Geophysical Research Abstracts,
Vol. 10, EGU2008-A-02421, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-02421
EGU General Assembly 2008

High-resolution summer temperature reconstruction from Lake Silvaplana based on in-situ reflectance spectroscopy

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Annually laminated (varved) sediments of proglacial Lake Silvaplana (46˚27'N, 9˚48'E, 1791 m a.s.l., Engadine, eastern Swiss Alps) provide an excellent archive for quantitative high-resolution (seasonal – annual) reconstruction of high- and low-frequency climate signals back to AD 1580. The chronology of the core is based on varve counting, Cs-137, Pb-210 and event stratigraphy.

In this study we present a reconstruction based on in-situ reflectance spectroscopy. In situ reflectance spectroscopy is known as a cost- and time-effective non destructtive method for semi-quantitative analysis of pigments (e.g., chlorines and carotenoids) and of lithoclastic sediment fractions. Reflectance-dependent absorption (RDA) was measured with a Gretac Macbeth spectrolino at 2 mm resolution. The spectral coverage ranges from 380 nm to 730 nm at 10 nm band resolution.

In proglacial Lake Silvaplana, 99% of the sediment is lithoclastic prior to AD 1950. Therefore, we concentrate on absorption features that are characteristic for lithoclastic sediment fractions. In Lake Silvaplana, two significant correlations that are stable in time were found between RDA typical for lithoclastics and meteorological data: (1) the time series R_{570}/R_{630} (ratio between RDA at 570 nm and 630 nm) of varves in

Lake Silvaplana and May to October temperatures at nearby station of Sils correlate highly significantly (calibration period AD 1864 – 1951, r = 0.74, $p < 0.01$ for 5pt-smoothed series; RMSE is 0.28˚C, RE = 0.41 and CE = 0.38), and (2) the minimum reflectance within the 690nm band (min690) data correlate with May to October (calibration period AD 1864 – 1951, r = 0.68, $p < 0.01$ for 5pt-smoothed series; RMSE = 0.22˚C, RE = 0.5, CE = 0.31). Both proxy series (min690nm and R_{570}/R_{630} values) are internally highly consistent (r = 0.8, $p<0.001$).

In proglacial Lake Silvaplana the largest amount of sediment is transported by glacial meltwater. The melting season spans approximately from May to October, which gives us a good understanding of the geophysical processes explaining the correlations between lithoclastic proxies and the meteorological data.

The reconstructions were extended back to AD 1580 and show a broad correspondence with fully independent reconstructions from tree rings and documentary data.