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Assimilation of satellite sea surface temperature and profile observations into a coupled ocean-atmosphere model

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Earth system models simulate different compartments like the ocean, atmosphere, or land surface in one framework, e.g., the AWI climate model AWI-CM. Data assimilation (DA) provides optimized initializations for improved predictions for such model states and parameters and helps to account for uncertainties by combining a model state with observations in a quantitative way. Until now DA into a coupled ocean-atmosphere model is still young and challenging. In this study, the parallel data assimilation framework (PDAF) is coupled with AWI-CM for numerical experiments. Within AWI-CM, the ocean model FESOM has a varying horizontal resolution of 20km to 120km, and the atmospheric model ECHAM has a resolution of 180km. In the current system, different types of observations, e.g., global satellite sea surface temperature (SST) and temperature and salinity profiles are used for assimilation into the ocean, which is the so called 'weakly coupled DA'. The satellite SST observations used in this study are the Copernicus Level-3 product and were collected daily from multiple sensors covering almost the complete globe (80 ^{o}N – 80 ^{o}S) with a resolution of 0.1 degrees. The temperature and salinity profiles are from the EN4 data set from the UK MetOffice. They can reach down to 5000m and the average number of profiles is about 1000 per day. The state vector contains all the ocean variables, including the sea surface height, velocity, temperature and salinity and were daily updated for year 2016. The local Error-Subspace Transform Kalman Filter (LESTKF) is used for DA. Different simulation scenarios were carried out with different types of observations to investigate to which extent the DA leads to a better estimation of the ocean states in the coupled ocean-atmosphere model. For the SST assimilation, the ocean water temperature error was reduced globally by up to 50% after 30 days. For profile assimilation, the assimilation of either temperature or salinity observations, or the combined assimilation of both were tested for the same year using the same model configuration.