Multi-proxy approach to constrain temperature and hydroclimate in arid regions

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Climate change impacts are most acutely felt in arid regions given the marginal nature of rainfall and temperatures often near the limits of habitability, and as such, there is an urgency to delineate the impact of future warming on these regions. Getting well-behaved continuous high-resolution proxies remains a challenge in these regions. And yet, the challenge can be overcome with the use of speleothem proxies that have different modes of perturbations to changes in temperature and moisture in conjunction with other high-resolution data from temperate regions. Given advances in the uranium-series chronology method the issue of constraining time is essentially solved.

We examine changes in precipitation and temperature based on stalagmites from the US Southwest (SW) in which there are summer and winter contributions to annual moisture and samples from the winter sensitive southern Great Basin of the USA, in comparison with global data to document changes in hydroclimate and temperature during the common era. Our data and analyses show that large scale moisture variability in the SW primarily reflects changes in the strength of the summer monsoon. As a result, there is coherent variability between the SW and the Asian monsoon over the Common Era. This contrasts with the inverse relationship between moisture regimes in these two regions over longer time-scales during which SW moisture variability is controlled by the balance between winter and summer precipitation. We show that overall, there is a positive correlation between growth rate and temperature, supporting the change in the strength of the summer monsoon as the primary control of the long time-scale moisture variability in the SW. However, this relationship does not hold during unusually warm intervals, likely due to changes in the balance between precipitation and evaporation.