Holocene Temperature and Water Budget Records from the Tropical-Latitude Andes (11°S) using Clumped Isotope (Δ_{47}) and Triple Oxygen Isotope ($\Delta'^{17}O$) Measurements of Lake Carbonates from Lake Junín and Laguna Pumacocha, Peru

View Presentation | Add to Schedule

Authors: Sarah A. Katz[1], Naomi E. Levin[1], Nicole M. DeLuca[2], Benjamin Passey[1], Donald T Rodbell[3] and Mark B Abbott[4], (1)University of Michigan Ann Arbor, Earth and Environmental Sciences, Ann Arbor, MI, United States, (2)Johns Hopkins University, Earth & Planetary Sciences, Baltimore, MD, United States, (3)Union College, Schenectady, NY, United States, (4)University of Pittsburgh, Department of Geology and Environmental Science, Pittsburgh, PA, United States

Carbonate $\delta^{18}O$ records ($\delta^{18}O_C$) from two adjacent lakes in the Peruvian Andes, Pumacocha and Junín, provide insights into Holocene precipitation and water budgets, but their interpretation is limited without independent controls on temperature and the degree of lake water evaporation. We use carbonate clumped (Δ_{47}) and triple oxygen ($\Delta'^{17}O$) isotope data to develop temperature and evaporation records from these lake cores. Over the last 9,000 years, water temperatures derived from Δ_{47} at both lakes were steady (Junín: 11 ± 1 °C, n = 6; Pumacocha: 11 ± 2 °C, n = 5) and match modern lake carbonate Δ_{47} temperatures in the region (13 ± 3 °C). Prior to 9,000 ybp, water temperatures at Junín were 5 °C cooler (6 ± 1 °C, n = 4), suggesting that Junín was cooler in the early Holocene than indicated by temperature estimates inferred from past glacier extent (2–4 °C cooler than present). We also reconstruct lake water $\Delta'^{17}O$ and $\delta^{18}O$ values ($\Delta'^{17}O_{rlw}$, $\delta^{18}O_{rlw}$) from carbonate Δ_{47}, $\Delta'^{17}O$, and $\delta^{18}O$ to test the assumptions that 1) Pumacocha $\delta^{18}O_{rlw}$ reflects unevaporated precipitation $\delta^{18}O$ and 2) Junín $\delta^{18}O_{rlw}$ is evaporated with respect to precipitation $\delta^{18}O$. As expected, $\Delta'^{17}O_{rlw}$ values are consistently lower at Junín than at Pumacocha and are lowest in the early to mid-Holocene (-10 ± 4 per meg; n = 6) before rising to 13 per meg at 1240 ybp, which indicates the changing evaporative fluxes from the lake and suggests heightened evaporation during the majority of the Holocene compared to today. At Pumacocha, $\Delta'^{17}O_{rlw}$ values average 26 per meg (± 1 per meg; n = 3) for the last 3500 years and are similar to $\Delta'^{17}O$ of modern precipitation (31 ± 5 per meg), affirming that Pumacocha $\delta^{18}O_C$ values reflect precipitation $\delta^{18}O$ and are not influenced by evaporation. However, prior to 3500 ybp, $\Delta'^{17}O_{rlw}$ values are 13 ± 8 per meg (n = 4) and suggest that either Pumacocha lake waters were slightly evaporated or that precipitation $\Delta'^{17}O$ was lower than the present day. In sum, our results 1) confirm that the $\delta^{18}O_C$ record from Junín reflects both changes in Holocene precipitation $\delta^{18}O$ and evaporative fluxes from the lake, 2) challenge our understanding of early Holocene temperatures in the Junín basin, 3) challenge the assumption that evaporation did not influence the Pumacocha $\delta^{18}O_C$ record and 4) highlight the insights that can be gained by adding Δ_{47} and $\Delta'^{17}O$ measurements to $\delta^{18}O_C$ records.