

Modelling wide-swath altimeter observation error correlations with a regularised diffusion operator

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Abstract

Unaccounted for observation error correlations have long been known to be detrimental to the quality of the analysis produced by weather or ocean forecasting and reanalysis systems. While progress has been made in the last decade on modelling inter-channel correlations, spatial correlations remain a challenge for large datasets. Common countermeasures such as variance inflation or data thinning prevent the extraction of valuable small-scale information from the observations. With the emergence of new sources of high-resolution data such as wide-swath altimeters, the need to address this limitation of data assimilation systems becomes more pressing. To do so, we have considered the use of a diffusion-based observation correlation operator, which has already been implemented for conventional altimeter data in a global ocean data assimilation system. However, some limitations had to be addressed in order to extend the use of a diffusion operator to wide-swath altimeter observation error correlations.

Former implementations of diffusion-based correlation operators could suffer from an excessive sensitivity to perturbations at small spatial scale when large observation error correlation length scales are used. As estimates of the SWOT observation error correlations seem to suggest such large length scales, a more robust formulation of diffusion-based correlation operators is required. We present here a regularised formulation of diffusion-based correlation operators, which prevents this excessive sensitivity while preserving the computational efficiency of the correlation operator, its inverse and its square root. We then demonstrate how to implement such an operator on a mesh based on SWOT observation locations, and integrate it in a realistic global ocean data assimilation system. To validate this new formulation, we perform data assimilation experiments with simulated wide-swath altimeter data. These experiments confirm that a regularised diffusion-based correlation operator is an appropriate tool to account for wide-swath altimeter observation error in a realistic operational configuration.