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Conference Abstract

Hyper-resolution decametric modelling of alpine catchments: development of a data processing framework to represent small scale-snow hydrological processes, over complex topography

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Abstract

Mountain ecosystems are under increasing pressure from anthropogenic forcings including warming, precipitation change and nutrient inputs. Understanding and projecting the consequences of these changes requires to be able to model transfer of energy and water (as a resource and the main agent of transport) both through vertical and lateral fluxes. The determination of these water paths is particularly challenging in complex mountain terrains, where small scale snow, topographic and geomorphological processes drive hydrology. Conceptual and semi-distributed hydrological models fail to represent the complexity of these water paths and land surface model often neglect lateral fluxes, making both approaches limited in studying trajectories of mountain ecosystems.To overcome these limitations, we applied the data-intensive and calibration-light critical zone model ParFlow-CLM3.5, to a highly instrumented alpine catchment (6.2

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km² area between 1950 and 3100 m.a.s.l) close to the Lautaret Pass, in the French Alps. Specific efforts have been directed toward the representation and definition of small-scale snow hydrological processes, that modify significantly the timing, amount, and location of water fluxes above and below the surface.

The representation of snow accumulation, redistribution, and melt was a key point of improvement in this model. Limitations of the initial snow scheme were overcome by refining the snow/rain transition dependencies on meteorological factors, by improving the snow albedo aging routine, by accounting for Saharan dust events and by selecting relevant spatial distribution methods for meteorological forcings over the watershed. The snow/rain transition was evaluated with disdrometer measurements. Meteorological forcings are distributed based on topography (slope effect on radiation and windspeed, shading, reillumination by longwave radiation), altitude (precipitation, temperature and humidity gradients), and remote sensing measurements (Leaf Area Index, snow redistribution maps).

In this presentation we will focus on snow scheme improvements, and the ability of the model to represent the dynamic of the snow cover during the season at decametric resolution. This will be evaluated spatially with drone, Sentinel-2, MODIS and Pleiades images (snow height, snow cover and albedo), locally with albedo, snow height and Snow Water Equivalent, and hydrologically with streamflow observations. Further on, this work aims to show that distributed and physics-based hydrological modelling is feasible over complex alpine terrain, with reduced field data needs, and to provide a reproducible framework. Future work will look at subsurface hydrological consequencies of snow melt spatial patterns on water paths.

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Conflicts of interest

The authors have declared that no competing interests exist.