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Ecological data assimilation to estimate forest ecosystem productivity and its sensitivity to climate

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Uncertainties in models of forest ecosystem dynamics lead to divergence regarding projections of climate change impacts on the terrestrial carbon cycle in the future. Here, we combine model simulations and observations, i.e. we employ a data assimilation approach, to improve ecosystem state prediction and uncertainty quantification.
We assimilated observations of carbon stocks and fluxes into a forest ecosystem model (3-PG) to calibrate the parameter distribution and validated model performance with independent data-sets. Then we estimate productivity of Norway spruce and Fagus sylvatica dominated forests in Switzerland, and evaluate their sensitivity to different climatic drivers over the past 20 years.
Data assimilation improved model performance and reduced the bias of model simulations from 28% to 7% for forest carbon stocks. Limited water availability during the growing season had a stronger effect on forest primary productivity than temperature. Forest productivity anomalies showed considerable regional variability. Overall, we demonstrated that constraining a forest ecosystem model with observations is crucial for developing robust predictions on forest growth.