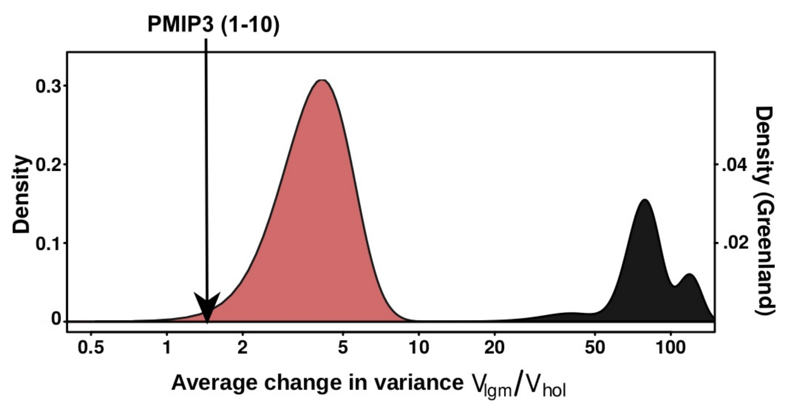
A spatio-temporal view of variability in pollen records during the last Glacial

Nils Weitzel, Moritz Adam, Anna Sommani, Kira Rehfeld
Institute of Environmental Physics, Heidelberg University, Germany

1 Introduction

Climate variability influences the probability of extreme events and is therefore of great importance for risk management. Nevertheless, changes in climate variability over time are far less studied than changes in the mean state of the climate system[1,2,3].



(A) Variability change in proxy data from LGM to Holocene[3]

Pollen records can be used to estimate the dependency of climate variability on the state and timescale, but their climate signal is perturbed by non-climatic processes and dating uncertainties. Our work extends previous estimates for the Holocene and Last Glacial Maximum (LGM) [3] (Fig A) to the terrestrial realm and to longer timescales.

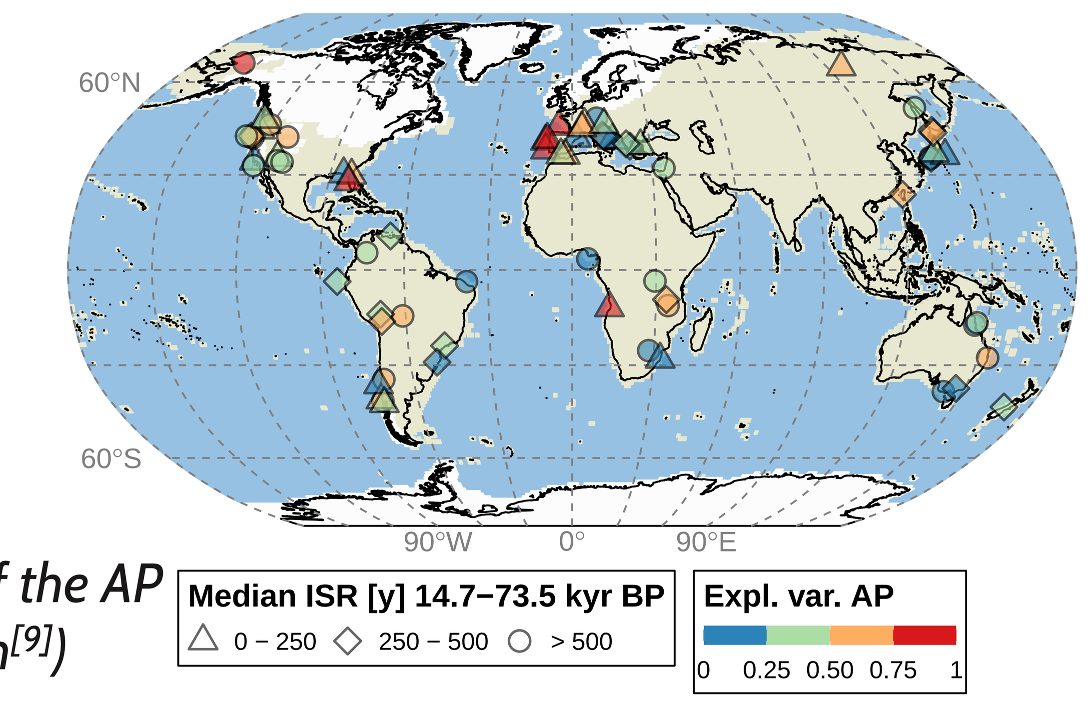
2 Data and methods

We use 74 records from the global pollen database ACER[4] which cover a sufficient part of the last Glacial (Fig. B). The database provides a harmonized taxonomy and chronology. Many records have a high resolution (median intersample range below 500yr).

We extract the arboreal pollen (AP) fraction of each sample. Using redundancy analysis[5,6], we compute the explained variance of the AP signal for each record (Fig B). We find that AP fraction explains a substantial part of the variability between MIS4 and MIS2 in most records.

We then fit Bayesian Generalized Additive Models with Beta response to each record[7,8]. We jointly estimate non-parametric processes for the mean (orbital scale) and variability (sub-orbital scale).

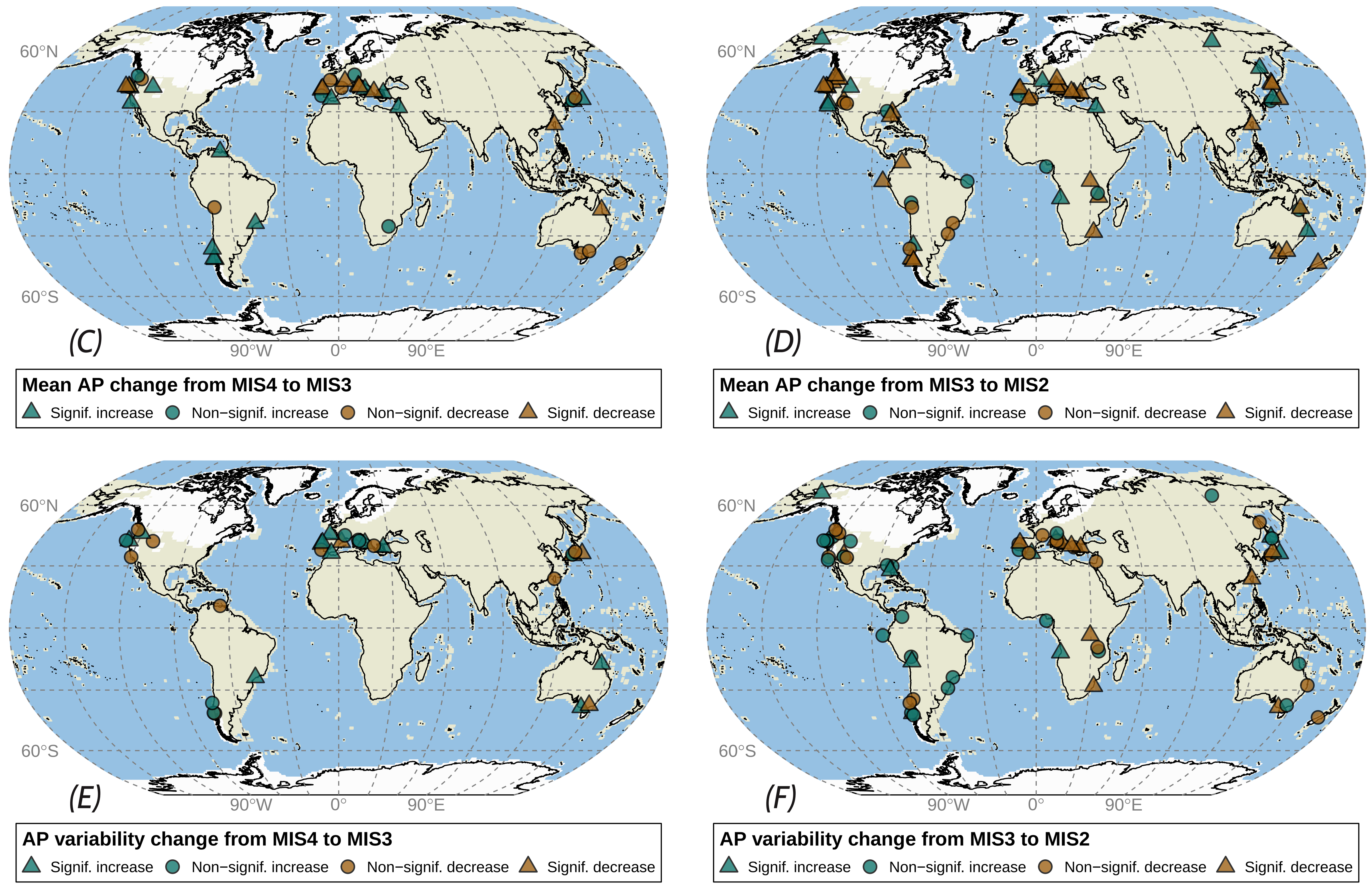
Finally, we extract and compare the AP mean fraction and sub-orbital variability during MIS4 (73.5-59.4kyr BP), MIS3 (59.4-27.8kyr BP), and MIS2 (27.8-14.7kyr BP).



(B) Resolution of the ACER records and explained variance of the AP signal (Background: ICE6G land-ice-sea-mask reconstruction[9])

3 Results

- Heterogeneous mean changes from MIS4 to MIS3 (Fig. C), but mostly decreasing AP fraction from MIS3 to MIS2 (Fig. D).
- Increasing sub-orbital AP variability from MIS4 to MIS3 (Fig. E). Increasing variability in the Americas from MIS3 to MIS2, but decreasing variability in Europe (Fig. F).
- Mean changes more often statistically significant than variability changes.



4 Outlook

- Study robustness of estimates
- Compare with alternative signals in pollen records
- Compare with climate and vegetation simulations of glacial climate
- Compare with other proxy types

References

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All analyses were performed in R v3.6.3 [10].

nweitzel@iup.uni-heidelberg.de
uni-heidelberg.de/palaeoclimate-dynamics