Local-scale uncertainty of seasonal mean and extreme values of in-situ snow depth and snow fall measurements

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Measurements of snow depth and snowfall can vary dramatically over small distances. However, it is not clear if this applies to all derived variables and is the same for all seasons.

To analyse the impacts of local-scale variations we compiled a unique set of parallel snow measurements for the Swiss Alps consisting of 30 station pairs with up to 50 years of parallel data. Station pairs are mostly located in the same villages or within close proximity (less than 3km horizontally and 100m vertically).

We calculated a series of snow climate indicators as derived values from the daily snow depth and snowfall measurements for various seasons (DJF, MA, and November-April). Snow climate indicators include average snow depth, max. snow depth, sum of new snow as well as snow onset and disappearance dates. Further, we quantified the return levels of a 10- and 50-year event for max. snow depth and the 3-day new snow sum to investigate the impact of local-scale variations on the estimation of extreme events, which are often used for prevention measures. We computed the relative differences for all these indicators at each station pair to demonstrate the potential uncertainty.

To address the local-scale variations of the measurement sites, we calculated the potential sunshine duration for each known location using GIS and a DEM. However, information from metadata (including the exact coordinates) has to be treated with caution as it can be correct, incomplete, incorrect or simply missing at all.

We found the largest differences for all indicators in spring and the smallest in DJF and Nov-Apr. Furthermore, there is hardly any difference between DJF and Nov-Apr. Surprisingly, median differences of snow disappearance dates are rather small (three days) and similar to the ones found for snow onset dates (two days).

We tried to explain the variations of snow disappearance dates with accumulated potential sunshine duration during March and April, however, no clear relationship could be found. This suggests that the potential sunshine duration is not an appropriate proxy for local-scale variations, mainly because vegetation, buildings and the like are not available in a DEM.
