Tailoring data assimilation for models using discontinuous Galerkin methods

Discontinuous Galerkin (DG) methods are rapidly gaining popularity in the geophysical community. In these methods, the model solution in each grid cell is approximated as a linear combination of basis functions. Ensemble data assimilation (EnDA) aims to bring the model closer to the truth by combining it with observations using error statistics estimated from an ensemble of model runs. It is known to suffer from several well-documented issues. We have tested whether the DG structure can be exploited to address the following three issues: 1) reduce the need for observation thinning, 2) reduce errors in gradients, and 3) produce a more accurate localised ensemble covariance. Using an idealised test setup it is found that reduction in error can be realised, especially for high DG orders as these methods offer more degrees of freedom per grid cell than finite volume methods at equivalent resolution. However, this does not result in a reduction of the error in the gradients. The DG basis is found to be expedient for scale-dependent localisation resulting in an ensemble covariance that is closer to the truth than one created using conventional, non-scale-dependent localisation.

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