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# Model error covariance estimation in observation space weak-constraint 4DVar

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Weak-constraint 4DVar (WC-4DVar) not only takes errors in initial conditions into account but also assumes that the physical model itself is erroneous. As model errors, arising e.g. from unresolved processes, can be substantial in geoscience applications, the weak-constraint formulation yields more accurate results compared to its strong-constraint counterpart. Furthermore, accuracy in forecasting should be improved since the algorithm produces an optimal solution at the end of the assimilation window, instead of revised initial conditions. Finally, WC-4DVar allows for longer assimilation windows because of reduced sensitivity to initial conditions.

However, for complex high-dimensional models, it is not simple to estimate the model error covariances, as needed in the WC-4DVar algorithm. A promising approach to address this challenge might look as follows: We start with a first-guess model error covariance, e.g. a scaled-down (in amplitude and length-scale) initial state (background) covariance (the so-called B-matrix) with added time correlation, and perform a WC-4DVar assimilation step. This yields, besides an optimised solution at the end of the assimilation window, estimates for the model errors. We then use these model errors to derive new model error covariances with which we perform the next assimilation step. This procedure is iterated.

In this talk, we present initial results of this approach applied to the Burgers’ equation and using an observation-space WC-4DVar algorithm (sometimes called PSAS). We outline the procedure, demonstrate its feasibility, and discuss extensions to real-world systems.