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Modelling wind-snow interaction during the accumulation season in an Alpine glacierized catchment

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The interaction between wind and snow is recognized as one of the dominant mechanisms determining snow accumulation patterns and their development in alpine environments. Several studies have investigated this interaction, but most have focused on areas of limited size or moderate topography. In high elevation catchments, the mechanisms by which wind-induced snow transport processes contribute to the development of end-of-season snow distribution is still poorly understood. In this study we investigate wind-induced snow transport processes in a glacierized catchment in the Swiss Alps for typical storm and interstorm periods. We consider the effect of wind both on precipitation and on already deposited snow. We evaluate the contribution of snow transport on snow deposition patterns during and after snowfall events. To achieve this goal, we build a modelling chain of physically-based models of high spatial and temporal resolution. First, we generate high spatial and temporal resolution 3D wind fields with the mass consistent model WINDS, which account for the air flow modification induced by the local topography. Wind fields are generated by a nesting procedure using as initial conditions the predictions provided by the non-hydrostatic limited-area atmospheric model COSMO 2.2. The goodness of the simulated wind fields obtained with this approach is evaluated comparing model simulations with the point scale observations available at a number of automatic weather stations in the catchment. Then, we use the physically based snow model Alpine3D forced with the modelled 3D wind fields to reconstruct the snow patterns on Haut Glacier d' Arolla during one accumulation season. Results show that the amount of mobilized snow is higher during snowfall events than after (when it is mostly negligible) for all the analysed cases, suggesting that accumulation patterns are influenced mostly by snow transport during snowfall events. We also show that snow deposition is dominant on most of the glacier area, while on mountain ridges and slopes erosion and deposition are prevalent. Depending on the wind direction events of similar magnitude can generate different snow distribution patterns. We conclude that the effect of wind plays an important role in delineating snow patterns during the accumulation season both at the glacier and catchment scale, that most of the redistribution occurs during snowfall events and that preferential deposition is the dominant mechanism on the main glacier.