Spatial Filtering of Small Ensemble-Based Estimations of Background Error Parameters at Convective Scale.

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Background error covariance modeling and estimation is a key point of variational data assimilation systems used in main meteorological centers. Current covariances are often stationary and uniform across the domain, whereas it is well established that they should be heterogeneous and flow-dependent. A current challenge is thus to add flow-dependency in background error covariance models.

Our strategy is to run a small ensemble (6 members) of perturbed forecasts that simulate background errors, from which we can draw flow-dependent statistics. However, noise due to sub-sampling must be filtered out before any use in the spatial transform of our covariance model. Objective spectral filters [1] have been successfully implemented for global models, but new issues arise for limited-area models at convective scale, such as the operational AROME-France model. Spatial filters, that ensure the positiveness of filtered variances and that handle field non-periodicity at the borders, have been especially developed and evaluated against reliable variances deduced from a large ensemble (90 members) for an intense convective event. Such homogeneous filters, based on statistics of the raw and filtered variances, give similar results than other methods based on heterogeneous filtering, but with a much lower computational cost.

Another interesting parameter of background error is the Hessian tensor of the local correlation function (LCH tensor, [2]). This tensor provides a diagnostic information about heterogeneity and anistropy of correlation functions at their origin, and can also be used as an input of correlation models using a diffusion equation [2]. Even more than for variances, LCH tensors estimated with small ensembles suffer from sub-sampling noise, that have to be damped before any further use. A nice feature of filters developed formerly for variances is their straightforward application to tensor components filtering. Moreover, assuming that all components are filtered in the same way, the positiveness of the filter ensures the positive-definiteness of filtered tensors, which is required.

Thus, robust and useful estimations of background error variances and LCH tensors can be obtained from a small ensemble after a positive, adaptive and cheap filtering step.

References

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