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Model-data fusion for a land surface model with fapar and eddy covariance flux data

G. Lasslop (1), M. Reichstein (1), J. Kattge (1), S. Zaehle (1), and C. Reick (2)
(1) Max-Planck Institute for Biogeochemistry, Jena,Germany, (2) Max-Planck Institute for Meteorology, Hamburg, Germany

The increasing availability of data streams observing the terrestrial carbon cycle offer a multitude of possibilities to challenge ecosystem models and to refine their structure. Eddy Covariance measurements have been used in various optimization studies to quantify parameters and their uncertainty. The success of such studies depends to a large extend on the quality of the data and a correct treatment of their errors and uncertainties. While random errors can be accounted for in the cost function of the optimization procedure, uncorrectable systematic errors (biases) are more difficult to address.

We use the photosynthesis module (BETHY) and the phenology model of the JSBACH land surface scheme and combine it with eddy covariance and in situ measured fapar data at the FLUXNET site Hainich, a deciduous broadleaved beech forest in Germany. We propose a strategy to consider the systematic errors of eddy covariance data by using two alternative estimates of gross ecosystem carbon uptake derived from two independent flux separation techniques, which approximate the range of systematic error in the data.

The additional constraint of the fapar data stream allows to disentangle phenological and physiological effects on gross ecosystem carbon uptake and to further localize model structural problems. In particular, we show that two distinct foliar growth phases are sufficient to describe phenology in a deciduous forest. Removing the decrease of fapar during summer, as observed by some remote sensing product and modeled by JSBACH, decreased a trend in the residuals of gross ecosystem carbon for both estimates.