Climate variability of Southern Chile since the Last Glacial Maximum: A continuous multi-proxy sedimentological record from Lago Puyehue (40°S)

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Several recent studies have demonstrated that climate records from Antarctic ice cores are clearly asynchronous with the rapid changes of the Northern Hemisphere. However, paleoclimate data from the rest of the Southern Hemisphere yield conflicting interpretations of interhemispheric synchrony/asynchrony of the climate system. In order to better constrain the paleoclimate history of southern South America since the Last Glacial Maximum, we investigated the sedimentary record of Lago Puyehue, located at the northern boundary of the southern westerly wind belt in mid-central Chile (40°S). A seismic-stratigraphic reconnaissance allowed us to image the sedimentary infill of the lake and to select an area of continuous and undisturbed sedimentation for coring. An 11 m long core spanning the last 17,900 years was then retrieved at PU-II site (48 m depth) and used for a multi-proxy sedimentological and geochemical study. The multi-proxy analysis includes magnetic susceptibility, grain-size, bulk and clay mineralogy, loss-on-ignition, major elements geochemistry, biogenic silica concentration and geochemical properties of the sedimentary organic matter (C/N, $\delta^{13}C$).

Results evidence that sediment grain-size is highly correlated with the biogenic content of the sediment and can be used as a proxy for lake paleoproductivity. On the other hand, the magnetic susceptibility signal is highly correlated with the aluminium and titanium concentrations and can be used as a proxy for the terrigenous supply. Moreover, the sedimentary organic matter of Lago Puyehue is characterized by low C/N ratios, evidencing that it mainly originates from algal production.

Temporal variations of the sediment composition and of the geochemical composition of the sedimentary organic matter demonstrate that, since the Last Glacial Maximum, the Chilean Lake District was characterized by 2 main abrupt climate changes superimposed on a long term climate evolution. These rapid climate changes are: (1) the end of the Last Glacial Maximum at 17,300 cal. yr. BP, marked by an abrupt increase in biogenic silica concentration and by a shift towards less negative $\delta^{13}C$ values. These changes are interpreted as an increase of lake paleoproductivity related to warmer temperatures and possibly to a higher nutrient supply due to the melting of the north Patagonian ice cap. (2) a 13,100-12,300 cal. yr. BP cold event characterized by a high terrigenous supply and by low biogenic silica concentrations. The timing of this event is compared with similar records in both hemispheres and demonstrates that this Southern Hemisphere climate change lags behind the Northern Hemisphere Younger Dryas cold period by 500 to 1000 years. The end of this event is abrupt and it is followed by a Holocene climatic optimum between 12,100 and 7500 cal. yr. BP. This period is characterized by a gradual increase in organic matter concentration and in the C/N ratio, reflecting the densification of the vegetation in the watershed. The data for the rest of the Holocene suggest a stabilisation of the vegetation in the lake catchment and a high but variable lake productivity.