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A comparison of linear and non-linear data assimilation methods using the NEMO ocean model

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The assimilation behavior of the widely used LETKF is compared with the Equivalent Weight Particle Filter (EWPF) in a data assimilation application with an idealized configuration of the NEMO ocean model. The experiments show how the different filter methods behave when they are applied to a realistic ocean test case. The LETKF is an ensemble-based Kalman filter, which assumes Gaussian error distributions and hence implicitly requires model linearity. In contrast, the EWPF is a fully nonlinear data assimilation method that does not rely on a particular error distribution. The EWPF has been demonstrated to work well in highly nonlinear situations, like in a model solving a barotropic vorticity equation, but it is still unknown how the assimilation performance compares to ensemble Kalman filters in realistic situations. For the experiments, twin assimilation experiments with a square basin configuration of the NEMO model are performed. The configuration simulates a double gyre, which exhibits significant nonlinearity. The LETKF and EWPF are both implemented in PDAF (Parallel Data Assimilation Framework, http://pdaf.awi.de), which ensures identical experimental conditions for both filters. To account for the nonlinearity, the assimilation skill of the two methods is assessed by using different statistical metrics, like CRPS and Histograms.