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Isotopic investigations of contemporary carbonate sedimentation in lakes from N Poland

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The study area of NE Poland is a region of most pronounced seasonal climatic contrasts and best preserved varved sediments in lakes. Within the project “Climate of northern Poland during the last 1000 years: Constraining the future with the past (CLIMPOL)” the isotopic investigations have been performed aiming to the creation of transfer functions for the reconstruction of temperature in the past.

The presented study will be focused on the results of isotopic measurements ($\delta^2\text{H}$, $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$) for samples of water and contemporary carbonates collected from the lakes along the West-East transect in northern Poland, which have been chosen to form the CLIMPOL training set for calibration space-for-time. The measurements have been performed with use of continuous-flow IRMS Isoprime coupled with automated carbonate/water preparation device Multiflow.

The measurements of $\delta^{18}\text{O}$ for lake water (47 samples) demonstrate variability of values from -7.7 to -1.9‰ (VSMOW) and show a general W to E gradient. The $\delta^2\text{H}$ measurements have been performed so far for 22 samples and the results vary from -71 to -19‰ (VSMOW). The plot of $\delta^2\text{H}$ versus $\delta^{18}\text{O}$ reveals linear correlation with the equation: $\delta^2\text{H} = 7.9\delta^{18}\text{O} - 4.6$ ($R^2 = 0.80$), which slope is identical to GMWL, while intercept is ca. 15‰ lower.

The $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ of carbonates from sediment traps have been determined for 35 samples, and the results range from -13.1 to -6.1‰ ($\delta^{18}\text{O}$, VPDB) and from -10.6 to +0.15‰ ($\delta^{13}\text{C}$, VPDB).

The obtained results have been used to calculate temperatures from $\delta^{18}\text{O}$ according to the “temperature equation” [1], which produced exotic results of 35 °C on the average. These results demonstrated that during the CaCO_3 precipitation the isotopic equilibrium was not present. On the other hand, the correlation between $\delta^{18}\text{O}$ in water and $\delta^{18}\text{O}$ in carbonates ($R^2 = 0.76$) suggested that carbonates recorded the isotope composition of water in which they were formed.

It seems that temperature signal can be recovered from the isotope dataset, as the values of $\delta^{18}\text{O}$ in sediment trap carbonate and summer temperature (June, July, August) correlated ($R^2 = 0.38$). This simple linear equation was tested as a transfer function to reconstruct the temperature for CLIMPOL master site record from Lake Zabinskie. The comparison of calculated temperatures and instrumental record for the last 120 years showed that generally the average temperature can be reconstructed, but the inter-annual variability was poorly reflected in the reconstructions.

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[1] Kim S-T, O’Neil JR. Geochim. Cosmochim. Acta 61 (1997)3461-3475.