Reconstruction of Indian Ocean summer monsoon dynamics at Nam Co using lipid biomarkers since 24 cal ka BP

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The Indian Ocean summer monsoon (IOSM) is an important component of the modern climate system and directly influences the environmental and hydrological conditions at the Tibetan Plateau. Lakes such as Nam Co, in southeastern Tibet, are affected by a strengthening or weakening of the IOSM which delivers up to 90 % of the annual precipitation in the summer months. Nowadays, precipitation and temperature are positively correlated with each other. Therefore, changes in the precipitation as well as temperature signal can be analyzed to better comprehend the monsoon system in the past.

We present one of the longest paleorecords on the Plateau enabling the investigation of the IOSM back to the Last Glacial Maximum. Based on AMS ^{14}C measurements, the sediment core from Nam Co dates back to 23.7 cal ka BP. Different organic geochemical proxies are applied to reconstruct the environmental and hydrological changes. Glycerol dialkyl glycerol tetraethers (GDGTs) are used as a temperature and pH proxy, while the hydrogen isotopes (δD) of *n*-alkanes are used as a hydrological proxy. The δD of the aquatic *n*-alkane C_{23} mainly retrace the isotope signal of the lake water and the δD of the terrestrial *n*-alkane C_{29} mainly record the isotope signal of the meteoric water.

The Last Glacial Maximum is characterized by a weak IOSM. Precipitation was lower and the calculated mean annual lake surface temperature was 1.8 °C colder than the present. Comparatively low temperatures are also recorded in Heinrich 1 event and Younger Dryas. In these cold periods, the monsoon intensity is decreased, while in warm periods a strengthening of the IOSM is measured. We detect the onset of the IOSM associated with increased precipitation and temperature during the Bølling-Ållerød. In this period, the highest temperatures are recorded for the Pleistocene, which are similar to present values. The Early Holocene is the period of the strongest IOSM with continuously high amounts of precipitation and increasing temperatures.

Most interesting is the fact that the response of the lake system lags changes in insolation with the terrestrial signal leading the aquatic one. The delayed response of the aquatic organisms can be ascribed to the strong influence of the wintery ice cover and melt water inputs. After the Younger Dryas event the aquatic system changes relative fast supporting the existence of ecological thresholds. We assume that these thresholds are potentially linked to lake size, ice-free seasons and nutrient availability to induce an appropriate response of the aquatic organisms. In contrast, the terrestrial vegetation is strongly influenced by high insolation at the Tibetan Plateau and mainly records a summer moisture signal modified by evapotranspiration. Therefore, terrestrial *n*-alkanes reveal environmental and climate changes faster and may be useful to reconstruct even short-term changes in the IOSM precipitation. The different response times of the aquatic and terrestrial vegetation play an important role for the IOSM reconstructions.

Keywords: *n*-alkanes, hydrogen isotopes, GDGTs, Indian Ocean summer monsoon, climate reconstruction, temperature, precipitation