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## A probabilistic approach to oxygen isotope modelling of speleothem data with age uncertainties

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Due to age uncertainties and poor resolution in speleothems, age-depth modelling techniques are often implemented for cross-examinations. In this study, we use a variation of the analogue method to perform a pseudo-proxy reconstruction of the large-scale variability in Indian and East Asian monsoon precipitation using synthetic oxygen isotope records from speleothem sites and an isotope-enabled climate model.

We present a probabilistic approach to synchronize speleothems through oxygen isotope data and individual independent age constraints, achieved by co-estimating the regional  $\delta^{18}\text{O}$  variations through time. The  $\delta^{18}\text{O}$  variability is modelled using Gaussian processes, and an adaptation of BACON age-depth model is further used for the individual speleothem chronologies.

The method is tested using synthetic speleothem data generated from the ECHAM/MPI-OM climate model and corrupted through realistic noise from speleothems from the SISAL database.

By incorporating accurate and realistic depth-dependent age-uncertainties rather than shifting, stretching or compressing the time-series of oxygen isotope data, this modelling approach may lead to advancements of handling speleothem data for regional to global evaluations on variability between speleothems and timescales.