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Exploring the spatial variability of baseflow δ^{18}O and δ^{2}H in a sub-Arctic glacierized catchment in northern Sweden

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Sub-Arctic glacierized catchments play a key role for the downstream regions sustaining with their runoff the baseflow in dry periods, influencing the timing and magnitude of floods and affecting the water quality and nutrient transport for the biological production in the river up to the sea.
Tracers such as the stable isotopes of the water (^{18}O and ^{2}H) are useful tools to reveal the water flow paths and understand the runoff generation mechanisms. By collecting daily or sub daily water samples from baseflow, rainfall and stormflow at the catchment outlet it is possible to separate the hydrograph and infer which component event or pre-event water contribute to streamflow. The underlying assumption of this approach is that the stream water, collected at the catchment outlet, represents the water composition of the entire catchment. We question whether this assumption is valid for runoff process or monitoring of sub-arctic glacierized catchments or whether it is necessary to consider the spatial variability of isotopic composition. To assess this, we collected water samples of streamflow, snow or firn, ice, glacier meltwater, lake water, exfiltrating soil water and groundwater in three baseflow snapshot campaigns during August-September 2018 in the Tarfala catchment (part of the SITES Water - Swedish Infrastructure for Ecosystem Science). The different water samples were analysed for their stable isotope composition to explore 1) the spatial variability of the baseflow isotopic composition in northern glacierized catchments and 2) changes of the isotopic signal of the different baseflow elements (e.g. glacier, lake, shallow and deep groundwater storages) within the catchment and downstream.
Our results show that the isotopic composition of streamflow within the catchment was spatially variable and the sources snow, glacier ice, glacier meltwater, lake water, streamflow could be identified due to their isotopic composition. Differences in the isotopic signal were found among the three campaigns reflecting differences in the catchment states and indicating temporal changing contributing sources. The isotopic composition of the lake water remained largely stable and did not show fractionation due to evaporation. Tracing the water through the catchment revealed, that some springs were fed by nearby melting snow patches, due to a similar isotopic composition, and did not change their isotopic signature until the main stream was reached. Other springs instead were dissimilar to the snow isotopic composition indicating the contribution of deeper groundwater, which ceased during longer dry periods. Overall, the isotopic signal at the catchment outlet was similar to glacier melt water due to the high glacier melt at that time. This result highlights the importance of glaciers providing baseflow to downstream regions. Our snapshot data complement the long-term ones available for the catchment (SITES Water, www.fieldsites.se) highlighting the large variability of spatial and temporal pools of water, that needs to be investigated to accurately predict future changes in runoff contributing sources.