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Climate monitoring in a high-mountain country - Long-term area-mean temperature series for Switzerland and three major sub-regions ranging back to 1864

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With its location in the heart of the Alps, Switzerland combines temperate oceanic to continental, Alpine and Mediterranean climates within one country border. In such conditions, long-term climate monitoring is challenging, because the small number of available station series is hardly representative for the complex orographic sectioning of the climate. Here, we derive new time-series of monthly-mean surface air temperature that range back to 1864 and represent area-mean conditions over the country as well as for three major sub-regions. To account for the complex climate, the methodology integrates data from a small sample (19 stations) of homogenized long-term series and data from a high-resolution (2 km) grid dataset over a short (20 years) period. The statistical combination defines an objective weighting of station data that delivers reliable and time-consistent area-mean estimates, despite coarse and biased coverage with stations in early years. The methodology also quantifies the uncertainty of the estimates. Validation of the method reveals plausible patterns of station weights, and estimation errors of about 0.1 °C, much smaller than inter-annual variations. The new series suggest a warming in Switzerland of almost 1.5°C from the early-industrial period (1864-1900) till the latest WMO standard period (1981-2010), with a linear trend of 1.29 °C per 100 years between 1864-2016. The warming is found to be larger in autumn than in other seasons, larger to the north of the Alps than to the south, and larger below (above) 1000 m asl in winter (summer). In all series, the warming is modulated by inter-decadal variations. Our methodology for deriving representative area-mean temperature series is general and easy to implement. It lends itself to defining such series, objectively, for other high-mountain regions.