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Building Ensemble-Based Data Assimilation Systems with Coupled Models

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Discussed is the construction of programs for efficient ensemble data assimilation systems based on a direct connection between a coupled simulation model and ensemble data assimilation software. The strategy allows us to set up a data assimilation program with high flexibility and parallel scalability with only small changes to the model. The direct connection is obtained by first extending the source code of the coupled model so that it is able to run an ensemble of model states. In addition, a filtering step is added using a combination of in-memory access and parallel communication to create an online-coupled ensemble assimilation program. The direct connection avoids the common need to stop and restart a whole coupled model system to perform the assimilation of observations in the analysis step of ensemble-based filter methods like ensemble Kalman or particle filters. Instead, the analysis step is performed in between time steps and is independent of the actual model coupler. This strategy allows us to perform both in-compartment (for weakly coupled assimilation) and cross-compartment (for strongly coupled assimilation) assimilation. The assimilation frequency can be kept flexible, so that assimilation of observations from different compartments can be performed at different time intervals. Using the parallel data assimilation framework (PDAF, http://pdaf.awi.de), the direct connection strategy will be exemplified for the ocean-atmosphere model ECHAM6-FESOM.