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A low-rank Kernel particle Kalman filter for fata assimilation with high dimensional systems

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We present a Low-Rank Kernel Particle Kalman (LR-KPK) filter wich provides an approximated ensemble solution of the optimal nonlinear filter suitable for atmospheric and oceanic data assimilation. The method is based on a local linearization in a low-rank Kernel representation of the optimal filter's probability density functions. In this new filter, the standard (weight-type) particle filter correction is complemented by a Kalman-type correction for each particle of the ensemble using the Gaussian-mixture covariance matrix, in contrast with the ensemble Kalman filter which makes use of the ensemble covariance matrix. Basically, the LR-KPK filter runs an ensemble of low-rank square-root Kalman filters and then provides the solution as the weighted average of all the filters' analysis. The Kalman-type correction reduces the risk of ensemble degeneracy which enables the filter to efficiently operate with fewer particles than the standard Particle filter. Combined with the low-rank approximation, it allows the implementation of the LR-KPK filter with highly dimensional systems. The new filter will be described and its relevance demonstrated using a realistic configuration of the Princeton Ocean Model (POM) in the Mediterranean Sea.