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# Signatures of transient hydrological change in glacierized catchments

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Timing and magnitude of streamflow changes in partially glacierized catchments as a response to climate warming can vary widely as they depend on the direct influence of climatic changes as well as on the indirect changes of glacier area and volume. This contribution assembled a dataset of long streamflow records from Canada, Norway and the European Alps and analysed transient hydrological changes in a large number of mountain catchments. Long-term variability of summer streamflow differs for the different mountain regions with signatures of declining melt-season flows in Canada since the mid-1970s, in the Alps since the 1990s and overall increases in Norway with only a very recent decrease in some catchments. Different statistical methods were applied to filter direct impacts of climate variables from lagged influences of glacier change with the aim to elucidate the different sources for change in catchments' melt-season and total annual water balance. In Western Canada and partly in the Alps, glacial rivers show decreasing specific discharges particularly in August despite prolonged melt seasons indicating progressed influence of glacier retreat. Norwegian glacial rivers, however, show increasing trends in summer streamflow over the period of record, though some catchments with low glaciation show decreasing trends when correcting for the direct effects of precipitation and temperature variability. Typical signatures of progressed influence from reduced melt component influences such as an increase in interannual variability of runoff and a decreasing temperature correlation, however, vary strongly among the catchments. The dataset provides opportunities to elucidate the complex drivers of change across a range of conditions that include a strongly seasonal (summer dry) climate in Western Canada with strong summer temperature response versus a more uniform precipitation distribution and hence a stronger dependence on precipitation in Europe. Due to the importance of mountain water resources some modelling experiments now consider the coupled climatic and glacier cover change. The diversity of responses found in this empirical study suggests that models should be rigorously tested against observed changes over the recent past in different geographic and climatic settings.