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Inverse optimization of the land surface model JSBACH using multiple constraints and long term observations

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Terrestrial ecosystems play a key role in the global carbon cycle. The characterization and understanding of ecosystem level responses to climatic drivers is essential for diagnostic purposes as well as improving the representation of land-atmosphere feedbacks in climate projections of coupled carbon-cycle climate models. The combination of biogeochemical models with multiple observations of ecosystem carbon and water fluxes through a model-data integration framework enables the recognition of potential limitations of modeling approaches.

Here, we evaluate the performance of the land surface scheme (JSBACH 2.0) of the Max Planck Institute Earth System Model (MPI-ESM) to simulate ecosystem carbon and water fluxes for two forest sites monitored using the eddy covariance technique since 1996: a beech (Hesse) and a pine (Le Bray) forest. An inverse optimization approach was performed considering daily carbon and water fluxes, as well as observations of vegetation and soil carbon stocks.

Our results show that multiple-constraints approaches including information about ecosystem states and ecosystem carbon and water fluxes provide a significant support in evaluating model structures as opposed to assimilation approaches only considering ecosystem flux measurements. Further, this work emphasizes the relevance of long time series to address the model performance of inter annual variability.