Alpine ecohydrology: exploring the interactions between topographic, climatic and vegetation gradients

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The interactions between topography, climate and vegetation in mountainous ecosystems are complex and hinder our understanding of the ecohydrological processes. Here, we used a numerical ecosystem model to investigate the spatial variability of several ecosystem variables (including transpiration, leaf area index, net primary production, and snow cover) and its potential drivers across different vegetation types, climatic conditions and spatial scales in the Swiss Alps, an area experiencing rapid warming and ecological changes. We found that the vegetation type and climate shape the spatial variability of most ecohydrological variables in a similar way. Counter to our expectations, radiation patterns only marginally affect vegetation in the Alps. Temperature and water limitations control all vegetation types; which of the two is the more important depends on topography and climate. Our analysis highlights the vulnerability of alpine ecosystems to drought. The results concur with many other smaller-scale modelling studies, tree-ring data and forest inventory campaigns in Switzerland, thus verifying the robustness of our modelling approach. We believe we need further high-resolution simulations of larger areas to better comprehend alpine ecohydrology and project the climate change impacts.