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Using fluxnet data to improve year to year variations of carbon and water fluxes simulated by ORCHIDEE land surface model

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We use the information from eddy covariance measurements (latent heat, sensible heat, and carbon fluxes for few sites) in order to optimize a mechanistic land surface model, ORCHIDEE. The objective is to assess the potential of ORCHIDEE to reproduce the inter-annual variability of ecosystem fluxes, after the optimisation of several critical parameters of the model.

ORCHIDEE is a state of the art mechanistic global vegetation model that can be run at local or global scale. It calculates the carbon, water, and energy budgets in the different soil and vegetation pools and resolves the diurnal cycle of the fluxes. ORCHIDEE is built on the concept of plant functional types (PFT) to describe the vegetation. It uses only climate variables as drivers together with a number of ecosystem parameters that have been assessed from laboratory and in situ experiments. These parameters are still associated with a large uncertainty and may vary between and within PFTs in a way that is currently not informed or captured by the model. The development of assimilation techniques allows the objective use of eddy covariance data to improve our knowledge of these parameters. In this study we use a Bayesian approach, with the minimization of a cost function containing the mismatch between simulated model output and observations as well as the mismatch between a priori and optimized parameters. Key parameters that are optimized concerned the photosynthesis (i.e., maximum carboxylation rate,..), the different respirations, the effect of soil water on respirations and stomatal conductance, the initial carbon pools, the phenology,...

The optimizations have been performed for two sites in France with several years of eddy covariance measurements: a beach forest at Hesse in the north and a pine forest at le Bray in the South West. The model parameters are optimized for a "normal" year (i.e. 2002) using half hourly measurements of NEE, LE, and H. We then evaluate the improvement of the model – data fit (using these new parameters) for subsequent years and in particular for the 2003 anomalous year (European summer heat wave). We also estimate a set of optimal parameters for each year, in order to highlight possible inter-annual variation of critical parameters like the maximum carboxylation rates that could be linked to processes not yet included in the model (i.e., nitrogen cycle). Special effort will be dedicated to the analysis of model deficiencies with respect to the inter-annual CO_2 and Water flux variations and some indications for model structure improvement will be provided. We will insist on the methodological aspect of this model-data fusion and the potential of Fluxnet data to improve the ability of ecosystem models to represent inter-annual carbon flux variations.