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Fossilized drip-water from a Sierra Nevada Cave, USA reveals changing conditions over the North Pacific during the last deglaciation

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Speleothem calcite stable isotope values (δ18Oc and δ13C) are considered reliable proxies of regional climate. Previous studies have shown that δ18Oc can be used to interpret changing continental temperatures and precipitation dynamics. However, the δ18O of speleothem calcite is not a direct measurement of precipitation δ18O, given temperature influence on water-calcite isotopic fractionation. Fluid inclusion stable isotope values (δ18O and δ2H) are the fossilized drip-water from which stalagmites precipitate, where drip-water and precipitation δ18O are related. Thus inclusion fossil waters have great potential to aide interpretation of δ18Oc as they are proxies of paleo-precipitation δ2H and δ18O. Here, we use fluid inclusions in a previously studied stalagmite from the western Sierra Nevada (ML-1), California to reconstruct conditions over the North Pacific, a predominant precipitation source to the region. We show that fluid inclusion δ18O and δ2H values from ML-1 are consistent with the modern local meteoric water line (δ2H = 7.8 x δ18O + 9.2) in relative warm periods but show a trend towards different d-excess values during the Last Glacial Maximum (18.9 to 17.5 ka), the Older Dryas (14.5 to 13.5 ka), and the Younger Dryas (12.7 to 11.04 ka). Fluid inclusion stable isotopes from warm periods are in line with stable water isotope enabled model outputs from CESM, which suggest that precipitation δ18O and δ2H signals are largely controlled by circulation changes. Additionally, our newly developed, streamlined method of noble gas temperature measurement from fluid inclusions indicates a paleo-temperature at the studied cave for the Last Glacial Maximum of 8.9 $\pm$ 2.2 °C, 3.6°C cooler than the modern mean annual temperature. The new findings from this region highlight the different roles of temperature change and variability in precipitation source on precipitation patterns in the western Sierra Nevada during the last deglaciation.