Geophysical Research Abstracts
Vol. 16, EGU2014-7642-1, 2014
EGU General Assembly 2014

Quantitative high-resolution rainfall reconstruction back to AD 750 from the varved sediments of Lake Oeschinen, northern Swiss Alps

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Varved lake sediments are valuable natural paleoclimatic archives due to their potential to preserve climate variability through very long times and at annual resolution. Well-calibrated records from lake sediments are critically important for quantitative climate reconstructions but they remain a methodological and analytical challenge. While several comprehensive paleotemperature reconstructions have been developed across Europe, quantitative studies on rainfall are still scarce.

Here we present a quantitative high-resolution warm season rainfall reconstruction from the varved sediments of proglacial Lake Oeschinen (north-western Swiss Alps) back to AD 750. Lake Oeschinen is a high-elevation lake (1580 m a.s.l.), 56-m deep, oligotrophic (< 5 % OM) and dimictic with an ice cover extending from December through early May. The lake was formed by a Holocene rock slide.

We used shoreline and delta-fan surface samples in combination with sediment trap data to interpret the varve formation process. Data from these sediments fingerprint different sediment source areas and transport process from the watershed and confirm the instant response of sediment flux to rainfall. Erodible sediments from the northern part of the catchment (Tertiary Flysch) are transported after snowmelt and warm season rainfall, whereas sediments from the southern glaciated part (Mesozoic limestone) are mainly transported with glacial meltwater independent from rainfall.

Based on a highly accurate, precise and reproducible chronology, we demonstrate that varve thickness can be used as quantitative predictor for boreal spring-summer (MJJA) rainfall ($r = 0.60$, $p < 0.01$, 3-yr filtered) for the calibration period AD 1901 – 2008. We use this calibration model to establish a spring-summer rainfall record back to AD 750.

Our rainfall reconstruction compares well with independent early instrumental precipitation data for the north-western Swiss Alps back to AD 1760 (HISTALP data set). The rainfall reconstruction shows variability in the range of the calibration period. Wetter periods seem to coincide with regional glacier advances, which is coherent with results found in other regions of the Swiss Alps.