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Application of the Gaussian anamorphosis to assimilation in a 3D coupled physical-ecosystem model of the North Atlantic with the EnKF: a twin experiment.

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We consider the application of the Ensemble Kalman Filter (EnKF) to a coupled ocean ecosystem model (HYCOM-NORWECOM). Such models, especially the ecosystem models, are characterized by strongly non-linear interactions active in ocean blooms and present important limitations for the use of data assimilation methods based on linear statistical analysis. Besides the non-linearity of the model, one is confronted with physical/biological limitations, the analysis state having to be consistent with the model, especially with the constraints of positiveness of some variables. Furthermore the non-Gaussian distributions of the biogeochemical variables break an important assumption of the linear analysis, leading to a loss of optimality of the filter.

We present an extension of the EnKF dealing with these limitations by introducing a non-linear change of variables (anamorphosis function) in order to execute the analysis step in a Gaussian space. We present also the initial results of the application of this non-Gaussian extension of the EnKF to the assimilation of simulated chlorophyll surface concentration data in a North Atlantic configuration of the HYCOM-NORWECOM coupled model. Our study reveals that applying the plain EnKF with a simple post-processing of negative values can lead to several assimilation biases (as a too high residual errors, a too early start of the spring bloom, etc..) which can be efficiently remedied by the introduction of Gaussian anamorphosis.