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Structural and parameterization issues of Dynamic Global Vegetation Models for long-term predictions

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Dynamic Global Vegetation Models (DGVMs) are widely used for analyzing forest growth dynamics and possible biophysical and biogeochemical feedbacks to climate. Their performance has been typically tested against flux tower and forest inventory observations and by model intercomparison studies. In the present analysis the parameterization of LPJ-GUESS, a state-of-the-art ecosystem model, was evaluated by performing a global sensitivity analysis. We show that simulated carbon fluxes and pools are highly sensitive to parameters related to photosynthesis. At the same time, the sensitivity to parameters controlling plant water relations was low even in relatively dry conditions. Both of these results seem to be in contradiction with recent evidence showing that photosynthesis is not the primary driver of plant growth while plant-water relations and thermal controls are significant. In addition, we investigate how parameter variability, driven by plant acclimation and evolution, is translated into uncertainties of model realizations. This is achieved by presenting an ensemble of global-scale simulations based on a simple "perturbed biophysics" experiment. Because the aim of DGVMs is often long term, climate non-stationary projections, we argue that significant amendments are needed in the their structures and not only in their parameterizations.