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Future changes in snow and its influence on seasonal runoff and low flows in Czechia

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Mountains are often called as “water towers” because they substantially affect hydrology of downstream areas. However, snow storages are decreasing and snow melts earlier mainly due to air temperature increase. These changes largely affect seasonal runoff distribution, including summer low flows and thus influence the water availability. Therefore, it is important to investigate the future change in relation between snow and summer low flows, specifically to assess a wide range of hydrological responses to different climate predictions. Therefore, the main objectives of this study were 1) to simulate the future changes in snow storages for a large set of mountain catchments representing different elevations and to 2) analyse how the changes in snow storages will affect streamflow seasonality and low flows in the future reflecting a wide range of climate predictions. The predictions of the future climate from EURO-CORDEX experiment for 59 mountain catchments in Czechia were considered. These data were further used to drive a bucket-type catchment model, HBV-light, to simulate individual components of the rainfall-runoff process for the reference period and three future periods.

Future simulations showed a dramatic decrease in snow-related variables for all catchments at all elevations. For example, annual maximum SWE decreased by 30%-70% until the end of the 21st century compared to the current climate. Additionally, the snow will melt on average by 3-4 weeks earlier in the future. The results also showed the large variability between individual climate chains and indicated that the increase in air temperature causing the decrease in snowfall might be partly compensated by the increase in winter precipitation. Expected changes in snowpack will cause by a month earlier period with highest streamflow during melting season in addition to lower spring runoff volume due to lower snowmelt inputs. The future climate scenarios leading to overall dry conditions in summer are associated with both lowest summer precipitation and seasonal snowpack. The expected lower snow storages might therefore contribute to more extreme low flow periods. The results also showed considerably smaller changes for the RCP 2.6 scenario compared to the RCP 4.5 and RCP 8.5 both in terms snow storages and seasonal runoff. The results are therefore important for mitigation and adaptation strategy related to climate change impacts in mountain regions.