Spatiotemporal patterns of snow depth within the Swiss-Austrian Alps for the past half century (1961 to 2012) and linkages to climate change

Our current knowledge on multi-decadal to centennial changes of snow in different parts of the world is based largely on observations of snow depth and depth of snowfall from national weather and hydrographic services. Studies analysing these snow observations in the European Alps are predominantly based on national data and are therefore limited by their respective borders in the detection of robust, spatiotemporal snow trends. In order to overcome this limitation, data from Austria and Switzerland, which cover a substantial fraction of the Alps when taken together, are merged for this study (196 station-records). Additionally, it is the first time that such an analysis is based on homogenized data. Our homogenization study shows that, although the detection of breaks in snow depth series works quite well with the existing methods, further research is needed to adequately correct snow depth series at a daily resolution. Roughly, 70% (139 station-records) of the snow depth series could be homogenized and are used for further trend analysis. The findings concern seven climatologically different areas that are identified by a regionalization (using empirical orthogonal functions) using station records from 1961 to 2012. These regions share a high degree of inner similarity and outer separation, and the temporal trends detected are rather different across the Swiss-Austrian domain. Regions in the south show a clear decrease in the snow depth of up to \(-12\) cm/decade on average, while those in the northeast are characterized by almost no change. The declining trend in the southern regions intensifies as altitude increases. Comparisons of these variations in depth changes with concurrent changes in air temperature and precipitation totals reveal a clear dichotomy with respect to elevation. Snow depths in low elevated areas are highly sensitive to air temperature changes, whereas those at high elevations strongly depend on alterations in precipitation totals.

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