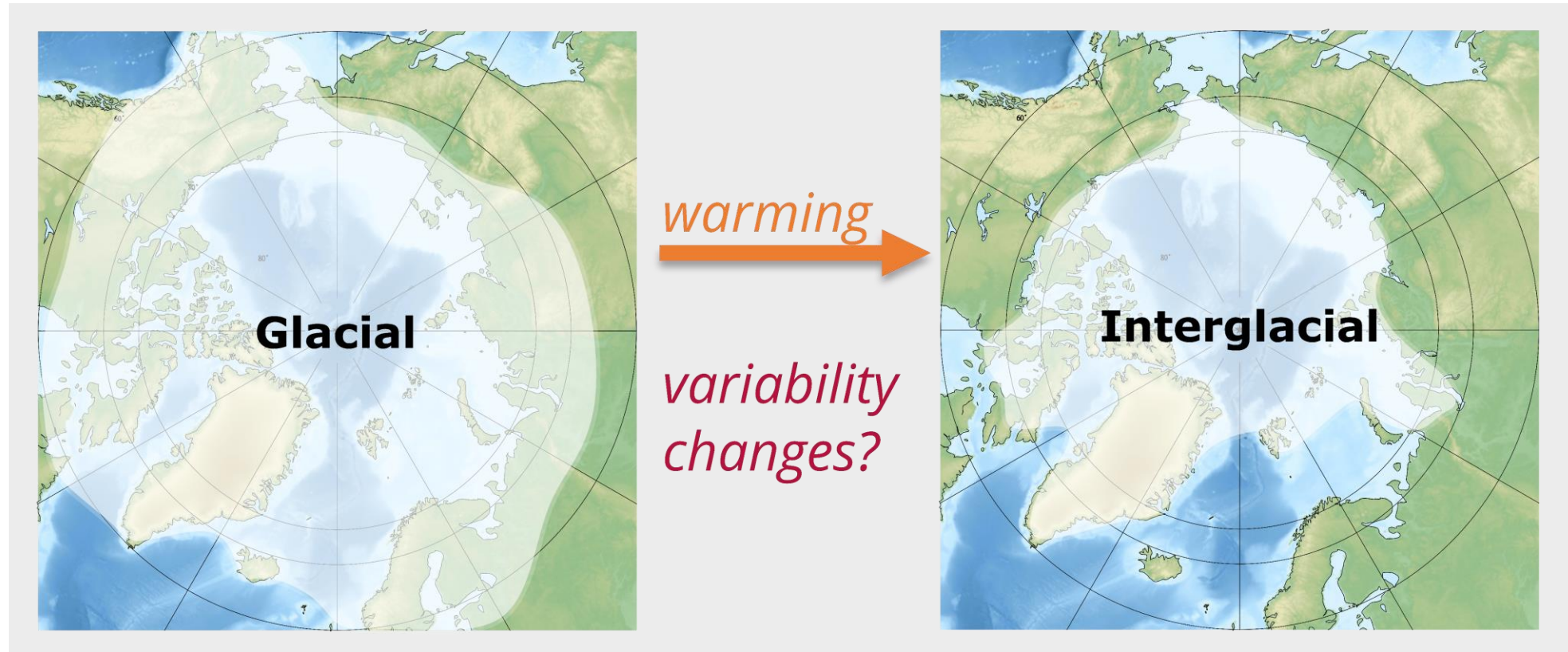


State-dependent effects of natural forcing on global and local climate variability

B. Ellerhoff, M. J. Kirschner, E. Ziegler, M. D. Holloway, L. C. Sime, K. Rehfeld



Paper: <https://doi.org/10.1029/2022GL098335> | **Data:** <https://doi.org/10.5281/zenodo.6074747> | **Code:** <https://doi.org/10.5281/zenodo.6474769>

mail: beatrice.ellerhoff@iup.uni-heidelberg.de
web: <https://uni-tuebingen.de/de/220608>



EBERHARD KARLS
UNIVERSITÄT
TÜBINGEN



Idealized title figure drawn based on
own data and map from Sémhur
([Wikimedia Commons](https://commons.wikimedia.org/wiki/File:Sémhur_Arctic_map.png), CC-BY-SA-3.0)



State-dependent effects of natural forcing on global and local climate variability

B. Ellerhoff, M. J. Kirschner, E. Ziegler, M. D. Holloway, L. C. Sime, K. Rehfeld



Geophysical Research Letters®

RESEARCH LETTER

10.1029/2022GL098335

Contrasting State-Dependent Effects of Natural Forcing on Global and Local Climate Variability

Beatrice Ellerhoff^{1,2} , Moritz J. Kirschner² , Elisa Ziegler^{1,2} , Max D. Holloway³ , Louise Sime⁴ , and Kira Rehfeld^{1,2}

¹Department of Geosciences and Department of Physics, Tübingen University, Tübingen, Germany, ²Institute of Environmental Physics, Heidelberg University, Heidelberg, Germany, ³Scottish Association for Marine Science, Oban, UK, ⁴British Antarctic Survey, Cambridge, UK



Paper: <https://doi.org/10.1029/2022GL098335> | **Data:** <https://doi.org/10.5281/zenodo.6074747> | **Code:** <https://doi.org/10.5281/zenodo.6474769>

Mail: beatrice.ellerhoff@iup.uni-heidelberg.de

Web: <https://uni-tuebingen.de/de/220608>



EBERHARD KARLS
UNIVERSITÄT
TÜBINGEN



Idealized title figure drawn based on own data and map from Sémhur (Wikimedia Commons, CC-BY-SA-3.0)



12 HadCM3 climate model simulations for a Glacial and Interglacial state

12-MEMBER SIMULATION ENSEMBLE

Time-varying forcing:

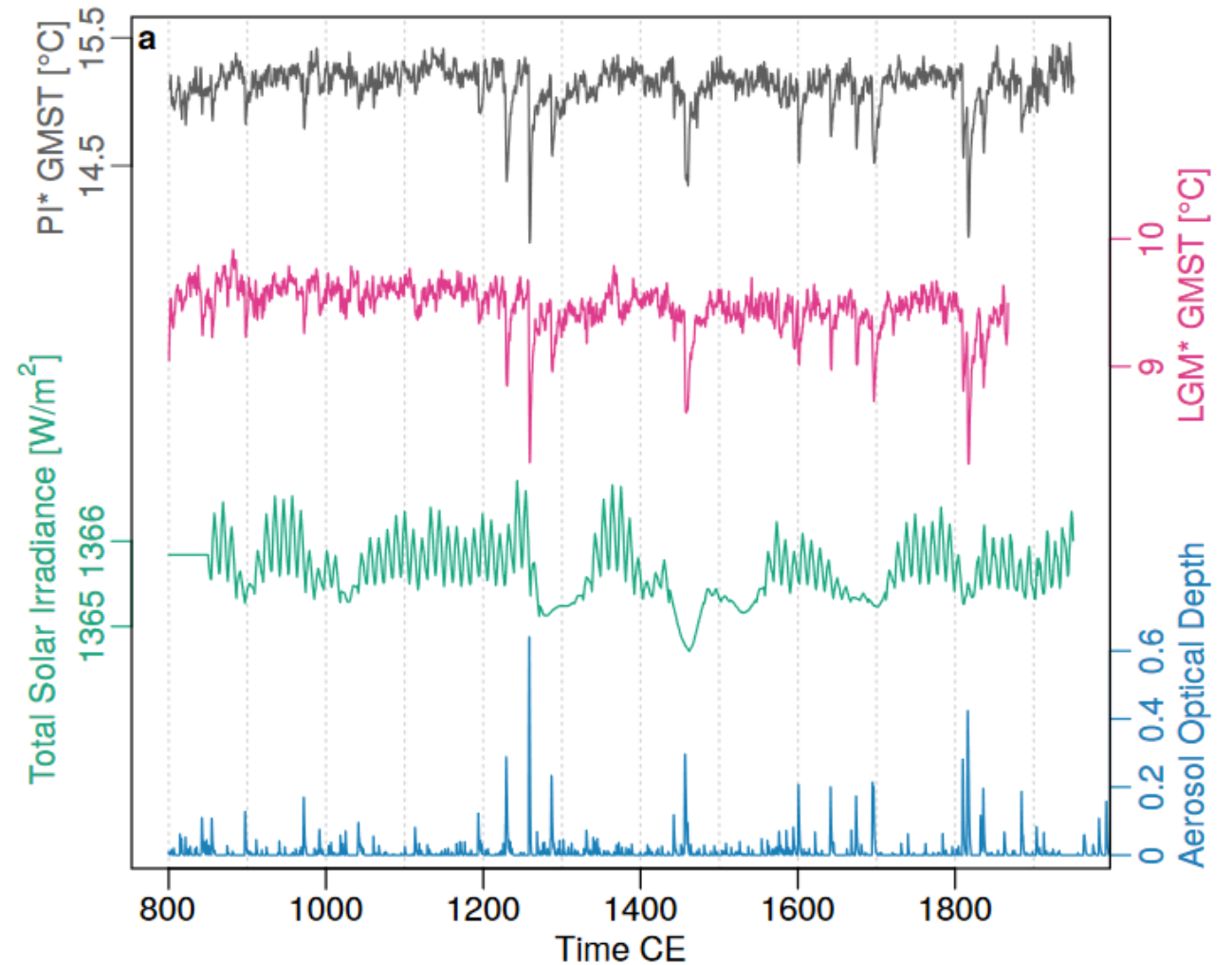
- ❖ Natural forcing (solar & volcanic)
- ❖ No transient forcing

Boundary conditions:

- ❖ Last Glacial Maximum (LGM)
- ❖ Pre-Industrial (PI)

Three runs for each configuration:

- ❖ LGM*, LGM, PI*, PI (*=forced)



Experiments to investigate state-dependency of global and local variability

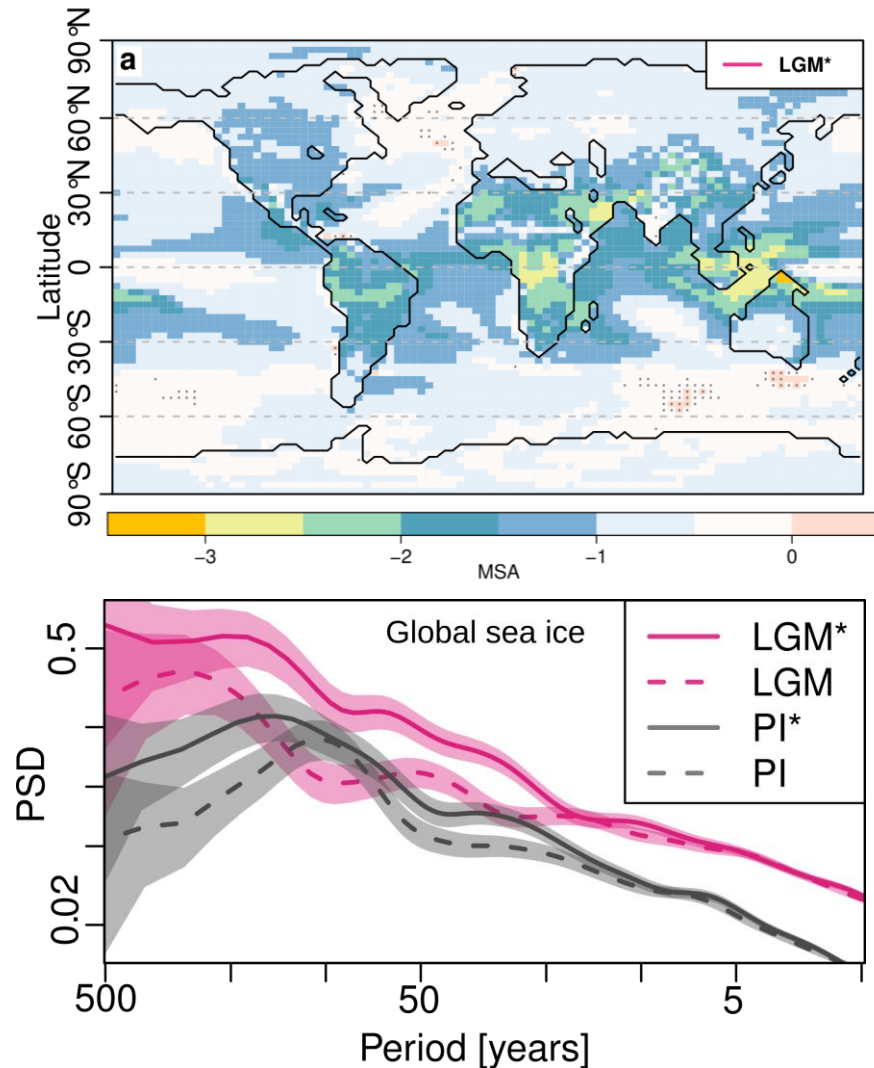
OUR STUDY

Comparison of:

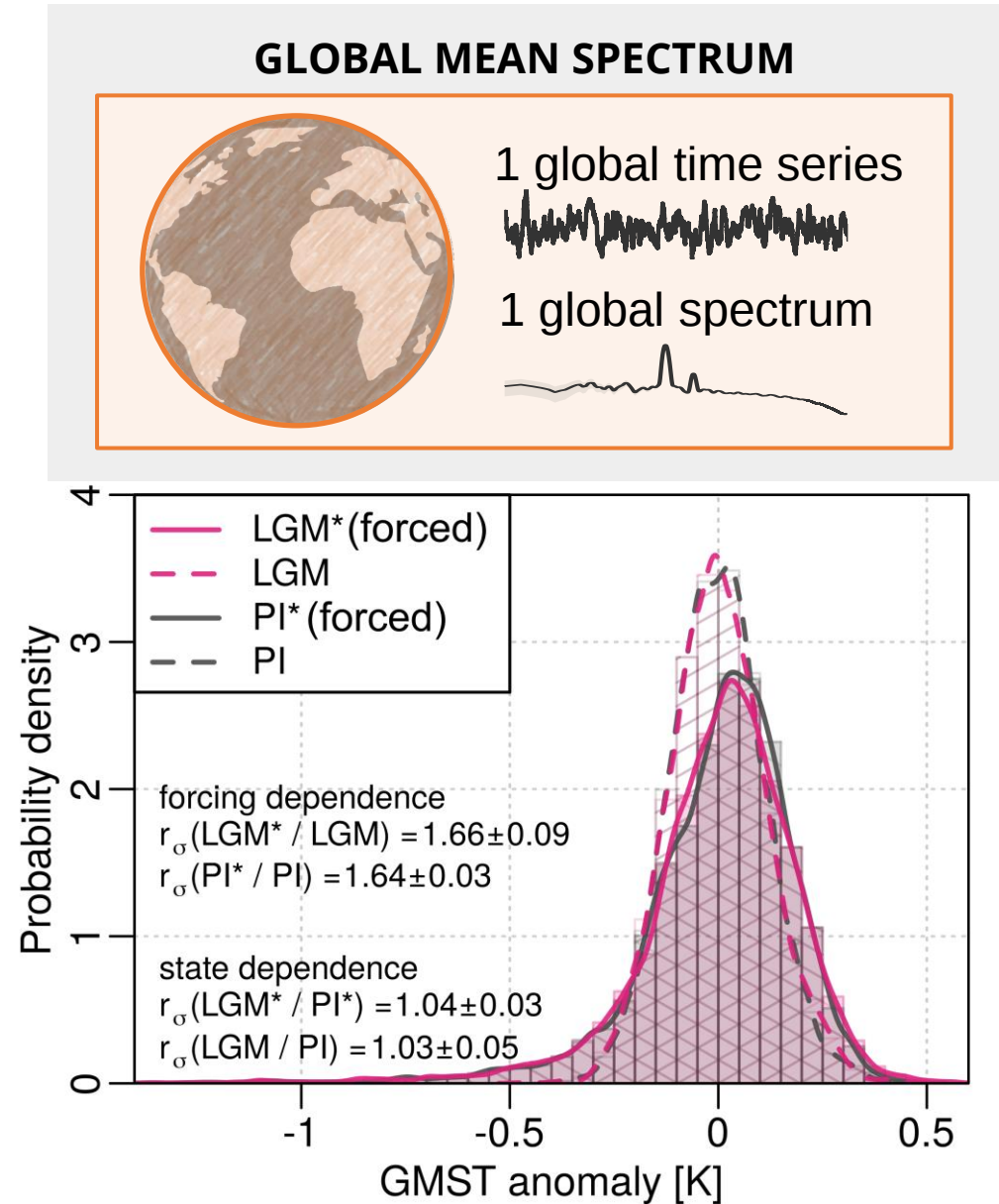
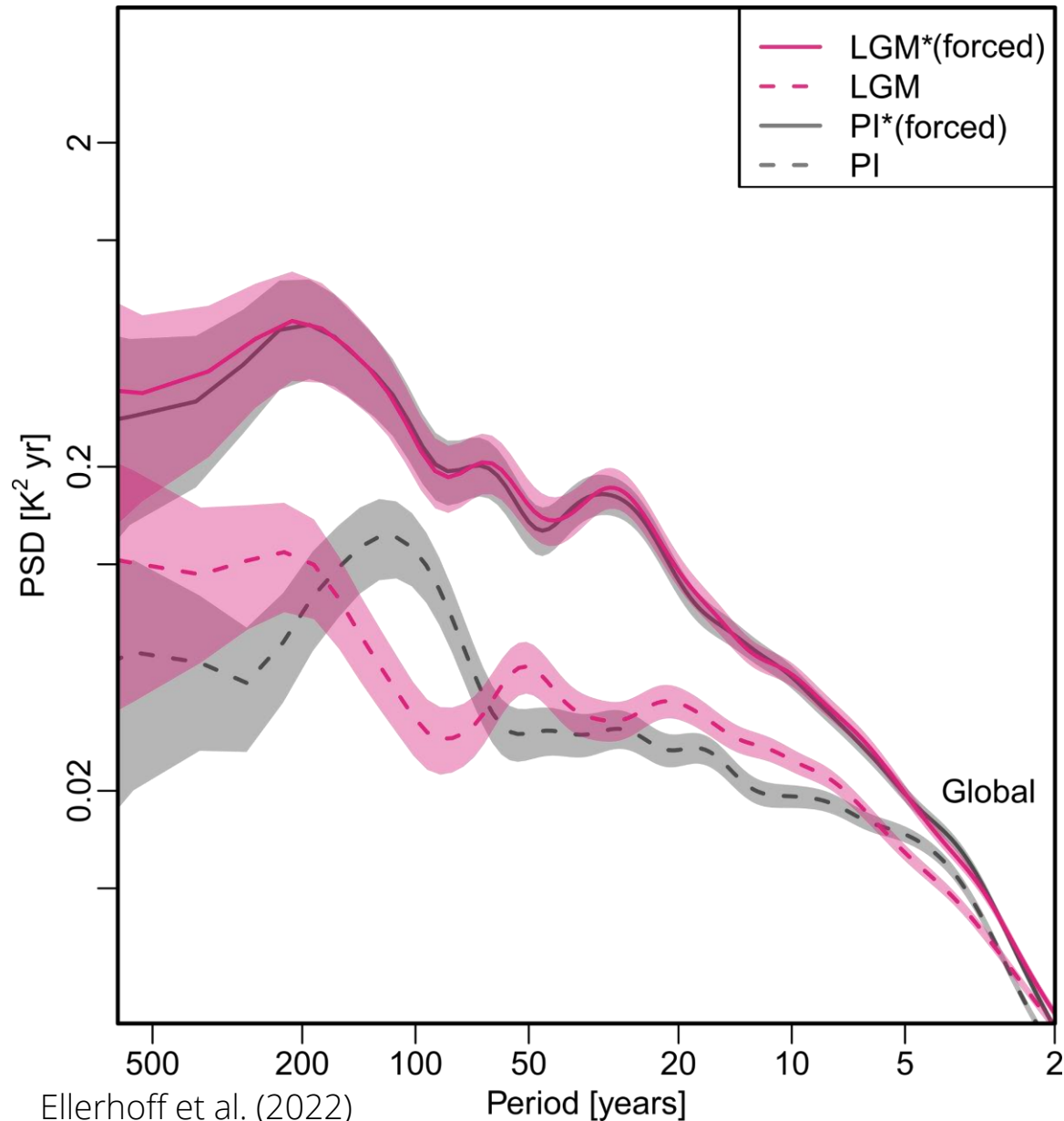
- ❖ forced & internal variability
- ❖ local, zonal & global variability
- ❖ timescale-dependent variance from paleoclimate data & simulations

Focus on:

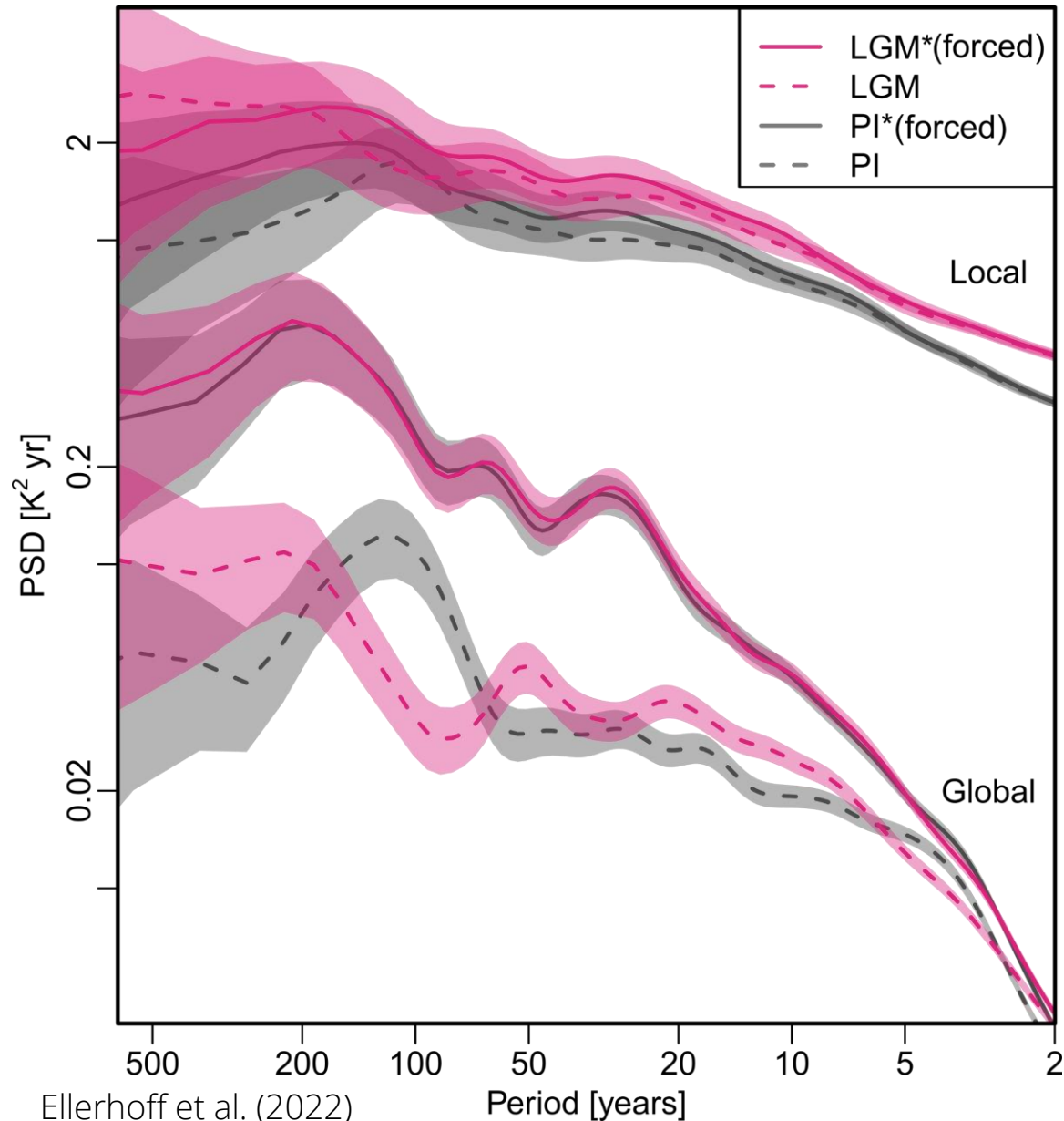
- ❖ local surface climate response to volcanic eruptions
- ❖ Sea ice dynamics as a mechanism of long-term variability



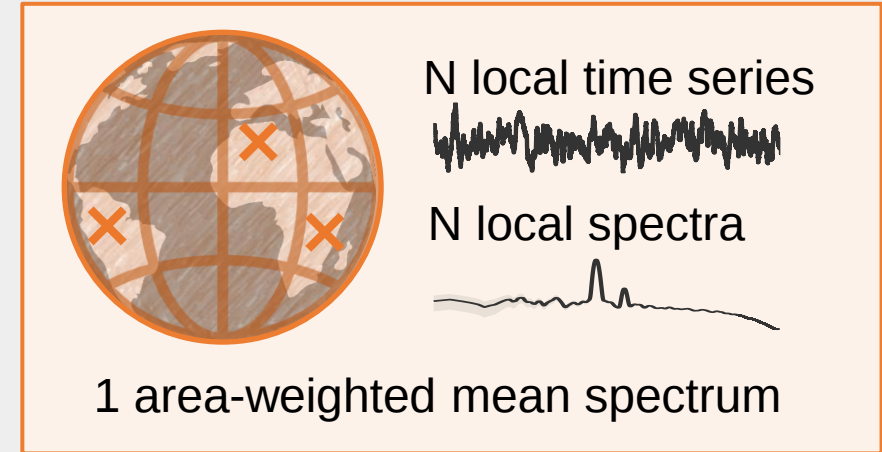
No state-dependent effect of natural forcing on global mean temperature



Mean decrease in local variability with warming



LOCAL MEAN SPECTRUM



- ❖ **Globally:** no state- but forcing-dependency
- ❖ **Locally:** decreased variability with warming
- ➔ Investigate zonal spectra & local response to volcanic eruption
- ➔ Validate against paleoclimate data

Conclusion

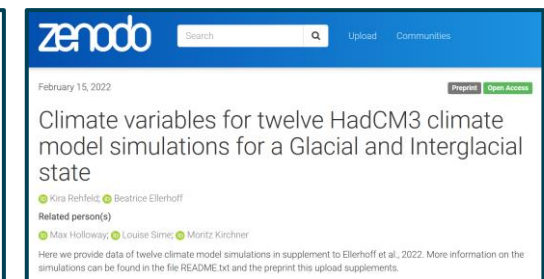
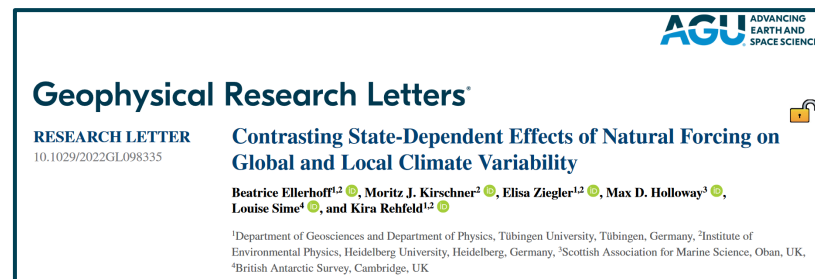
- ❖ Low state-dependent effects as global & local response is similar across states
- ❖ Local state-dependent variability where ice can form
- ❖ Natural forcing contributes to long-term variability & improves data-model mismatches



High-frequency forcing and representation of **sea ice dynamics**
important for **simulated variability** and data-model comparison



Questions?



Paper: <https://doi.org/10.1029/2022GL098335> | **Data:** <https://doi.org/10.5281/zenodo.6074747> | **Code:** <https://doi.org/10.5281/zenodo.6474769>



EBERHARD KARLS
UNIVERSITÄT
TÜBINGEN



HEINRICH BÖLL STIFTUNG
Die grüne politische Stiftung



GERMAN
CLIMATE
MODELING
INITIATIVE



References

Paper: B. Ellerhoff, M. J. Kirschner, E. Ziegler, M. D. Holloway, L. C. Sime, K. Rehfeld: Contrasting state-dependent effects of natural forcing on global and local climate variability, GRL, <https://doi.org/10.1029/2022GL098335> (2022)

Data: Rehfeld , B. Ellerhoff: Climate variables for twelve HadCM3 climate model simulations for a Glacial and Inter-glacial state, <https://doi.org/10.5281/zenodo.6074747> (2022)

Code: B. Ellerhoff, M. J. Kirschner, E. Ziegler, M. D. Holloway, L. C. Sime, K. Rehfeld: Code in supplement to "Contrasting state-dependent effects of natural forcing on global and local climate variability" <https://zenodo.org/record/6474769>

Data and Figure References

G. A. Schmidt et al., Climate forcing reconstructions for use in PMIP simulations of the Last Millennium (v1.1), Geoscientific Model Development (2012)

T. J. Crowley and M. B. Unterman, Technical details concerning development of a 1200 yr proxy index for global volcanism, Earth System Science Data (2013)

F. Steinhilber et al., Total solar irradiance during the Holocene, Geophysical Research Letters (2009)

Y. Wang et al., Modeling the Sun's Magnetic Field and Irradiance since 1713, The Astrophysical Journal (2005)

The idealized title figure uses the map from Sémhur ([Wikimedia Commons](#), CC-BY-SA-3.0). We have drawn an approximate and idealized land and sea ice extent for the Last Glacial Maximum and Pre-Industrial based on own simulation data.

The summary and conclusion slide uses icons from freepik.com and <https://www.flaticon.com/authors/vectors-market>