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ITCZ migration and monsoon extremes estimation from Holocene speleothem records

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Evidence is emerging of the migration of the intertropical convergence zone (ITCZ) during the Holocene. Oxygen isotope records from stalagmites have over the past years become an important source of information about the strength of the monsoon during the Holocene. The stalagmite archive yields series with absolutely dated timescales, a high time resolution and a signal preservation seemingly undisturbed by post-depositional processes. Speleothem oxygen isotope time series thus offer the chance to (1) measure Holocene ITCZ changes and (2) detect rare events of extreme monsoon conditions (droughts or wet spells).

The task of statistical time series analysis is to quantify the signals and the evidence about changes and extremes. Reliable error bars are thereby essential for any meaningful interpretation of results. The bootstrap resampling approach has the potential to supply such error bars despite (1) uneven timescales, (2) non-Gaussian distributional shapes and (3) persistence in the data.

We compare a new monsoonal proxy series from the Heshang cave, China, which was produced at Oxford, with published data from the Qunf cave, Oman, other series from the Arabian peninsula and the Dongge cave, China. Ramp regression (Mudelsee 2000 Computers and Geosciences 26:293–307) is used as a tool to quantify change-points of long-term trends. It is assumed that ITCZ changes imprint on the change-points. Then variations in the timing of the change-points among different locations allow to infer the speed of ITCZ migration during the Holocene. Robust detection

of monsoon extremes is performed using running median smoothing (Mudelsee 2006 Computers and Geosciences 32:141–144). This reveals that only the occurrences of extreme droughts, not wet spells, are significant during the Holocene.