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Snow cover as key boundary condition for ecosystem development on a glacial forefield

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Snow protects vegetation against freezing during winter and provides water during the melting season. In the frame of the ecosystem-development study BigLink, focussing on the glacier forefield of the Dammagletscher (central Switzerland), we assessed the water equivalent distribution of the snow cover and its duration using time-lapse photography and a physical-based surface process model with emphasis on snow and soil processes. Further, we assessed how the modelled soil temperature and moisture were affected by the snow cover simulations.

The snow accumulation distribution was inferred by matching the melt-out pattern evolution monitored during an ablation season through terrestrial photography. This was done by combining a temperature-index melt model with a simple snow-accumulation model. Through an iterative procedure, the modelled ablation patterns were adjusted to reproduce the observations by adjusting a prescribed snow accumulation distribution. The inferred snow accumulation distribution showed topography-controlled effects such as wind drift and avalanching. The distribution of the maximal snow water equivalent in the catchment agreed well with field measurements. The obtained spatial distribution of snow water equivalents of the parts of the watershed visible from the camera agreed well with manual observations.

The snow cover of the glacier forefield was simulated by a detailed surface process model based on physical processes, and driven by meteorological data and different precipitation scenarios. The results were compared against the snow water equivalent distributions derived from the photographs. The simulated ablation patterns agreed well when distributing precipitation using a simple method based on terrain-parameters. Furthermore, the simulated soil temperatures agreed well with point observations if the snow cover duration was accurately reproduced. Our modelling suggested that a more accurate snow cover simulation leads to a better estimation of the soil moisture development during the snowmelt season. The soil temperature and moisture are associated with ecological studies and the presented measurement and modelling methods may be useful when assessing past and future ecosystem development.