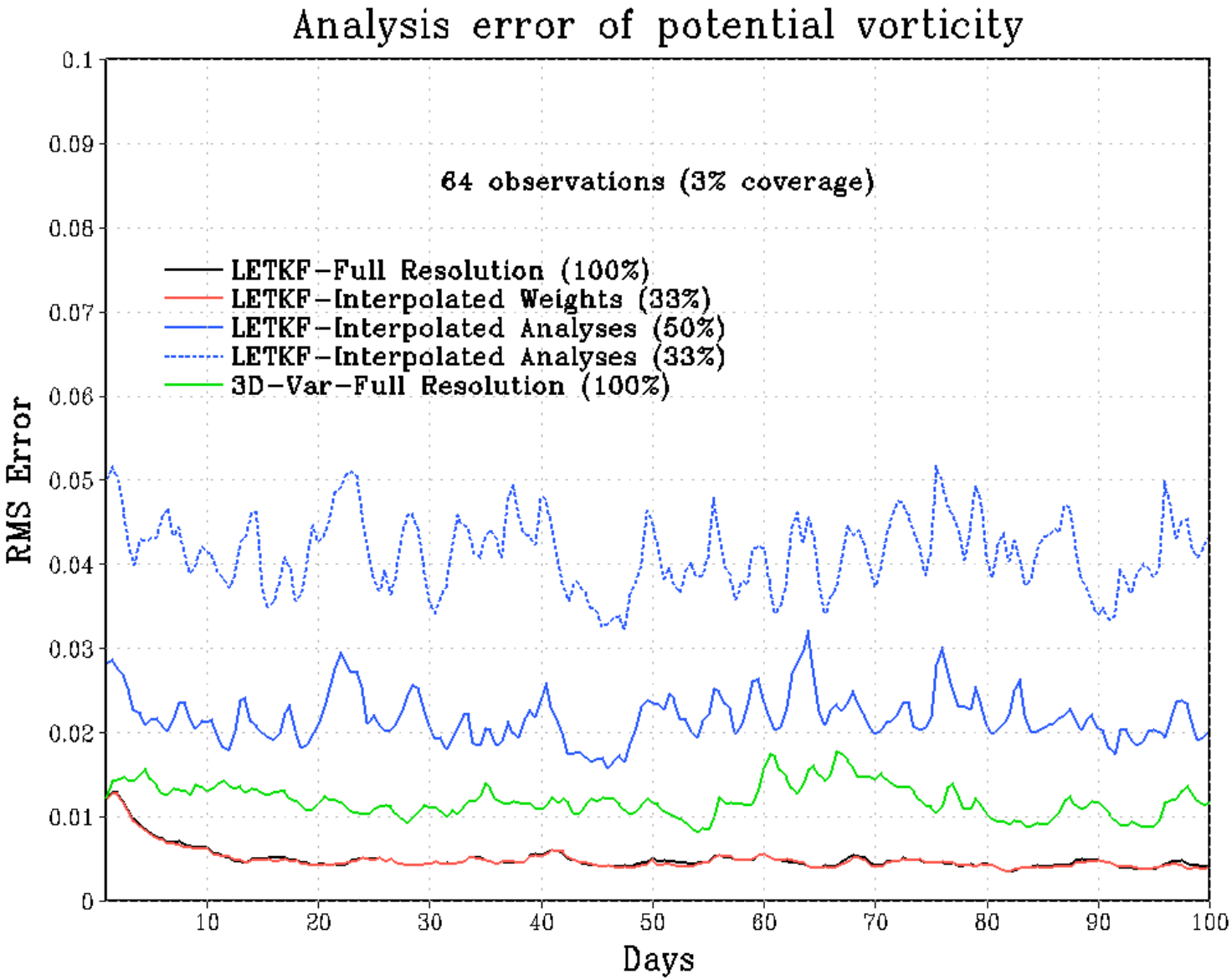
The weight interpolation is done by applying the **Cubic Spline smoothing** twice: first in the y direction to fill in the non-analysis grid points, then in the x direction.

33% analysis grid points



53% analysis grid points




Analysis error of potential vorticity
64 observations (3% coverage)
LETKF-Full Resolution (100%)
LETKF-Interpolated Weights (33%)
LETKF-Interpolated Analyses (50%)
LETKF-Interpolated Analyses (33%)
3D-Var-Full Resolution (100%)
RMS Error
Days
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
10
20
30
40
50
60
70
80
90
100