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Tracer and hydrometric techniques to determine the contribution of glacier melt to a proglacial stream in the Ötztal Alps (Tyrol, Austria)

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Glaciers are important seasonal water contributors in many mountainous landscapes. For water resources management it is important to know about the timing and amount of released glacier melt water, especially in downstream regions where the water is needed (hydropower, drinking water) or where it represents a potential risk (drought, flood). Seasonal availability of melt water is strongly dependent on boundary layer atmospheric processes and becomes even more relevant in a changing climate. Environmental tracers are a useful tool in the assessment of snow and ice water resources, because they provide information about the sources, flow paths and traveling times of water contributing to streamflow at the catchment scale. Previously, high-elevation tracer studies throughout the Alps have been scarce as they require intense field work in remote areas. However, hydrometric and meteorological measurements combined with tracer analyses help to unravel streamflow composition and improve the understanding of hydroclimatological processes. On top of that, empirical studies are necessary to parameterize and validate hydrological models in more process-oriented ways, rather than comparing total measured and simulated runoff only.

In the present study three approaches are applied to derive glacier melt contributions to a proglacial stream at the seasonal scale and to identify their individual advances and limitations. Tracers used for each approach are (1) electrical conductivity, (2) stable isotopes of water and (3) heavy metals. The field work was conducted during the summer of 2015 in the glaciated (35%) high-elevation catchment of the Hochjochbach, a small sub-basin (17 km^2) of the Ötztaler Ache river in the Austrian Alps, ranging from 2400 to 3500 m.a.s.l. in elevation. Hydroclimatological data was provided by an automatic weather station and a gauging station equipped with a pressure transducer. Water samples from shallow groundwater, streamflow, glacier and snow melt, as well as rain were collected throughout the ablation season and analysed for electrical conductivity, stable isotopes and heavy metals. Hydrograph separation is applied with tracer signatures of potential end-members identified by principal component analysis. The proposed contribution describes the experimental setup and discusses preliminary results of the three approaches of hydrograph separation.