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Modeling of a forested study site with the Community Land Model version 5 using climate projections for the 21st century.

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Modeling forest ecosystems is important to facilitate adaptations in forest management approaches necessary to address the challenges of climate change, particularly of interest are ecohydrological states and fluxes such as soil water content, biomass, leaf area index, and evapotranspiration.

The community land model in its current version 5 (CLM5) simulates a broad collection of important land-surface processes; from moisture and energy partitioning, through biogeophysical processes, to surface and subsurface runoff. Additionally, CLM5 contains a biogeochemistry model (CLM5-BGC) which includes prognostic computation of vegetation states and carbon and nitrogen pools. However, CLM5 predictions are affected by uncertainty related to uncertain model forcings and parameters. Here, we use data assimilation methods to improve model performance by assimilating soil water content observations into CLM5 using the parallel data assimilation framework (PDAF).

The coupled modeling framework was applied to the small (38.5 ha) forested catchment Wüstebach located in the Eifel National Park near the German-Belgian border. As part of the terrestrial environmental observatories (TERENO) network, the SoilNet sensors at the study site provide soil water content and soil temperature measurements since 2009.

CLM5 simulations for the period 2009-2100 were made, using local atmospheric observations for the period of 2009-2018 and an ensemble of regional climate model projections for 2019-2100. Simulations illustrate that data assimilation of soil water content improves the characterization of past model states, and that estimated model parameters and default model parameters result in different trajectories of ecohydrological states for 2019-2100. The simulations also illustrate that this site is hardly affected by increased water stress in the future.

The developed framework will be extended and applied for both ecosystem reanalysis as well as further simulations using climate projections across forested sites over Europe.