

Toward improved LETKF assimilation of non-local and dense observation by direct covariance localization in model space

*Daisuke Hotta¹

1. Meteorological Research Institute, Japan Meteorological Agency

Covariance localization is an indispensable component for ensemble-based data assimilation system with a limited member size. The benefit of localization is two-fold: (1) it suppresses spurious correlation due to sampling error, and (2) mitigates the rank-deficiency issue of the sample covariance matrix.

In Local Ensemble Transform Kalman Filter (LETKF), localization is typically implemented by domain localization (i.e., by performing analysis independently at each model grid) and by applying the so-called R-localization, in which the impact of an observation to the analyzed state variable is artificially damped by inflating the observation error covariance R by a factor that is a decreasing function of the physical distance between them.

Recent study at Japan Meteorological Agency using its operational global LETKF revealed that, while R-localization effectively suppresses spurious impact from an observation onto remote grids, it does not help to alleviate rank deficiency issue within the local analysis, hindering the LETKF from extracting information from dense observations such as satellite radiances. R-localization also poses difficulty when assimilating non-local observations (e.g., ground-based GNSS observations, satellite radiances, or even in-situ surface pressure observations) whose physical locations are not clearly defined.

To resolve the above issues, we explore possibility of applying model-space localization. The advantage of model-space localization over the R-localization will be discussed using an idealized one-dimensional toy system, with its application to assimilation of ground-based GNSS moisture observations in mind.

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