Holocene Water Availability in the Atacama Desert as Recorded by Seasonal Tree Ring Oxygen Isotope Variations

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The Atacama Desert in northern Chile is one of the driest regions on Earth, receiving less than 12 mm of precipitation per year [1]. As a result, the Atacama Desert ranks among the most important geographic locations for investigating the hydrological responses to extreme climate variability in hyperarid environments [2]. Water availability in the Atacama Desert of northern Chile is primarily driven by recharge and runoff from high elevation regions in the Andean Altiplano [3]. Oxygen isotope analysis on *Prosopis tamarugo* tree ring α-cellulose over multiple time-series spanning the Holocene provide sub-annually resolved records and display regional variations in climate and hydrogeology in the Atacama.

Ancient (9.1 to 4.5 ka) *P. tamarugo* samples from the Pampa del Tamarugal region of the Atacama Desert record $\delta^{18}O$ values that range from 32.8 to 33.8‰ with relatively low seasonal (intra-ring) variability (avg. 1.1‰, 2σ=0.6‰). Samples from Ramaditas, an archaeological site in the region, date from 2.0 to 2.5 ka and have a significantly larger range of $\delta^{18}O$ values (22.8 to 39.4‰) and greater seasonal variability (avg. 3.3‰, 2σ=2.4‰). Modern samples have $\delta^{18}O$ values that are similar to the ancient samples (range = 33.5 to 34.6‰) with low seasonal variability (1.1‰, 2σ=0.8‰). Seasonal variations in the $\delta^{18}O$ values of *P. tamarugo* record periods of unstable conditions and/or increased runoff from 2.0 to 2.5 ka, possibly as a result of changes in monsoonal precipitation in the Altiplano recharge regions. Low seasonal variability in $\delta^{18}O$ values in ancient and modern *P. tamarugo* trees record a stable moisture source that is most likely groundwater controlled. These sub-annually resolved records demonstrate that over the past 9ka water availability in the Atacama Desert has been driven by significant regional-scale variations in climate and hydrogeology in the Altiplano.

[1] Clarke (2006), *Geomorph.* **73**, 101–114 [2] Gayo *et al* (2012), *E-SR* **113**, 120–140 [3] Houston (2002), *Hydro. Proc.* **16**, 3019-3035