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Improving model parameterisations through Data Assimilation

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In Numerical Weather Prediction (NWP), parameterisations are used to compensate for errors in the model. Errors in NWP models can be due to a lack of scientific understanding or a lack of computing power available to address all known physical processes. Parameterisations are sources of large uncertainty in a model as parameter values used in them are often not well known and/or unmeasurable quantities.

Whilst there are many efficient and effective methods for state/parameter estimation in data assimilation, most are based upon linearisations and there are few methods for estimating parameters that can be extended to the estimation of parameterisations. This is due to the fact that in order to estimate parameterisations, we also need to deduce the structure of the model errors. The method we propose has the potential to utilise these structures and hence estimate parameterisations.

We propose a new method for estimating parameters that uses a model trajectory given from a data assimilation method to estimate the model error. The method compares a pure model run to the analysed data assimilation trajectory and examines the differences in trajectories to get estimates of the parameters.

This method has been applied to estimate parameters in the linear advection equation. This model is used as it is understood how a change in the parameter affects the dynamics of the state. The method has been applied analytically to fully understand the connections between estimated model error and differences in the true model parameter and our best estimate of the parameter. Numerical experiments on the linear advection equation will also be shown as these will include the added difficulties of numerical diffusion and dispersion. Furthermore, the method has been used to estimate parameters in more realistic numerical experiments. Results using non-linear models will be presented to illustrate the advantages and disadvantages of this method.