A new way to infer non-Gaussian observation errors based on ensemble innovations

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Abstract

The proper specification of the observation error is critical to a well-performing data assimilation system. The observation error can be divided into the measurement error, which is an inherent part of the results of the measurement, and the representation error, which is the uncertainty in the forward operator. The measurement error is usually well-known based on the design of the instrument, while the representation error is often less understood and often dominant. Previous studies have infered the observation error from the innovation statistics, often assuming that the background error in observation space and the observation error are Gaussian. However, this Gaussian assumption can be problematic, especially for nonlinear forward operators. This study infers a non-parametric observation error pdf based on a background ensemble without any assumption on the shape of the background error or observation error pdfs. The only assumption is that each ensemble member is statistically indistinguishable from the truth. Since the innovation pdf is the convolution of observation error and background error pdfs, the observation error pdf can be found by expressing the pdfs as histograms and solving a linear system. Experiments with toy systems and real cloudy observations show that this new method is able to retrieve non-Gaussian observation pdfs, even multimodal pdfs, demonstrating the potential of this method for complex representation errors in real atmospheric observations.

Keywords: observation errors, ensemble innovations

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