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Climate Variability in Southwestern North America: Insights from a Uniquely Long, Continuous Sedimentary Record from Fish Lake, Utah



Proper allocation and restrictions of southwestern North American water supplies have been a topic of debate in recent years as increasing aridity and temperature severely limits available water. Freshwater scarcity may be remediated naturally by regional precipitation; however, the responses of seasonal precipitation patterns to anthropogenic greenhouse gas (GHG) emissions and subsequent rising temperatures remain unclear. This dissertation seeks to address the relationship between hydroclimate and temperature with natural climate variability and elucidate past climate dynamics in the rapidly drying southwestern U.S.

Fish Lake, Utah, preserves a long, continuous, high-resolution sediment record. The utility of the Fish Lake record allows for examination of regional hydroclimate and temperature change over the past 67 kyr. This record spans the Last Glacial Maximum (LGM) to present, which can be directly connected to regional records preserving the same time interval. Importantly, the sediment record also captures Marine Isotope Stage (MIS 3), a period prior to the LGM that is generally understudied in the region, and can provide insight into a period of moderate boundary conditions relative to the LGM and the Holocene while containing multiple climate perturbations (i.e., rapid changes in GHGs).

This dissertation details a reconstruction of past precipitation change over the last ~67ka using the hydrogen isotope composition ($\delta^2\text{H}$) of terrestrially sourced leaf wax lipids preserved in Fish Lake sediments. This record is interpreted alongside temperatures reconstructed from branched glycerol dialkyl glycerol tetraethers (brGDGTs) and additional proxy records. Together, distinct shifts in the seasonal contribution of different moisture sources and localized glacial dynamics are observed. Next, changes in leaf wax sources prior to regional deglaciation and an isotopic paradox across the deglacial and Holocene transition prevent the estimation of precipitation-evaporation (P-E) balance at Fish Lake, indicating a need to examine potential drivers of isotope and source changes. Finally, changes in P-E across a major climate transition from late MIS 4 to middle MIS 3 are thoroughly examined, as this period marked by high temperatures, elevated GHG concentrations, and changing seasonal insolation. This work highlights the dynamic relationship between regional P-E and GHGs, while showcasing the robust tie between precipitation and seasonal insolation

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