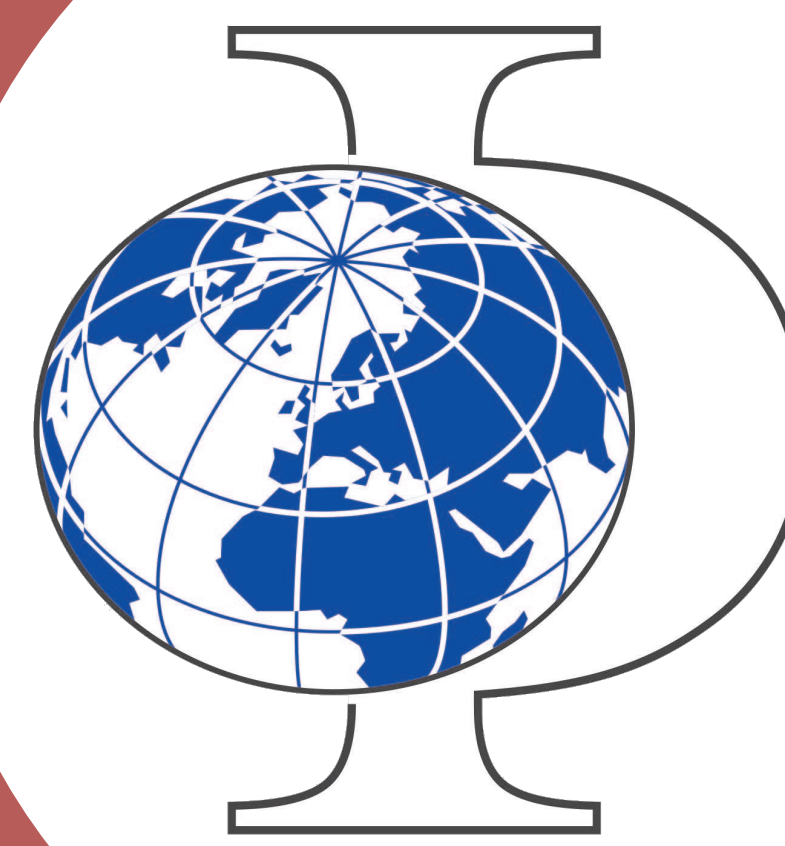




Comparison of isotopic signatures in speleothem records and model simulations for the past millennium

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1 Motivation

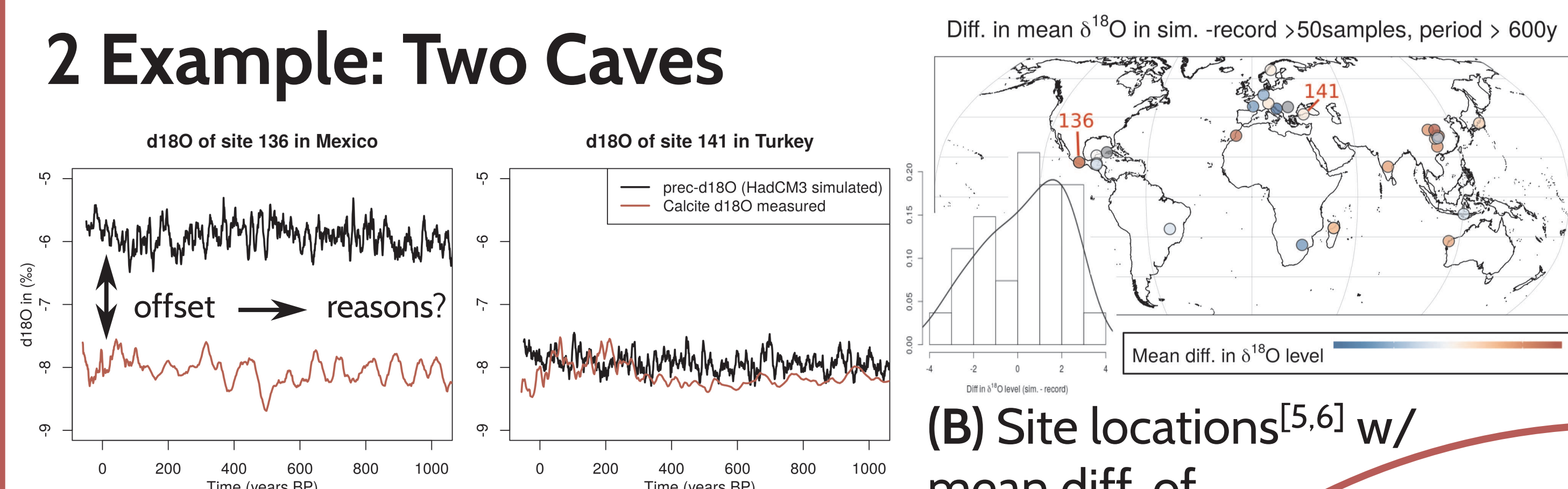
Global changes in climate not only affect its mean, but also its variability^[1], and thus living conditions on Earth. Model-data comparison between climate simulations and paleoclimate archives can test and validate the capability of general circulation models (GCMs) to simulate changes in variability.

However, the precisely dateable and well preserved (semi-)continuous $\delta^{18}\text{O}$ signal in speleothem calcite^[2] doesn't directly represent the local $\delta^{18}\text{O}$ composition of precipitation. We compare modeled changes in $\delta^{18}\text{O}$ over the last millennium in mean (2) and correlations (3, 5) with the aim to assess the isotope-enabled model's^[3,4] capability to simulate climate variability beyond the instrumental period.



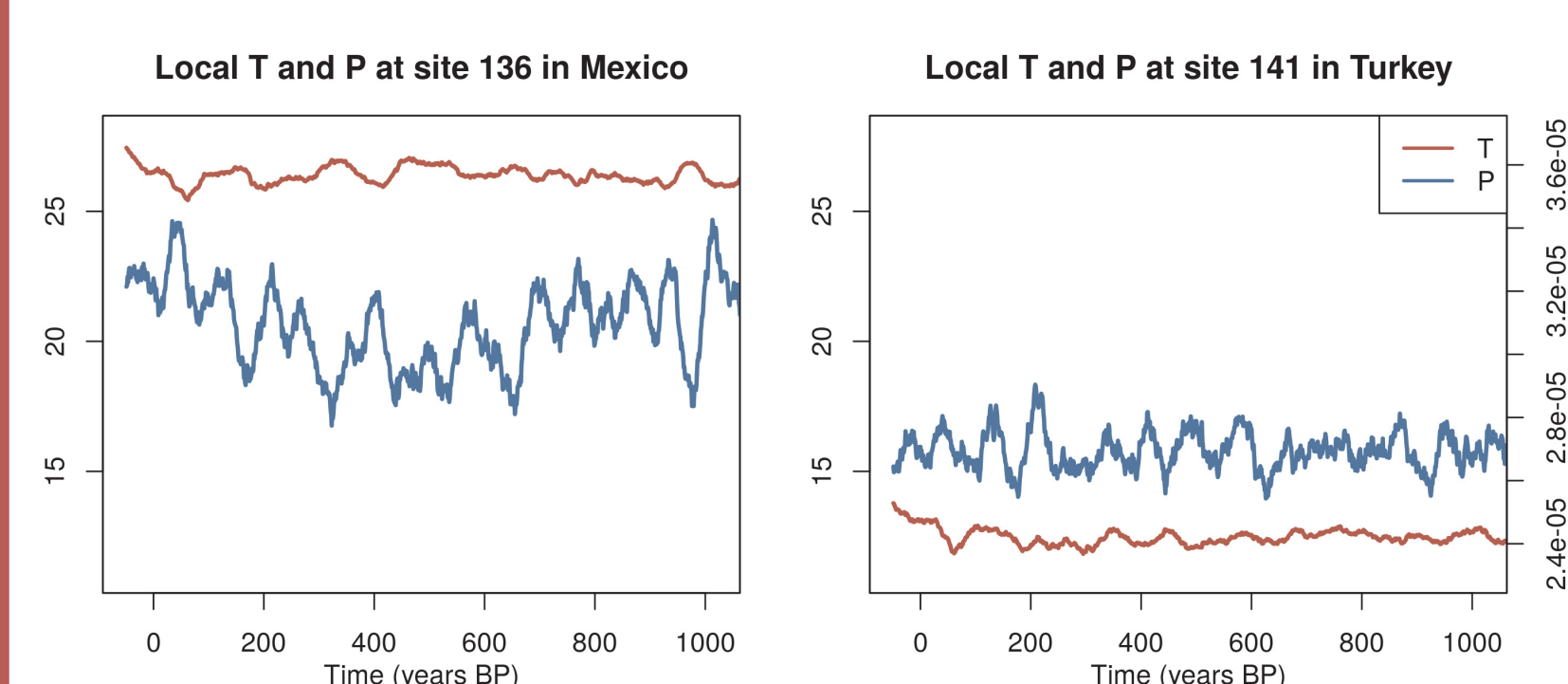
(A) Schematic of a PSM interacting between different types of both models and proxies

2 Example: Two Caves



(B) Site locations^[5,6] w/ mean diff. of $\delta^{18}\text{O}$ over last 1ky

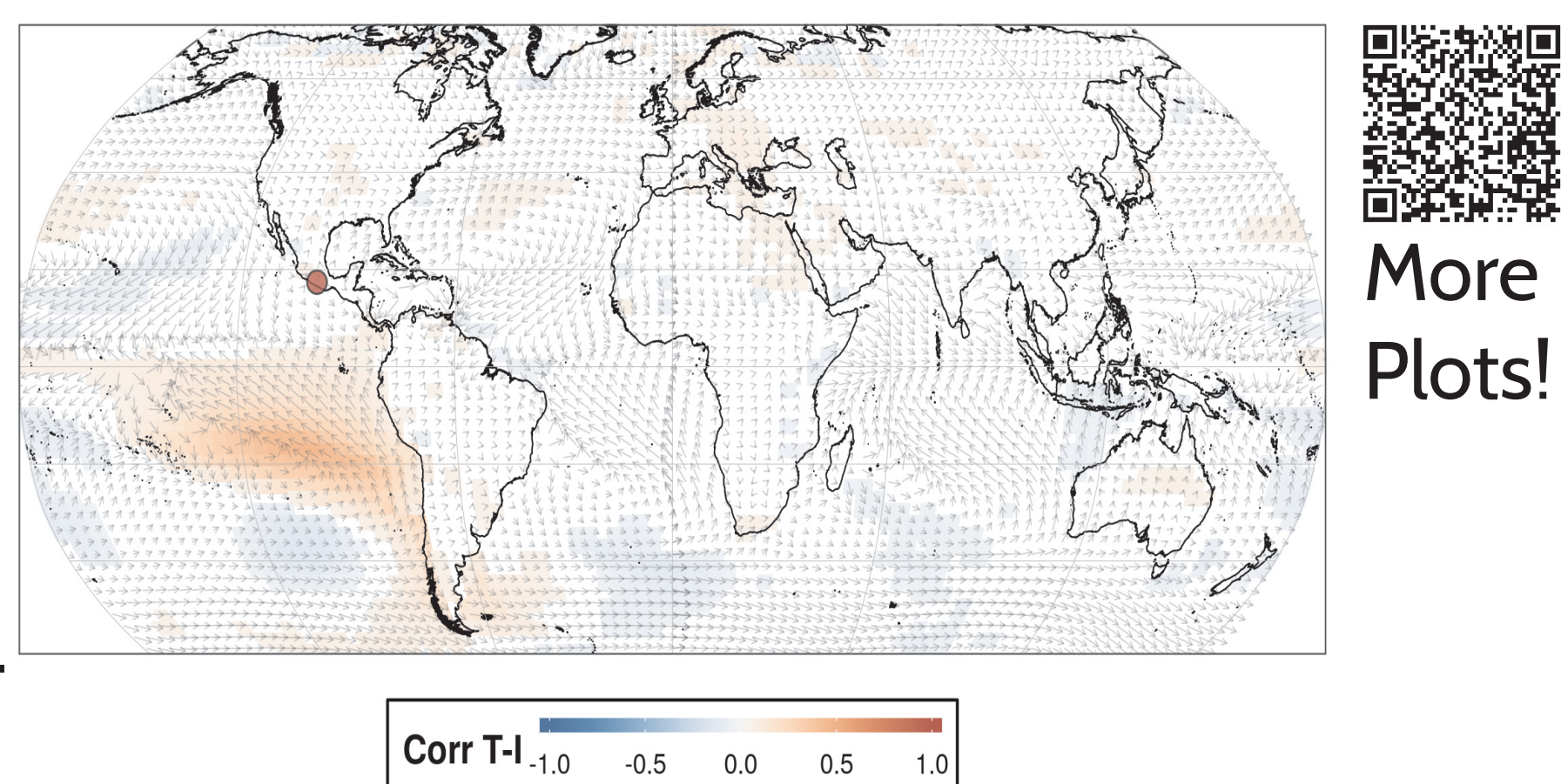
Calcite $\delta^{18}\text{O}$ can be influenced by both local precipitation (P) and temperature (T) but also other factors (e.g. evapo-transpiration, parent rock, vegetation) play a role.



3 Correlation Analysis

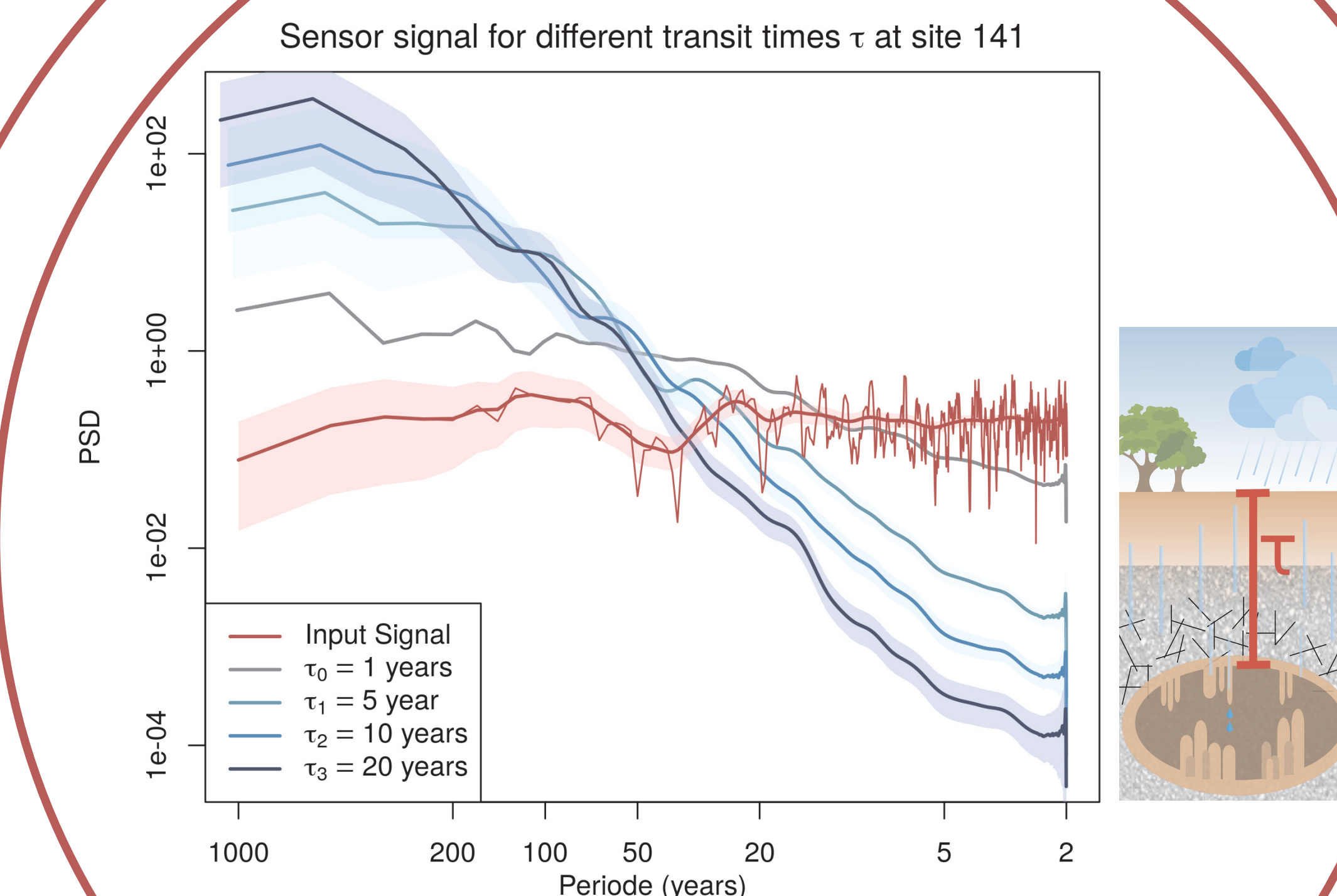
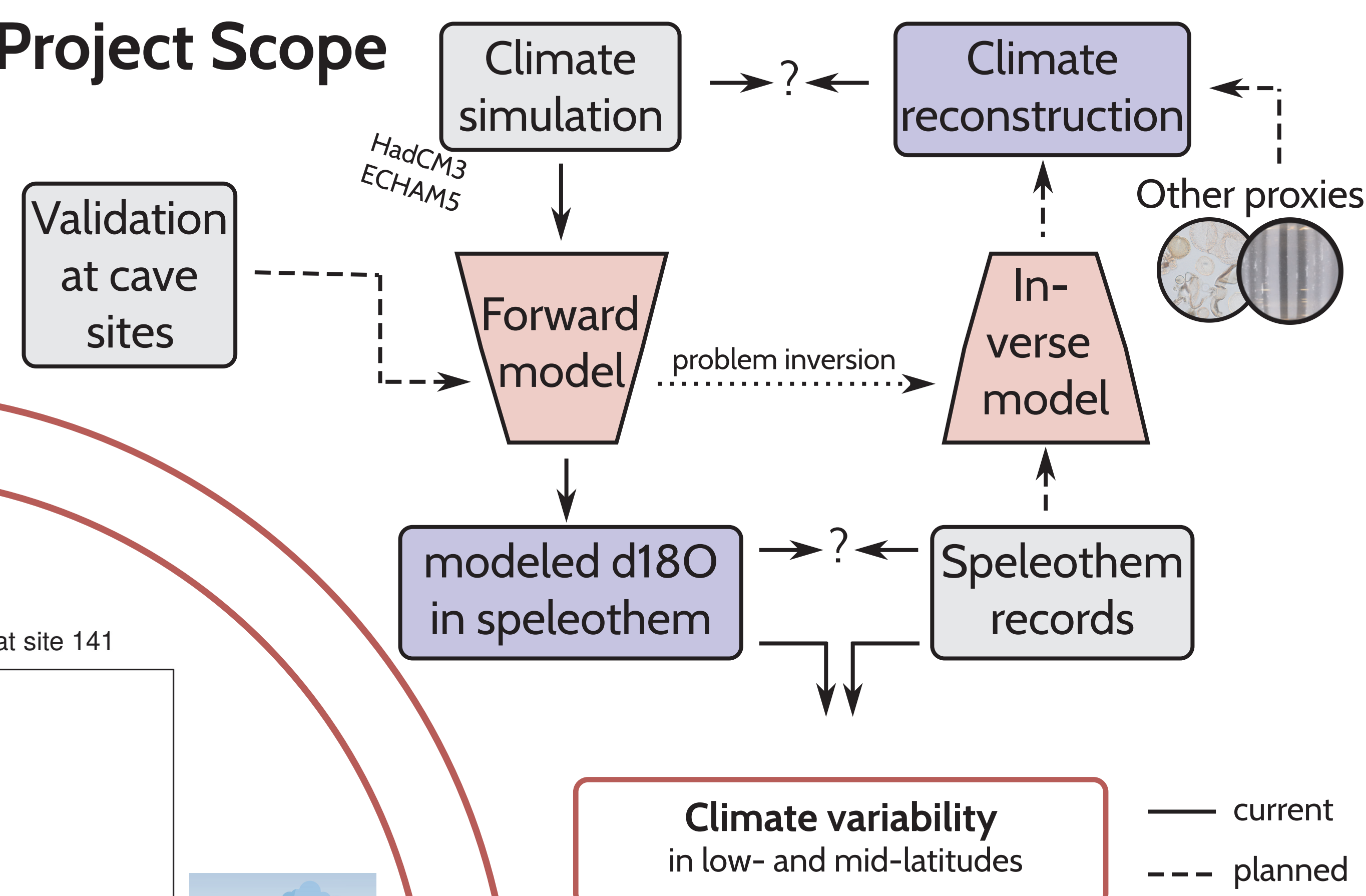
Correlation patterns of records from SISAL database^[5,6] (top) differ from those of simulated P- $\delta^{18}\text{O}$ from HadCM3^[3,4] (bottom).

(D) Point corr.-map for example cave site 136 (2) T w/ local isot.-comp. including wind, $p < 0.1$



(C) Cross-correlation table of selected entities. 'X' = insignificant ($p > 0.1$)

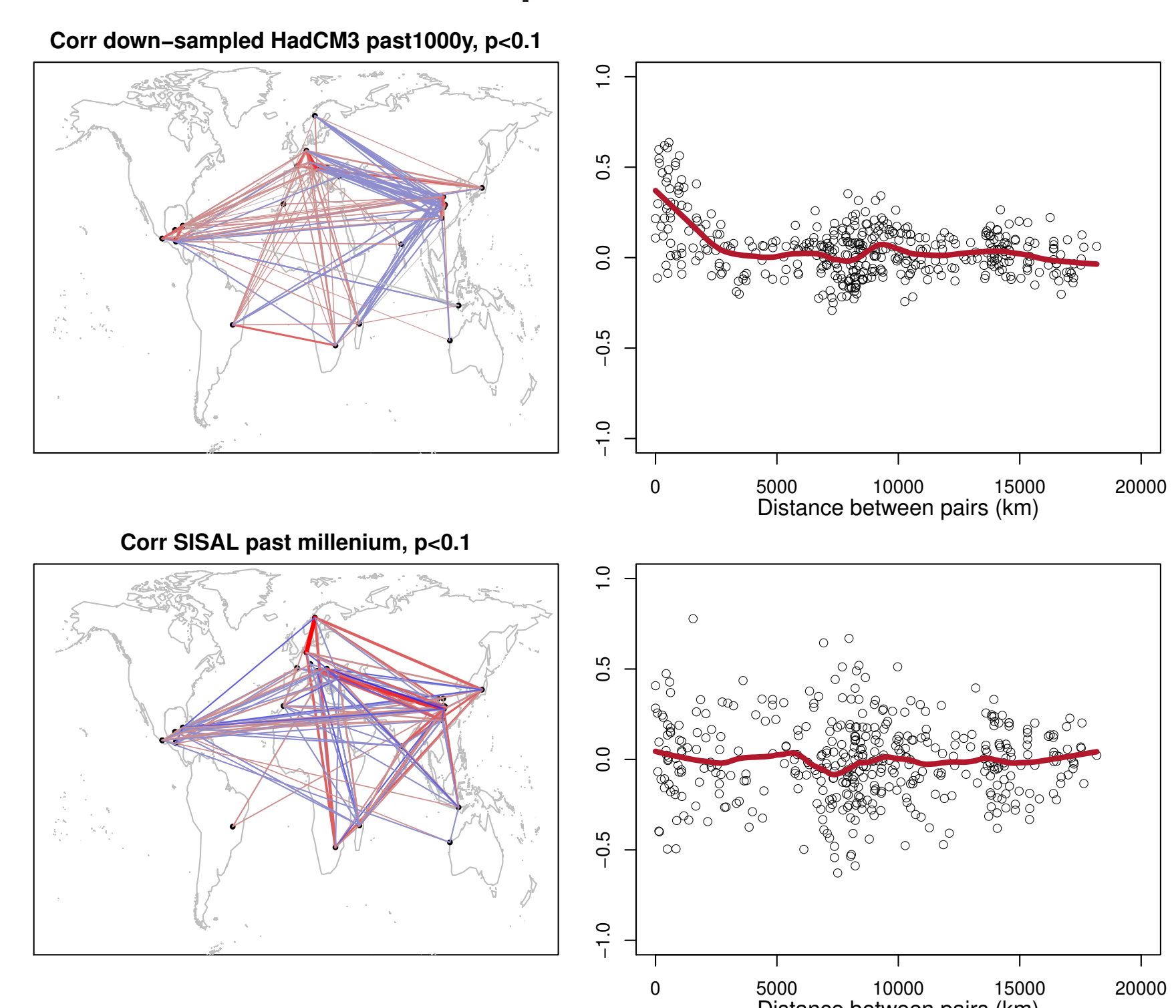
4 Project Scope



(E) PSM filter characteristics: transit time τ strongly influences the variability of the signal on different time scales^[7,8].

5 Network Analysis

(F) Cross-corr. btw caves for last 1000y. Sim. down-sampled to res. of records.



Network (left) and correlation decay over distance (right) for HadCM3 (top) and SISAL cores (bottom).

6 Outlook

- Compare $\delta^{18}\text{O}$ gained from forward model to $\delta^{18}\text{O}$ from record by correlation, trend, spectral analysis
- Include other past millenium simulations for model-data comparison
- Cave site validation and forward model optimization

7 Acknowledgements



8 References

- [1] Katz, R. & Brown, B., Clim.Change 21, 289-302 (1992)
- [2] Wong, C. et al., QSR 127, 1-18 (2015)
- [3] Gordon, C. et al., J. Clim. Dyn.16, 147-168 (2000)
- [4] Tindall, J. C. et al. J. Geophys. Res. Atmos. 114, 1-12 (2009)
- [5] Atsawawaranunt, K. et al, ESSD 10, 1687-1713, (2018)
- [6] Comas-Bru, L. et al, CLIM PAST 15, 1557-1579 (2019)
- [7] Dee, S. et al., J Adv Model Earth Sy 7, 1220-1247 (2015)
- [8] Wackerbarth, A. et al., Earth Planet Sc Lett 299, 387-397 (2010)

