Scalable Sequential Data Assimilation with the Parallel Data Assimilation Framework PDAF

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Data assimilation applications with high-dimensional numerical models exhibit extreme requirements on computational resources. Good scalability of the assimilation system is necessary to make these applications feasible. Sequential data assimilation methods based on ensemble forecasts, like ensemble-based Kalman filters, provide such good scalability, because the forecast of each ensemble member can be performed independently. However, this parallelism has to be combined with the parallelization of both the numerical model and the data assimilation algorithm. In order to simplify the implementation of scalable data assimilation systems based on existing numerical models, the Parallel Data Assimilation Framework PDAF [1,2,3] has been developed. PDAF is suitable for educational use with toy models but also for high-dimensional applications and operational use [4]. PDAF is distributed as open source software.

PDAF provides a framework for implementing a data assimilation system with parallel ensemble forecasts and parallel numerical models. For maximum efficiency, a single assimilation program can be built that includes both the model and the analysis step. A well-defined interface connects PDAF to the model as well as to the observations. To compute the analysis, PDAF provides several optimized parallel filter algorithms and smoothers. Included are ensemble filters like the Local Ensemble Transform Kalman Filter (LETKF) [5] and the Error Subspace Transform Kalman Filter (ESTKF) [6].

We discuss the philosophy behind PDAF as well as features and scalability of data assimilation systems based on PDAF on the example of data assimilation with the finite element ocean model FEOM.

References

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