

# Analysing the degree of replication of palaeoclimate records

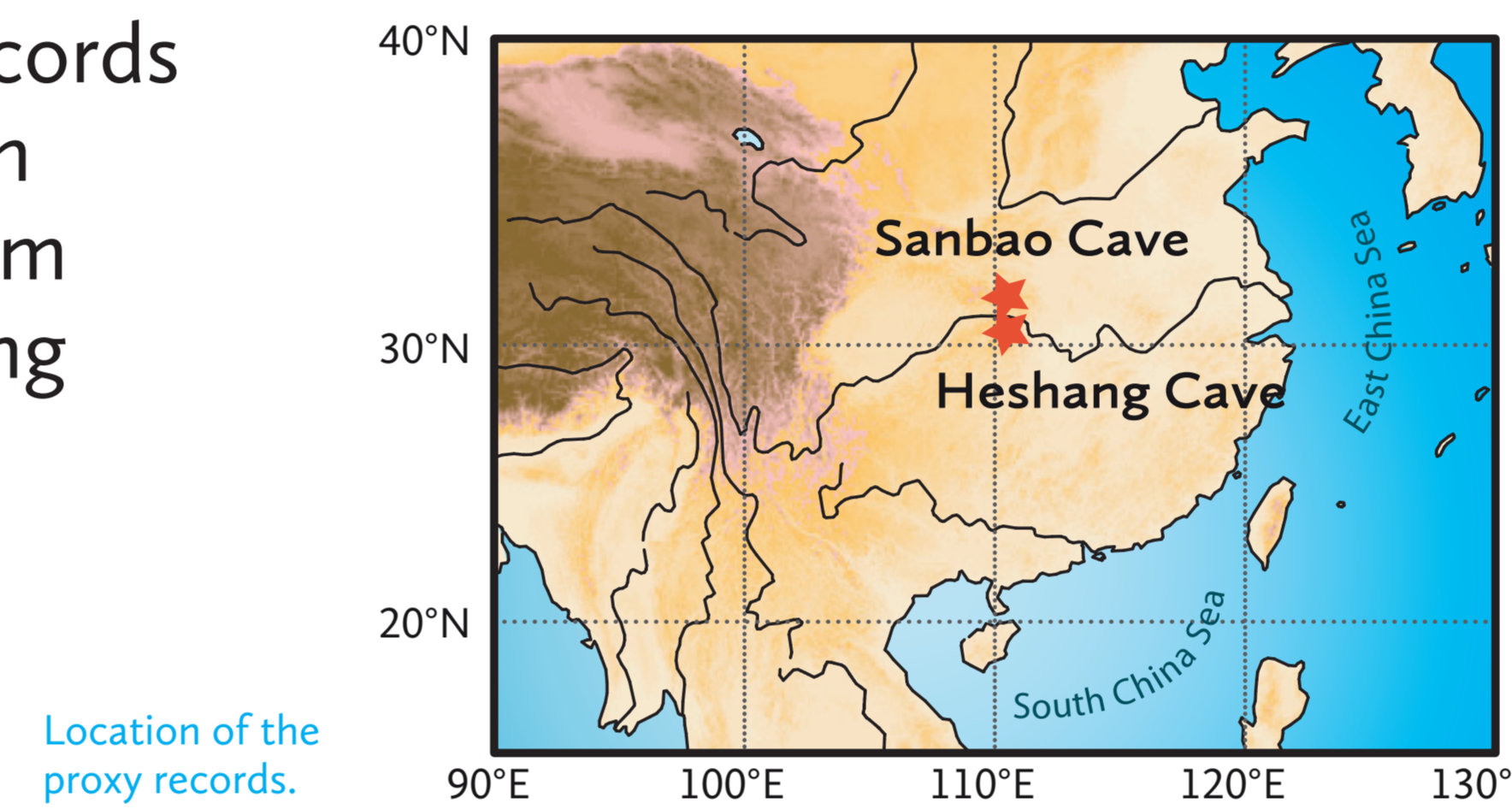
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Proxy records (such as time series derived from ice cores or stalagmites) from almost the same location should represent a similar variation over time – this is called **replication** of proxy record. Replication is frequently difficult to achieve, because either the proxies are not reflecting the paleoclimate variation or external factors dominate the climate signal in the proxy record. Moreover chronological uncertainties inherent to each proxy time series needs to be taken into account. The investigation of the degree of replication is therefore an important first step in palaeoclimate analysis.

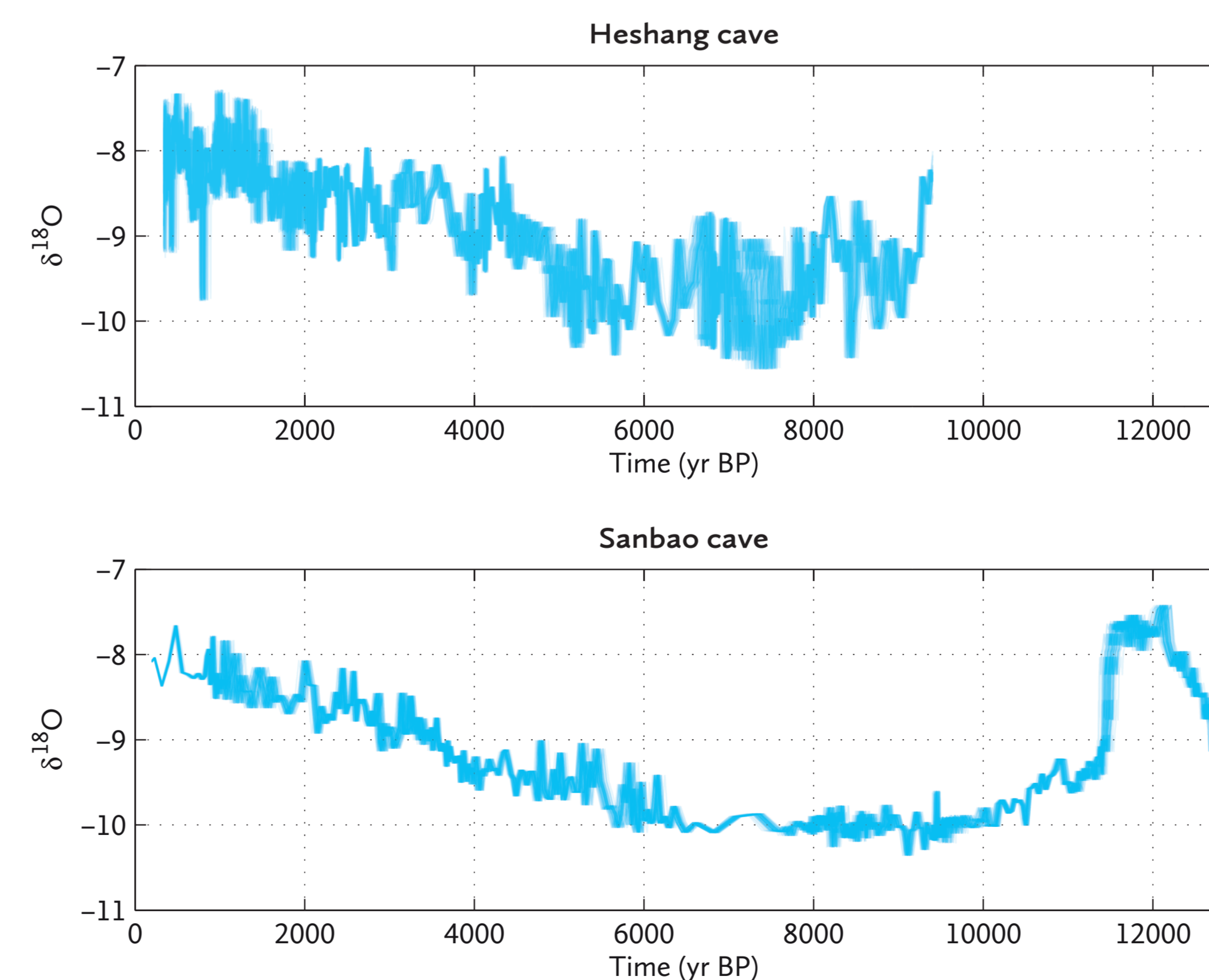
## PALAEOCLIMATE PROXY RECORDS

Palaeoclimate proxy records for Holocene East Asian monsoon variability from the Sanbao and Heshang cave.



Stalagmite from Heshang cave (photo: Hu et al, 2008).

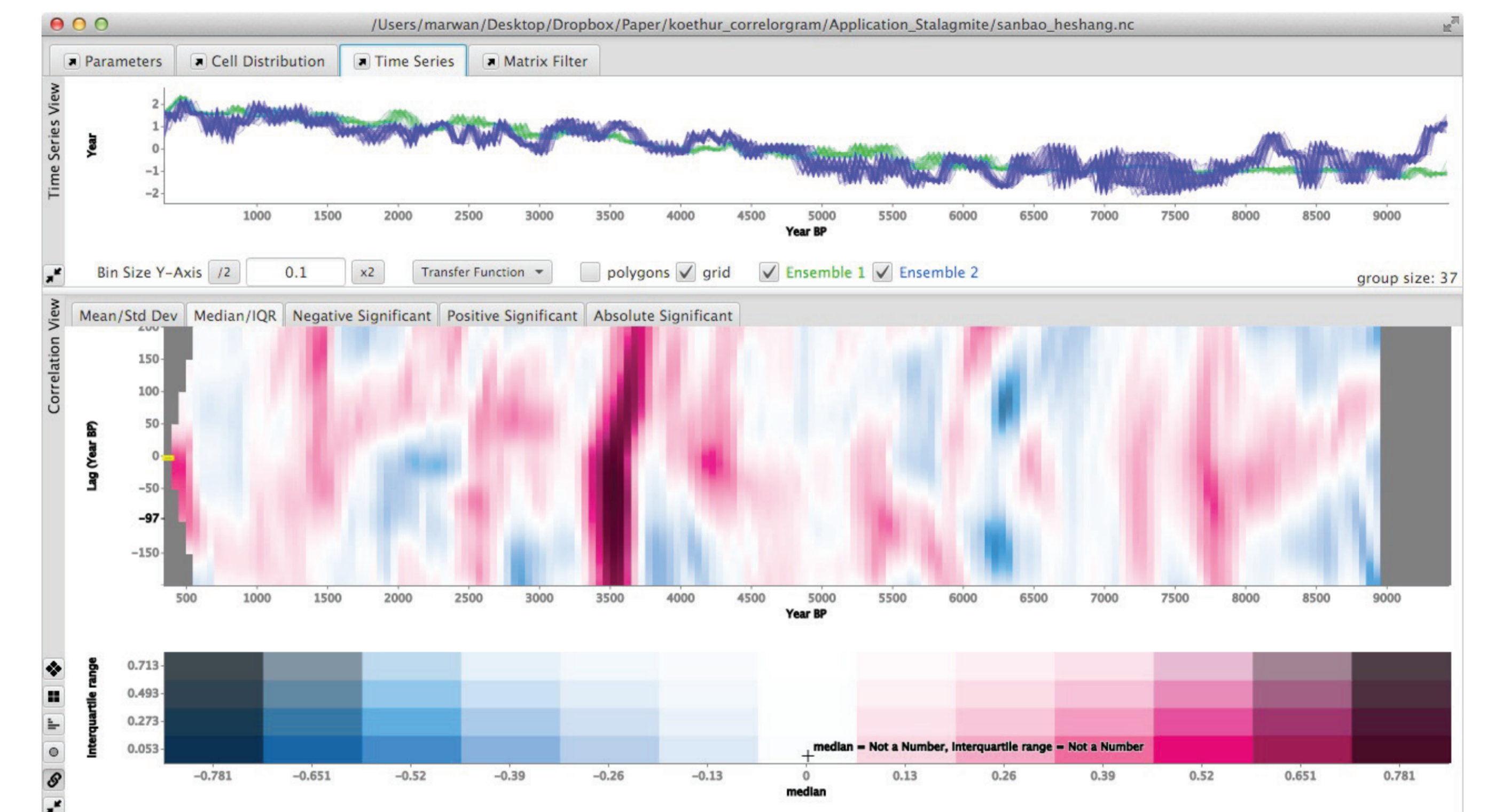
Replicability is difficult to analyse by eye. Subjectivity of alignment as well as dating uncertainties are important issues but often handled with insufficient care.



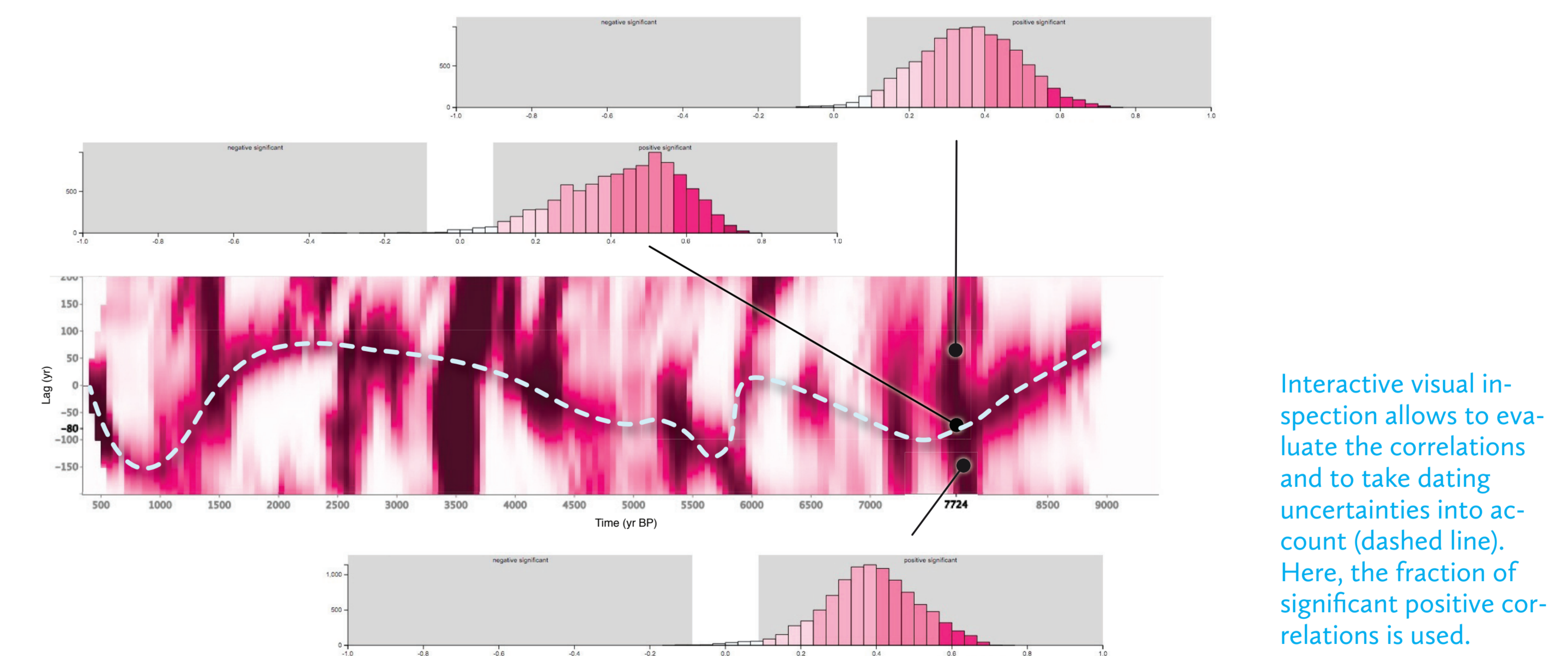
Ensembles of Oxygen isotope ratios as signatures of East Asian monsoon variability from almost the same location in China. However, visual inspection of replicability is quite difficult.

## ENSEMBLE CORRELOGRAMS

Correlograms allow cross-correlation over time (windowed cross-correlation). Here we combine the ensemble based correlation analysis with interactive visualisation techniques.



Correlogram of palaeoclimate proxy records from Heshang and Sanbao cave representing epochs of higher correlations (median values) and, thus, replicable palaeoclimate variation.

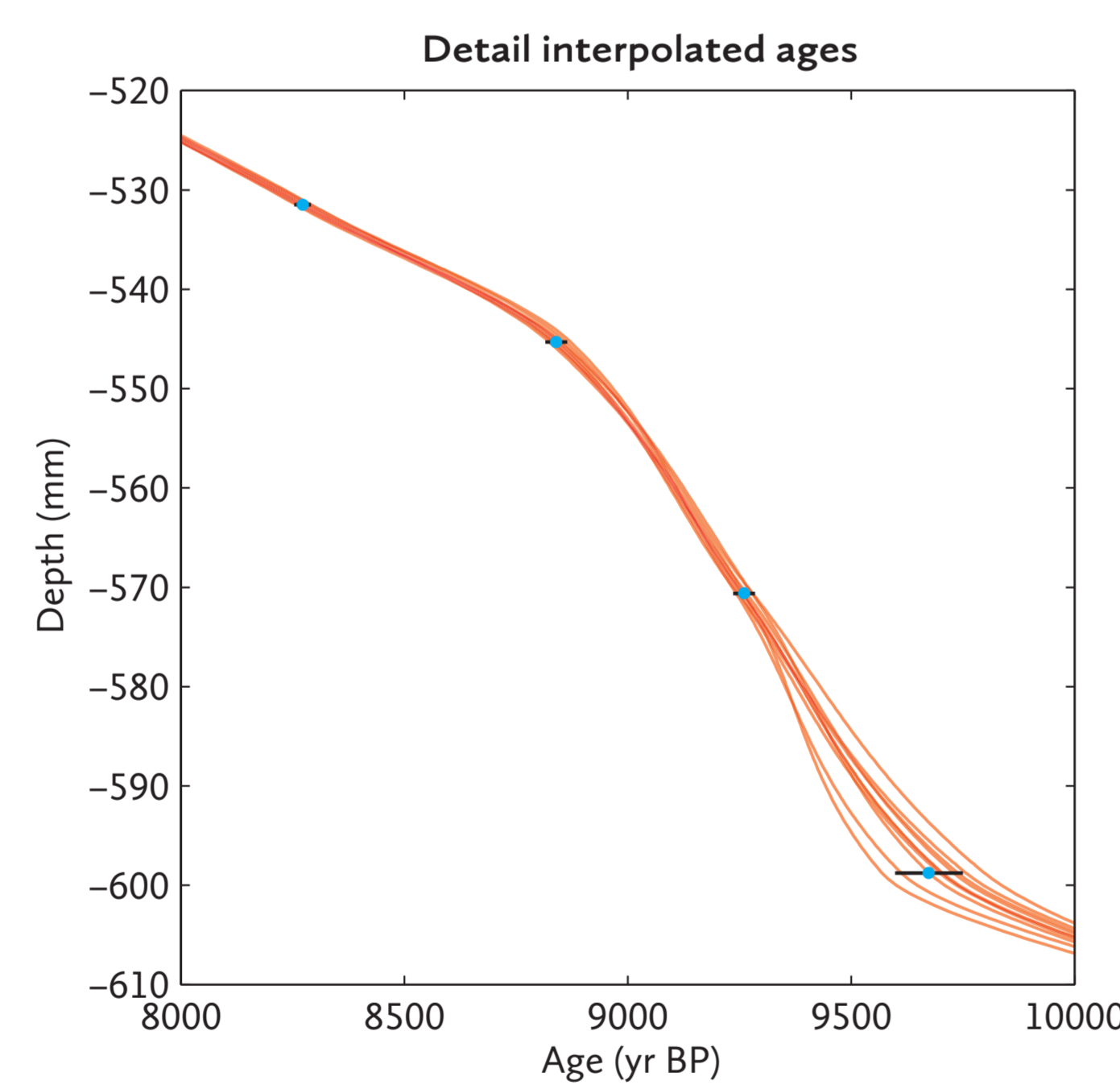


Interactive visual inspection allows to evaluate the correlations and to take dating uncertainties into account (dashed line). Here, the fraction of significant positive correlations is used.

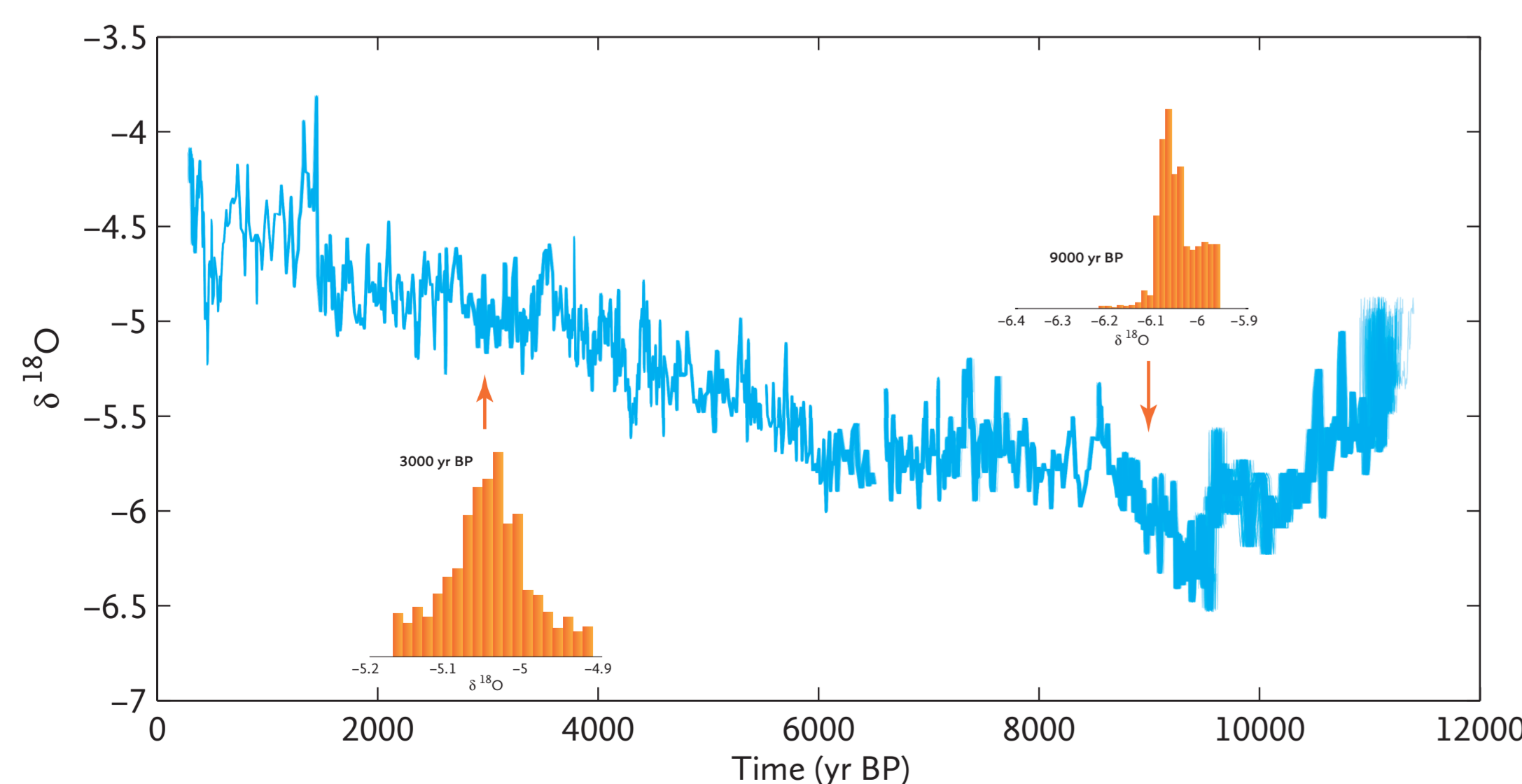
Both proxy records replicate well; differences are caused by unresolved processes influencing the dating procedure. A correction function can be extracted that reduces the uncertainties in the dating procedure.

## ENSEMBLE BASED DATA

Dating uncertainties are considered by many realisations of the age model, providing an ensemble of proxy records (e.g., by using COPRA).



Ensemble of age models (detail of an arbitrary example) reflecting the dating uncertainties.



Ensemble of a proxy record (arbitrary example) considering the dating uncertainties.