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The impact of using reconditioned correlated observation error covariance matrices in the Met Office 1D-Var system

Recent developments in numerical weather prediction have led to the use of correlated observation-error covariance (OEC) information in data assimilation and forecasting systems. However, diagnosed OEC matrices are often ill-conditioned and may cause convergence problems for variational data assimilation procedures. Reconditioning methods are used to improve the conditioning of covariance matrices while retaining correlation information. In this article, we study the impact of using the "ridge regression"method of reconditioning to assimilate Infrared Atmospheric Sounding Interferometer (IASI) observations in the Met Office 1D-Var system. This is the first systematic investigation of how changing target condition numbers affects convergence of a 1D-Var routine. This procedure is used for quality control, and to estimate key variables (skin temperature, cloud-top pressure, cloud fraction) that are not analysed by the main 4D-Var data assimilation system. Our new results show that the current (uncorrelated) OEC matrix requires more iterations to reach convergence than any choice of correlated OEC matrix studied. This suggests that using a correlated OEC matrix in the 1D-Var routine would have computational benefits for IASI observations. Using reconditioned correlated OEC matrices also increases the number of observations that pass quality control. However, the impact on skin temperature, cloud fraction, and cloud-top pressure is less clear. As the reconditioning parameter is increased, differences between retrieved variables for correlated OEC matrices and the operational diagonal OEC matrix reduce. As correlated choices of OEC matrix yield faster convergence, using stricter convergence criteria along with these matrices may increase efficiency and improve quality control.

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