

Accounting for non-locality of vertical error correlation within ETKF through eigen-spectral localization

*Daisuke Hotta¹

1. Meteorological Research Institute, Japan Meteorological Agency

Covariance localization is an indispensable component of any EnKF and it is most straightforwardly formulated as tapering of the sampled background error covariance matrix by means of Schur product (B-loc). However, within most (L)ETKF implementations, this operation is substituted by artificial inflation of R-matrix for observations distant from the analyzed grid-point (R-loc) due to the computational difficulty of B-loc approach. Recently studies (Bocquet et al. 2016; Bishop et al. 2017) have derived an efficient way to implement B-loc within an ETKF, so that B-loc within ETKF is now a feasible option.

The author's recent work has focused on clarifying the differences between B-loc and R-loc, and showed with idealized 1D models that B-loc can increase the effective rank of the background covariance while R-loc cannot and that B-loc can more faithfully reproduce canonical KF analysis than R-loc does when the observation operator is non-local, suggesting that B-loc is particularly advantageous in cases where the desired amount of assimilated observations are much larger than the affordable ensemble size and/or the observation operator is highly non-local.

This work extends the B-loc approach to accommodate situations where the true background error covariance is not well localized (i.e., the correlation between two grid-points is not given in terms of the physical distance between them). In the proposed scheme, the state vector of each background ensemble is first linearly transformed into the space spanned by the (truncated) eigenbasis of the climatological background error covariance prior to performing data assimilation. The transformed ensemble is then used to form sample covariance to which we apply localization (i.e., control on sampling noises) by neglecting all the off-diagonal components. This method reposes on two assumptions: (1) the true covariance, when expressed in its eigen-space, is diagonal, so that, in this space, any off-diagonal component present in the sample covariance from ensemble is a sign of sampling error, and (2) the eigenstructure of the true covariance is close to its climatological expectation.

In this presentation, I will show several preliminary verifications of this approach using an idealized 1-dimensional system and discuss its promise and limitations.

Keywords: data assimilation, covariance localization, EnKF