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Lossless reduced rank square root Kalman filter

D. Treebushny

Ukrainian Center of Environmental and Water Projects (dima@env.com.ua, fax: +380 44 266 3615)

The reduced rank square root Kalman filter (RRSQRT KF) is a time-saving suboptimal version of the Kalman filter. It operates with deterministic ensembles of model outputs, and thus it posseses a certain popularity in ecophysical modeling community. The filter has an intrinsic truncation step introduced by Martin Verlaan in his original paper to keep the rank of covariance matrix square root constant along the modeling interval. The truncation step extracts the essential part of a matrix with bigger rank and preserves it in a matrix of a lower rank. Some part of the information is always rejected due to the nature of truncation.

Here, an alternative step (compactification) is introduced, where no information is lost during the descrease of matrix rank. The compactification step is based on the two alternative formulae of the RRSQRT filter update, with utilization of iterative Lanczos procedure for SVD decomposition of matrices of a special structure. The performance of the new filter is illustrated in a simple application of an Advection-Diffusion pollution transport model.