Correlated Observation Errors in High Resolution Data Assimilation

N.K. Nichols[a], J.A. Waller[a], S.L. Dance[a], A.S. Lawless[a], L.M. Stewart[b], J.R. Eyre[b]

[a]*School of Mathematical and Physical Sciences, University of Reading, UK, n.k.nichols@reading.ac.uk,*
[b]*Remote Sensing, Met Office, UK*

Remote sensing observations often have correlated errors, but the correlations are generally not taken into account in data assimilation for numerical weather prediction (NWP). Correlated errors of representativity are present between channels that observe spatial scales or features that the model does not represent well. Errors in the forward model, such as those of spectroscopy, may also be correlated between channels. The assumption of zero correlations is often used with data thinning and inflation methods, resulting in a loss of information [1]. Recently it has been demonstrated that using approximate observation correlations in data assimilation can give more accurate analyses than using inflation techniques and can be implemented practically [2]. As operational centres move towards higher-resolution forecasting, there is a requirement to make better use of available observations in order to retain data providing detail on many scales.

In previous work, error correlations in satellite observations from certain instruments have been identified that may be caused by representativity error [3]. Errors of representativity are the result of small scale observational information being incorrectly represented in the model. In this work we aim to achieve a better understanding of these errors to allow them to be incorporated into the observation error statistics in data assimilation. Initially a technique for diagnosing static representativity error covariances has been implemented in which it is assumed that the observations can be written as the mapping of a high resolution state into observation space and that the model state is a truncation of the high resolution state [4]. We have applied this technique to determine the structure of static representativity errors in a nonlinear advection-diffusion model with multi-scale behaviour and have also applied the method to temperature and humidity data from the Met Office UKV system [5]. The results from these experiments show that errors of representativity are correlated and are state and time dependent. We show also that these errors vary with height throughout the atmosphere and are more significant for humidity than temperature. It is demonstrated that these errors are reduced where the resolution of the model is increased or where the observation length-scale is increased, but that the variance is independent of the number of observations available.

From this work we have concluded that although this diagnostic method can be used to reveal the structure of representativity errors, the results are not readily applicable in data assimilation due to the underlying assumptions. We have now developed and tested a new method for diagnosing and incorporating time-dependent representativity error covariances in an ensemble data assimilation system. The new work is the subject of another joint abstract submitted to this symposium by J.A. Waller.

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[2] L.M. Stewart, S.L. Dance and N.K. Nichols, "Data assimilation with correlated observation errors: experiments with a 1-D shallow water model," *Tellus A*, **65**, 19546, 2013.
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