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Multi-site and multi-ecosystem optimization of the ORCHIDEE model with eddy covariance data

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Terrestrial ecosystem models are used to predict the response of Earth's ecosystems to environmental changes. However, the estimated water and carbon fluxes remain subject to large uncertainties, partly because of unknown or poorly calibrated parameters. Assimilation of in-situ data in these models helps adjusting their parameters, but so far most of the efforts have focused on site-specific optimizations while most land surface models rely on a generic parameterization of their structural equations within broad classes of ecosystems (PFT). Using a variational data assimilation framework, in situ flux measurements (net CO_2 flux NEE and latent heat flux LE) from numerous sites have here been simultaneously taken as a constraint for the ORCHIDEE global ecosystem model (Organizing Carbon and Hydrology In Dynamic Ecosystems), in order to derive PFT-generic optimized parameters sets. For each of the seven natural PFTs considered in this study, our goal is to assess the potential of the model to simulate, with a generic set of parameters (here in the order of 20), the carbon and water fluxes of several sites under a broadly similar climate regime but for various plant species (of the same PFT) and various soil types. We compare the model-data fit given by this "multi-site" optimization approach to those of the prior model, and to site-specific optimizations. The seasonal information content of the assimilated in situ flux measurements has also been evaluated at the global scale: using the LMDZ transport model to compare observations of atmospheric CO_2 concentrations with ground-based measurements, and in terms of vegetation activity, by correlating the modeled FAPAR with remote sensing NDVI measurements from the MODIS instrument.