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Tracing the spatial and temporal variability of different water sources in a glacierized Alpine catchment (Eastern Italian Alps)

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Glacierized catchments are important sources of fresh water. Although recent tracer-based studies have been carried out in these environments, more investigations are needed to understand more in detail the complex dynamics of snowmelt, glacier melt and groundwater contributions to stream water, the spatial and temporal variability of these sources of runoff and suspended sediment. In this study we used stable isotopes of water and electrical conductivity (EC) as tracers to identify the origin of different waters in the glacierized Sulden/Solda catchment (130 km^2, Eastern Italian Alps). The site ranges in elevation between 1112 and 3905 m a.s.l. and includes two major sub-catchments. Rainfall samples were taken from bulk collectors placed along an elevation gradient (905-2585 m a.s.l.). Winter-integrated snowmelt samples were collected from passive capillary samplers installed at different elevations (1600-2825 m a.s.l.), whereas snowmelt was sampled from dripping snow patches. Glacier melt samples were taken in summer from small rivulets on the glacier surface. Samples from the two main streams were collected monthly in 2014 and 2015 at different stream sections, major tributaries and springs. At the outlet, stream water was sampled daily by an automatic sampler, and EC, turbidity and water stage were measured every 5 minutes. Meteorological data were measured by two weather stations at 1600 and 2825 m a.s.l.. Manual samples were taken from February 2014 to November 2015 while the automatic sampling at the outlet was carried out from May to October 2014 and 2015.

Results indicate that precipitation originated from air masses coming from the Atlantic Ocean, with limited influence of Mediterrean air masses. Snowmelt showed a pronounced isotopic enrichment during summer, which was also found for glacier melt, but less strong. Spring water from both sub-catchments seemed to be affected by infiltrating snowmelt during summer and represented the major stream component during winter baseflow. The tracer-based comparison of stream locations in both sub-catchments showed similar isotopic and EC dynamics during summer, highlighting that meltwater dynamics may hide the hydrochemical impact of different geology in both sub-catchments. However, EC dynamics in the left sub-catchment during winter indicated a spatial gradient of increasing solute concentrations along the stream. In contrast, an inverse spatial gradient of solute concentrations was found in the right sub-catchment, revealing a different geological setting and highlighting the impact of intensive subglacial weathering.
At the outlet, EC and isotopic composition could identify clear seasonal melt water dynamics with periods of pronounced snowmelt contributions in early summer followed by dominant glacier melt contributions. Rainfall events seemed to play a major role on stream water composition in autumn. Also the impact of early snowfall and its melting in autumn 2015 could be traced and well distinguished from early summer snowmelt water. Turbidity showed strong oscillations at the daily scale during summer melt periods and markedly responded to rainfall events, which could be attributed to rapid mobilization of fine sediments and suspended sediment transport in the study catchment.