The effect of model errors in variational assimilation

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Abstract

A linearized, one-dimensional shallow water model is used to investigate the effect of model errors in four-dimensional variational assimilation. A suitable initialization scheme for variational assimilation is proposed. Introducing deliberate phase speed errors in the model, the results from variational assimilation are compared to standard analysis/forecast cycle experiments. While the latter draws to the data and reflects the model errors only in the data-void areas, variational assimilation with the model used as strong constraint is shown to distribute the model errors over the entire analysis domain, thus leading to severe analysis errors even in areas with good data coverage. The implications for verification and diagnostics are discussed. Temporal weighting of the observations can reduce the errors towards the end of the assimilation period, but may deteriorate the subsequent forecasts.

An extension to variational assimilation is proposed, which seeks not only to determine the initial state from the observations but also some of the tunable parameters of the model. The potentional usefulness of this approach for parameterization studies and for a separation of forecast errors into model- and analysis errors is discussed. Finally, variational assimilations with the model used as weak constraint are presented. While showing a good performance in the assimilation, forecasts can suffer severely if the extra term in the equations up to which the model is enforced are unable to compensate for the real model error. In the discussion, an overall appraisal of both assimilation methods is given.

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