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Optimization of vegetation model parameters through sequential assimilation of surface albedo observations

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The dynamic global vegetation model JSBACH, which is the land component of the MPI Earth System Model, uses different plant functional types (PFT) to represent the heterogeneity of vegetation on the land surface. Each PFT is described by a set of parameters and the global distribution of PFTs allows for a spatially differentiated description of the land surface. The PFT parameters, however, are constant over time and thus neglect processes that lead to seasonal changes of the described properties.

In the case of land surface albedo, modelled as a combination of background albedo from below the vegetation and canopy albedo, this simplification decreases the seasonal variability of modelled albedo because the constant canopy albedo parameters in JSBACH do not adequately represent the seasonal changes of the leaves' radiative properties. Compared to surface albedo observations of the Moderate Resolution Imaging Spectroradiometer (MODIS), the modelled variability is too low.

To judge the seasonal variability of the canopy albedo parameters and to derive an appropriate seasonally varying parameterization, we set up a sequential data assimilation framework that allows to estimate a time series of parameter values. Every time a new observation of land surface albedo becomes available, the data assimilation framework combines the model states and parameters together with knowledge about their uncertainty with the observed values and knowledge about the observation error to arrive at an improved estimate.

We incorporated a standalone version of JSBACH into the Data Assimilation Research Testbed (DART). Because of the vicinity of the canopy albedo parameters to the physical boundaries of albedo we combined the Ensemble Kalman Filter with a Gaussian anamorphosis technique in order to use non-Gaussian distributions for the representation of the model and observation errors. We performed perfect model experiments to show that the assimilation system is able to retrieve seasonally varying parameters. The synthetic observations for these experiments are generated in a control run of JSBACH with seasonally varying canopy albedo parameters. They were perturbed to mimic observation error and subsequently used in an assimilation run. The results of the assimilation were evaluated with respect to reproducing the parameters of the control run.