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Reducing the memory requirements of parameter estimation using model order reduction

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Previous development of a parameter estimation scheme for a Global Tide and Surge Model (GTSM) showed that accurate estimation of the parameters is currently limited by the memory use of the analysis step and the computational demand. Because the estimation algorithm solver requires storage of the model output matching each observation for each parameter (or ensemble member), the requirement of memory storage gets out of control as the model simulation time increases, the model output and observation matrix become too large. The popular approach of localization does not work here because the tides propagate all over the globe in days, while parameter estimation requires weeks at least. Proper Orthogonal Decomposition (POD) is a useful technique to reduce the high dimension system with a smaller linear subspace. Singular values decomposition (SVD) is one of the methods to derive the POD modes, which is generally applied for space patterns. In this study, we focus on the application of POD in time patterns by using SVD to reduce the dimension in time patterns. As expected, the time patterns show a strong resemblance to the tidal constituents, but the same method is likely to work for a wider range of problems, which indicate that the memory requirements can be reduced dramatically by projection the model output and observations onto the time-POD patterns.