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An orthogonal expansion of filtering function in localization and its application to solution of CNOP

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In recent years, ensemble-based approaches have been widely used in various aspects, e.g., data assimilation and solution to conditional nonlinear optimal perturbation (CNOP). Because the ensemble is generally composed of far fewer members than both the number of observational data and the degrees of freedom of model variables, many spurious correlations between different observation locations, or between different model grids, or between observation locations and model grids, would be lead to. Location technique is a practical and easy way to deal with this problem, which could ameliorate the spurious long range correlations. However, localization would be very expensive when the problem we are solving is of high dimension (say 106 or higher). To greatly reduce the cost of localization for high-dimension problems such as data assimilation and CNOP calculations for operational prediction models, an economical approach to implement localization is proposed in this paper. The filtering function in location is theoretically expanded using a group of basis function so that the schür product between high-dimension matrices is reduced to a series of schür products between vectors. The new approach is successfully applied to solution of CNOP for the Advanced Regional Eta Model (AREM), a prediction model widely used in China.