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Climate change responses of carbon storage depend on spatial variability in forested mountain catchments

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Forests carbon both in living biomass and in soils and whether forests have the potential to act as carbon sinks in the future depends on the complex, non-linear response of Net Ecosystem Exchange (NEE) to changes in driving forces such as temperature, precipitation and atmospheric CO2 concentration. Mountains catchments with their a complex topography show often a great variability of these driving forces over very short horizontal distances, e.g. along elevation gradients, or with slope angle and aspect.
We use a biogeochemical process based model to investigate the carbon budget of forested mountain catchments in the European Alps using recent regional climate change scenarios. For the European Alps, higher summer temperatures and a decrease in summer precipitation are to be expected. We use climate scenarios that differ in the extent and duration of droughts to investigate the response of mountain forest ecosystems to extreme events compared to a monotonous decrease in growing season precipitation.
We could show that changes in carbon storage capacity vary strongly between and within catchments. The overall effects of increasing temperatures and changes in precipitation patterns depended on the elevation gradient of the investigated valleys; they are thus strongly dependent on the spatial resolution that is used in the simulations. Considering that forested mountain catchments harbor a large fraction of the biospheric carbon, we conclude that in order to estimate the carbon storage capacity and hence the mitigation potential of forests in highly complex terrain such as the European Alps, the non-linear effects of interacting driving forces must be considered, and they must be studied at high spatial resolution in biogeochemical models, otherwise misleading results may be obtained.