Accounting for spatial correlations of observation error in data assimilation: Application to the future SWOT High-Resolution altimeter mission

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Résumé

Altimetric observations are routinely assimilated in ocean circulation models. Most data assimilation algorithms requires the inverse of the covariance matrix of the observation errors. In practical applications, the cost of computing this inverse matrix with spatially correlated observation errors is prohibitive. Common practices are therefore to subsample or combine the observations so that the errors of the assimilated observations can be considered uncorrelated. As a consequence, a large fraction of the available observational information is not used in practical applications.

A method is here developed to account for the spatial correlations of observation errors in data assimilation, with a focus on the future Surface Ocean and Water Topography (SWOT) Mission for which the problem will be critical. Technically, the method consists in the transformation of the observation vector so that the inverse of the corresponding covariance matrix can be replaced by the inverse of a diagonal matrix, thus allowing to genuinely take into account errors that are spatially correlated in physical space.

Numerical experiments of Ensemble Kalman filter analyses of SWOT-like observations are conducted with three different observation error covariance matrices. Results suggest that the proposed method provides an effective way to account for error correlations in the assimilation of the future SWOT data. The transformation of the observation vector proposed

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herein yields both a significant reduction of the root mean square (rms) errors and a good consistency between the filter analysis error statistics and the true error statistics.