Fossilized drip-water from a Sierra Nevada Cave reveals stadial vs. interstadial variability in precipitation stable isotopes

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Speleothem calcite stable isotope values (δ18Occ and δ13Ccc) are considered reliable proxies of regional climate. However, the δ18O of speleothem calcite is not a direct measurement of the δ18O of drip water or precipitation given that temperature effects the water-calcite isotopic fractionation. Fluid inclusion stable isotope values (δ18O and δ2H) are considered to be more representative of precipitation as fluid inclusions are the fossilized drip-water that promoted the growth of a given stalagmite. In turn, inclusion waters have great potential as proxies of paleo-precipitation δ2H and δ18O if a clear relationship between drip-water stable isotopic composition and local precipitation can be established and as proxies of paleo-temperature when compared to the host calcite δ18O. We analyzed fluid-filled inclusion in a stalagmite from the western Sierra Nevada to reconstruct conditions over the Pacific, the precipitation source for California. Fluid δ18O and δ2H values indicate that for colder periods such as the Last Glacial Maximum, precipitation was more negative, indicating a North Pacific source. Furthermore, fluid inclusion δ18O and δ2H values are consistent with the modern local meteoric water line (δ2H = 7.8 x δ18O + 9.2) in warm periods but cluster around a δ18O average of -13.1 ‰ during the Last Glacial Maximum (LGM; >17.5 ka) and an average of -11.8 ‰ during the Older Dryas (OD; 13.5 to 14.5 ka). The shift in fluid δ18O and δ2H values from the LGM through OD along with the difference in values of stadial and interstadial populations may record a ‘stadial precipitation regime’ governed by continental ice dynamics in North America. This record improves our understanding of the proxy δ18Occ record for this Sierran stalagmite and provides new insight into the variability in atmospheric organization during the waning of the Laurentide ice sheet and warming of the last deglaciation.