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High resolution climate reconstruction (AD 1580-1950) from proglacial Lake Silvaplana based on biogenic silica and x-ray diffraction.

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Annually laminated (varved) freeze-core samples of Lake Silvaplana (46˚27'N, 9˚48'E, 1791 m a.s.l., Engadine, eastern Swiss Alps) provides an excellent archive for quantitative reconstruction of high- and low-frequency climate signals back to AD 1580.

The chronology of the core is based on varve counting, ^{137}Cs, ^{210}Pb and event stratigraphy. Subsamples were taken in individual laminae year by year.

Annual biogenic silica flux (BSi) and XRD peak intensity ratios were analyzed and calibrated against instrumental temperature data (AD 1864 - 1949; varve counting from AD 1950 onwards is difficult and eutrophication is signifiant) from nearby meteo station Sils Maria, and compared with (i) early instrumental data back to 1760 AD, and (ii) two fully independent temperature reconstructions for the same area (based on dendroclimatological and documentary data) back to 1580 AD.

Annual biogenic silica flux to the sediments yielded a significant correlation against instrumental autumn (September – November) temperatures (calibration period AD 1864 - 1949, $r = 0.7$, $p < 0.01$). The correlation is stable in time and the structure of variations agree very well with independent autumn temperature reconstructions based on documentary evidence.

XRD peak-intensity ratios of different minerals were analyzed in each varve for the calibration period (AD 1864 – 1949). Mica/plagioclase and mica/chlorite were positively correlated with autumn SON precipitation ($r = 0.68$) and summer MJJAS precipitation ($r = 0.59$), respectively; quartz/amphibole and quarz/plagioclase were negatively correlated with annual precipitation ($r = -0.67$, $r = -0.52$ respectively); chorite/mica was negatively correlated with autumn SON temperature ($r = -0.59$). All correlations are significant ($p < 0.01$) and stable in time. Different origin and mechanisms of sediment transport (glacial abrasion in dry and hot summers, soil erosion during wet and cold summers) from different sub-catchments with characteristic bedrock mineralogy provide a sound physical explanation for the statistical relationships between differential XRD peak intensity ratios and the climate parameters. These relationships were extensively tested with surface sediments from the catchments and high-resolution sediment trap data.