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Insights into LGM-Holocene hydroclimate variability in SW North America from clumped carbon and oxygen isotope data

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There is a dramatic difference in the hydroclimate of Southwestern (SW) North America between the Last Glacial Maximum (LGM) and the Holocene. During the LGM, the region was dotted by large lakes whose remnants are now either dry playas or shrunken salty lakes. The change in hydroclimate may be due to increased evaporation and/or changes in the amount of precipitation and/or temperature-driven changes in effective moisture.

Finding absolute temperature proxies has remained a challenge. Similarly, without temperature estimates and modern water isotope values, it is not possible to constrain the paleo precipitation isotope values. Developments in clumped isotope techniques have opened new possibilities. Cave pool deposits offer materials that can be precisely dated using uranium-series isotopes and carbonate material crystallized under near-equilibrium conditions. We present clumped isotope temperature data from Lechuguilla Cave, New Mexico, SW North America. The samples, all pool deposits, range in age from the Middle Holocene to the Last Glacial. The samples have average age uncertainties in the range of 170 years (2-sigma). Four to ten fractions of each sample were used to obtain individual clumped isotope absolute temperatures, with uncertainties of ± 2 to 4 ^{0}C (2-sigma). The samples come from different depths of Lechuguilla Cave, and present-day pool water temperatures are calculated using elevation and the geothermal gradient in the cave.

We obtained a mean Last Glacial Maximum (LGM) temperature relative to the present of -6.7 ± 1.4 ^{0}C (n=5) and a Middle Holocene mean temperature of 1.0 ± 1.3 ^{0}C (n=3). About 7-degree difference between the LGM and pre-industrial temperature is within the range inferred from other continental proxies. Paired mass-47 and mass-48 measurements (‘dual’ clumped isotopes) suggest near-equilibrium precipitation and show no variation in equilibrium conditions with time.

A difference of 7 ^{0}C between the LGM and Holocene would add a significant temperature component to estimate the source balance and precipitation amount estimate for the LGM. However, our preliminary data also suggest that the $d^{18}O$ values of paleo waters we get from dual clumped isotope analyses were different than modern $d^{18}O$ values. Additional results based on these findings will be presented.