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A high-resolution summer temperature reconstruction for Central Chile back to AD 850 based on in-situ reflectance spectroscopy from lake sediments

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A quantitative high-resolution (1-3 years) austral summer DJF temperature reconstruction for the central region of Chile back to AD 850 is presented here. We used non-destructive multi-channel reflection spectrometry data of a short sediment core from Laguna Aculeo, Central Chile (33˚50'S/70˚54'W, 355m a.s.l.). The depth to age model of the sediment core was made using ^{137}Cs and ^{14}C dates, and a series of seismites related to major historical earthquakes. Large seismites were identified by eye, smaller seismites by significant shifts in the mode of the grain size distribution record at very high resolution. We used the reflectance 660nm/670nm which is typical for the preservation index of the pigment chlorin as an indicator for aquatic biological productivity, and smoothed and re-sampled the original data set (data resolution 2 mm corresponding to 0.5-1 years) with a 3-yr triangular filter to account for dating uncertainties. The time series of the 660nm/670nm reflectance data from Laguna Aculeo revealed highly significant correlations with austral summer DJF temperatures ($r = 0.73$, $p<0.01$; calibration period 1901 – 2000; reanalysis data of Mitchell et al. 2004 for the grid point Laguna Aculeo). The DJF temperature reconstructions back to AD 850 were then calculated using scaling and linear regression techniques; Root squared mean error values (RMSE) amount to 0.36˚C and 0.33˚C respectively.

Our DJF temperature reconstruction suggest relatively mild summers with an average

similar to the 20^{th} century (+0.04˚C wrt 20^{th} century) from ca. AD 850 to AD 1350 with multi-decadal cooler periods (-0.40˚C wrt 20^{th} century) and a warmer period from ca. AD 1150 to AD 1350 (+0.30˚C wrt 20^{th} century). A sharp drop in DJF temperatures (-0.29˚C / 10 yr, decadal trend) is observed around AD 1350, followed by constantly cool (-0.66˚C wrt 20^{th} century) summer conditions until AD 1750. This period can most likely be related to a regional Little Ice Age type event. After AD 1750 summer temperatures show higher variability at decadal scales with warmer and colder phases alternating until the beginning of the 20^{th} century.

This lake sediment- based summer temperature record for central Chile is significant considering the fact that all the other known natural climate archives in this area (mostly tree rings) are sensitive to winter precipitation.