Reconstructing Eastern Mediterranean Cyclone and Precipitation Characteristics during the Last Interglacial: Insights from PMIP4 Simulations

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Introduction

The Last interglacial (LIG) between 133-115 ka is characterized by an elevated average global temperature, rising sea levels, and increasing CO_2 concentration. During the peak of the LIG (127 ka), proxy-based reconstructions suggest that the East Mediterranean region and Levant experienced abrupt wet conditions during an otherwise hyper-arid period. The evidence suggests that during the peak of the LIG, relatively wetter conditions persisted in the southern Levant, and across the eastern Sahara, Red Sea, and Arabia, compared with other LIG times. According to climate reconstructions, some of the precipitation occurred in powerful and brief events[1], which are more characteristic of systems with tropical influences. In previous studies using climate models, only an increase in precipitation was observed, but the source of this increase not identified. The purpose of this work is to compile and analyze climate models to reconstruct proxy-based climate data, specifically to determine the sources.

Figure 1: *Map of the Levant*

Methods

- Semi objective synoptic classification.
- Delta Precipitation-Evaporation. Calculation of the changes in the wind field and the humidity field. Decomposition into a dynamic and thermodynamic component.

Abbreviations

AWI- Alfred Wagner Institute.
EC- *European community* Earth 3 model, ERA 5- *ECMWF Reanalysis V 5.*
CL - Cyprus Low ,**RST**-Red Sea Trough.
SON -September, October, November.
DJF- December, January February.
MAM-March, April, May.
JJA- June, July, August.

Results

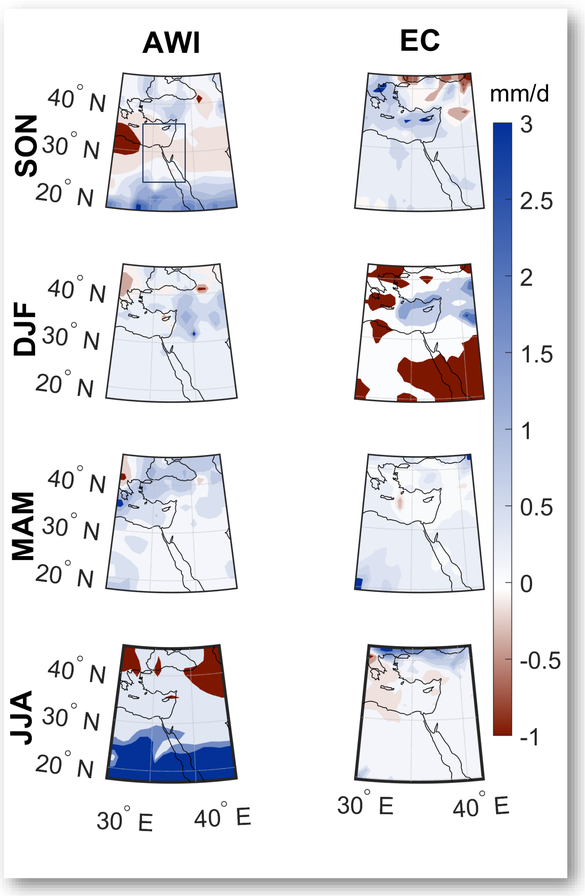

Figure 2: Differences in precipitation [mm/d] between LIG - PI. In each of the seasons, the square in the first panel indicates the area where the synoptic classification was made

We conducted a comparison between two models to interpret the seasonal precipitation amounts. In both models, a difference in winter precipitation between the LIG and Pre-Industrial (PI) periods can be observed. However, in the AWI model, we also see a difference in summer precipitation

In both models, the local seasonality of the synoptic systems can be observed. Summer is characterized by PT systems, and winter by precipitation systems such as CL. No change in the frequency of the systems throughout the year is evident. In summer, there are almost no precipitation systems like CL and RST. In the other months, there are differences, but most of them are not statistically significant

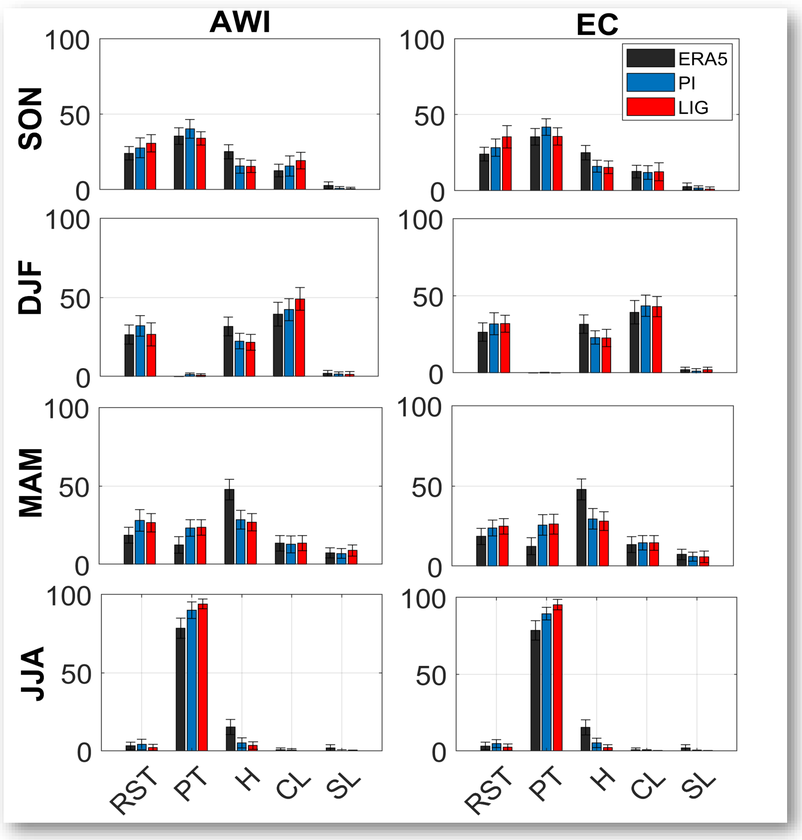

Figure 3: Synoptic classification seasonal frequencies.

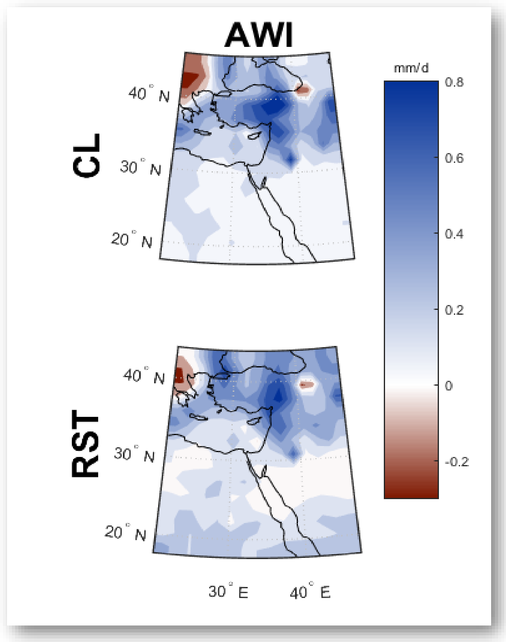

Figure 4: Differences in precipitation [mm/d] for precipitation system Red Sea Trough [RST], Cyprus Low [CL] between Last Interglacial [LIG], Pre-industrial [PI]. At AWI Alfred Wagener Institute-Germany

On CL days, we observe an increase in precipitation primarily in the northern Levant, which aligns with the behavior of the CL system. On RST days, in addition to an increase in the northern Levant, there is also an increase in the south. However, as indicated by the classification, the increase in precipitation from these systems does not explain the overall increase in summer precipitation. Increase in precipitation in summer and autumn the rise the thermodynamic component, with increased moisture transport to the southern Levant during the LIG compared to the PI period. In winter and spring, the increase is related to the dynamic component

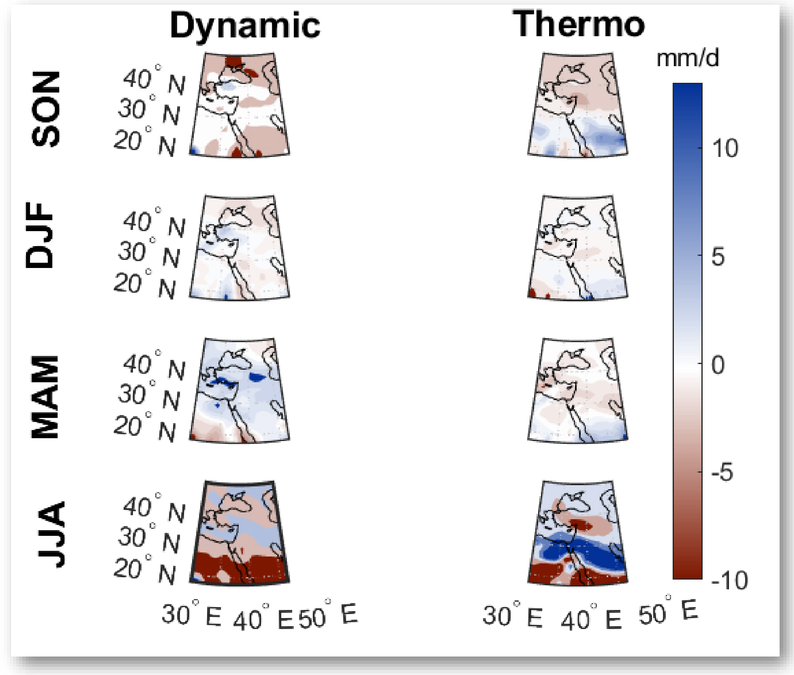

Figure 5: The dynamic and thermodynamic components of delta precipitation – evaporation, ΔP − E in the AWI model [mm/d] .

Conclusions

- Only the AWI model is compatible with proxy-based reconstructions. This model shows an increase precipitation during the summer south Levant.
- On average, CL days display an increase in precipitation of 17.3 % per day and 23.3 % on RST day .
- An increase in summer precipitation is a thermodynamic component.

References

[1] Palchan, D., Stein, M., Goldstein, S. L., Almogi-Labin, A., Tirosh, O., & Erel, Y. (2018). Synoptic conditions of fine-particle transport to the last interglacial Red Sea-Dead Sea from Nd-Sr compositions of sediment cores. *Quaternary Science Reviews*, *179*, 123-136.

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