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Data Rescue and Homogenization of Historic Mass Balance Measurements on Swiss Glaciers

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Long-term glacier monitoring in Switzerland has resulted in some of the longest and most complete data series globally. Point mass balance observations, starting in the 19th century, are the backbone of the monitoring as they represent the raw and original data demonstrating the response of surface accumulation and melt to changes in climate forcing. Some of these time series on Swiss glaciers provide over 100 years of continuous measurements.

In the past, the variety of sources of historic measurements has only been partially investigated and never been completely and systematically processed and documented. Therefore, a new format for a point mass balance database was developed that allows full traceability of all measurements back to their original source as well as indicators for the quality of the data and corresponding measuring uncertainties. All previously included data sources were transferred into the new data base format and the original sources were re-assessed to validate or correct the entries and identify metadata. Furthermore, newly investigated measurements were added to the data base. The sources of data include an extremely diverse field from over 140 years of measurements such as published reports or studies, unpublished documents from field projects, field notes, digital sources as well as metaknowledge of the observers. Currently, data series with complete metadata for about 60 individual glaciers are available, corresponding to almost 60.000 point observations, one third of which are newly added.

In addition to extending the data base, this project also allowed us to systematically and homogenously fill in missing information such as estimates of the surface elevation of the measurement points and snow/firn density. In the past, these density values often had to be assumed without actual measurements but those assumptions could vary up to 20% within different projects and assumptions were rarely flagged as such. The newly added metadata now allows performing an analysis of all actually measured density values and a homogenous interpolation of missing values across all times series based on known values. Furthermore, a system to estimate uncertainties of the mass balance measurements based on the metadata was developed as the accuracy of measurements between different measuring techniques and projects with very differing scientific objectives over a time frame of 140 years can vary significantly and therefore needs to be assessed. This quality-checked and complete data base

now permits the re-analysis of consistent time series of glacier-wide mass balance allowing further interpretation of the climate change impacts on Swiss glaciers.