Geophysical Research Abstracts
Vol. 18, EGU2016-3816, 2016
EGU General Assembly 2016

Non-intrusive Ensemble Kalman filtering for large scale geophysical models

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Advanced data assimilation techniques, such as variational assimilation methods, present often challenging implementation issues for large-scale models, both because of computational complexity and because of complexity of implementation. We present a non-intrusive wrapper library that addresses this problem by isolating the direct model and the linear algebra employed in data assimilation from each other completely. In this approach we have adopted a hybrid Variational Ensemble Kalman filter that combines Ensemble propagation with a 3DVAR analysis stage. The inverse problem of state and covariance propagation from prior to posterior estimates is thereby turned into a time-independent problem. This feature allows the linear algebra and minimization steps required in the variational step to be conducted outside the direct model and no tangent linear or adjoint codes are required. Communication between the model and the assimilation module is conducted exclusively via standard input and output files of the model. This non-intrusive approach is tested with the comprehensive 3D lake and shallow sea model COHERENS that is used to forecast and assimilate turbidity in lake Säkylän Pyhäjärvi in Finland, using both sparse satellite images and continuous real-time point measurements as observations.