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UNIVERSITY OF TEXAS ARLINGTON

National Science Foundation
WHERE DISCOVERIES BEGIN

SIMULATION OF CLIMATE ACROSS THE PERMIAN-TRIASSIC BOUNDARY WITH AN EMPHASIS ON THE PHYTO-GEOGRAPHICAL DATA ANALYSIS

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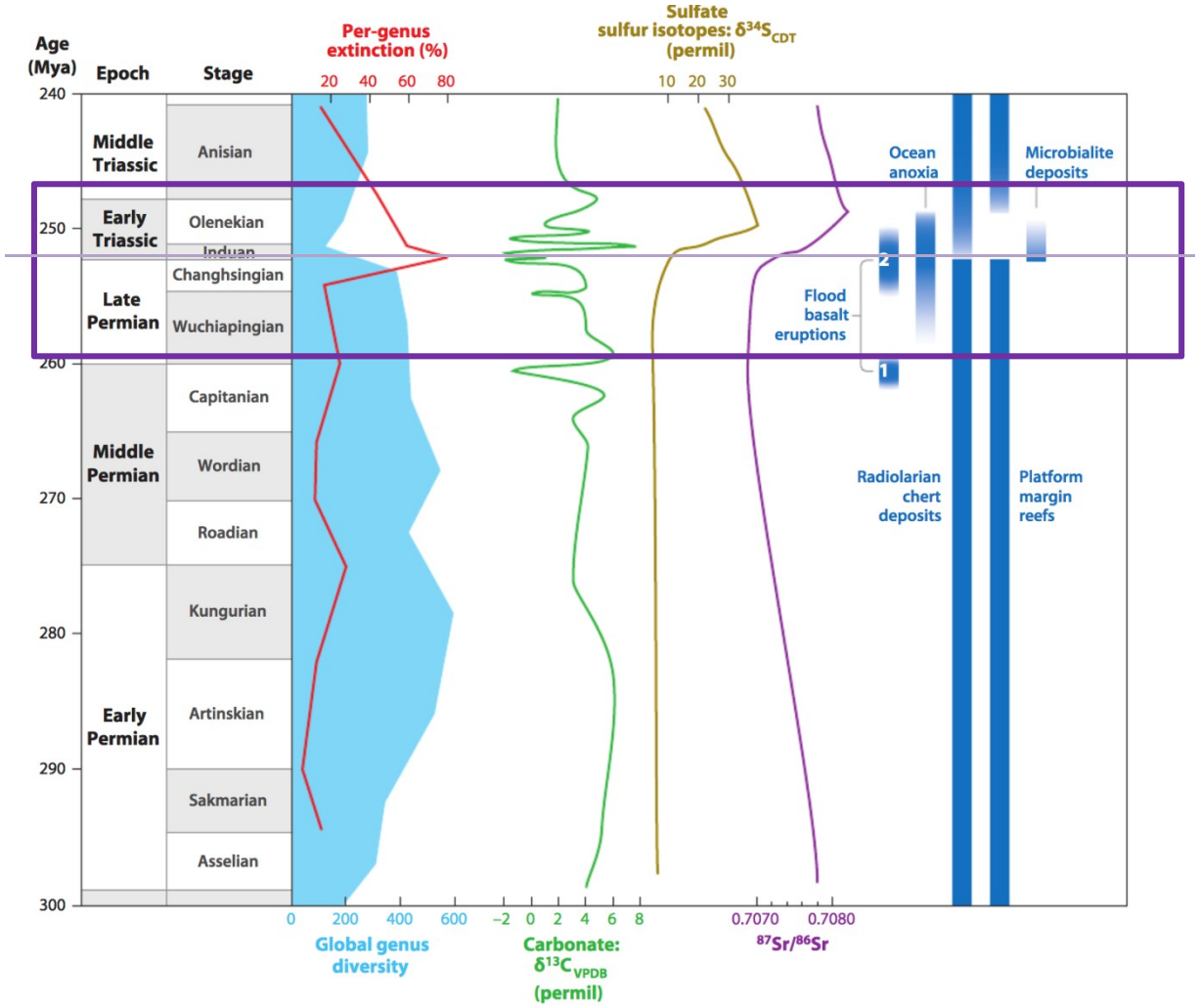
1.1 The End Permian Mass Extinction Event



Payne and Clapham, 2012

The End Permian Mass Extinction (EPME) occurred ~251.9 Ma (Shen et al.,2006)

Around 90% of marine and 70% of terrestrial species went extinct - also referred as "*The Great Dying Event*" (Erwin, 1990)

2. Objectives

- How did the seasonality change across the PTB?

- How did phyto-geographic patterns change due to changes in seasonality caused by aerosol and CO_2 radiative forcing?

- How much radiative forcing is required to simulate a climate consistent with the reconstructed biogeographic patterns?

3.1 Model Description and Boundary Conditions for CCSM3

- A fully coupled comprehensive model, the Community Climate System Model (CCSM3; Collins et al.,2005), is applied for the climate sensitivity experiments.

Boundary Conditions

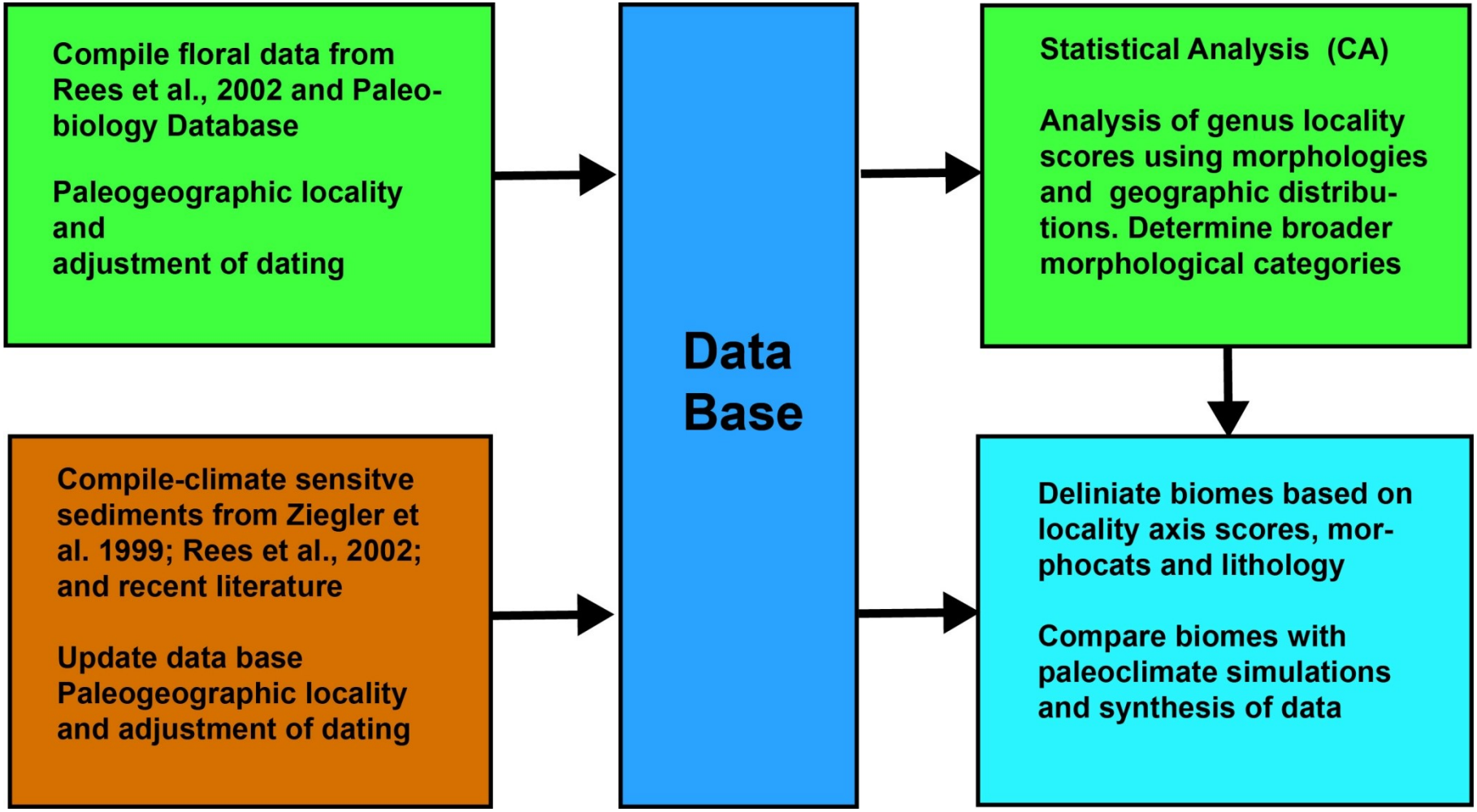
- Intensity of solar radiation: 2.1% reduced compared to present day (Caldeira and Kasting, 1992), S =1338 W m^{-2}
- Greenhouse gas concentrations (Kiehl and Shields, 2005)

  CO_2: 3550 ppmv

  CH_4: 0.7 ppmv

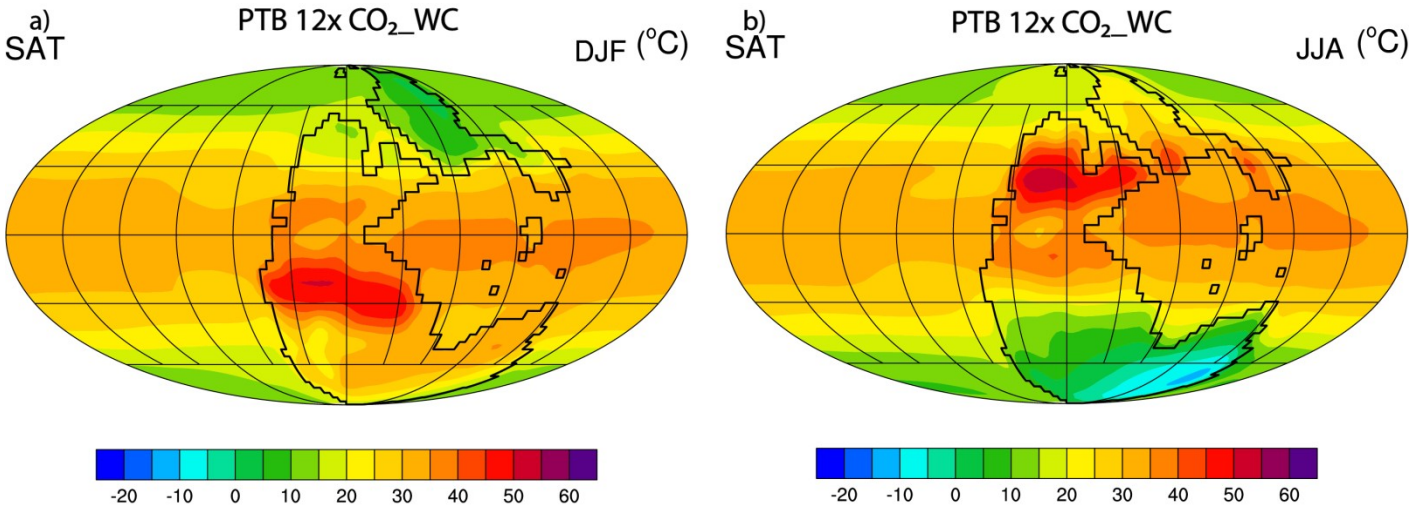
  N_2O: 0.275 ppmv
- Orbital cycles: Eccentricity 0°, Obliquity 23.5°
- Vegetation cover following Rees et al., 1999
- Topography: Paleogeographic Atlas Project

3.2 Phytogeographical Analysis

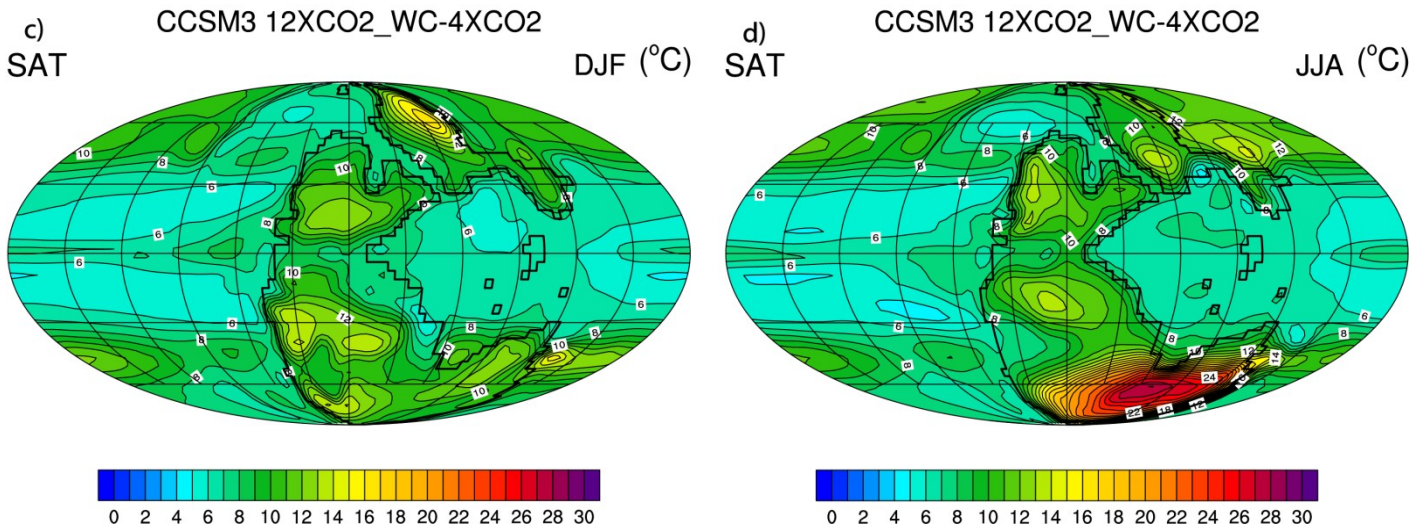


4.1 CCSM 3 Climate Model Simulations

12.7x CO_2 Warm Climate SAT for DJF (a) and JJA (b)



12.7x CO_2_WC - 4x CO_2 SAT for DJF (c) and JJA (d)

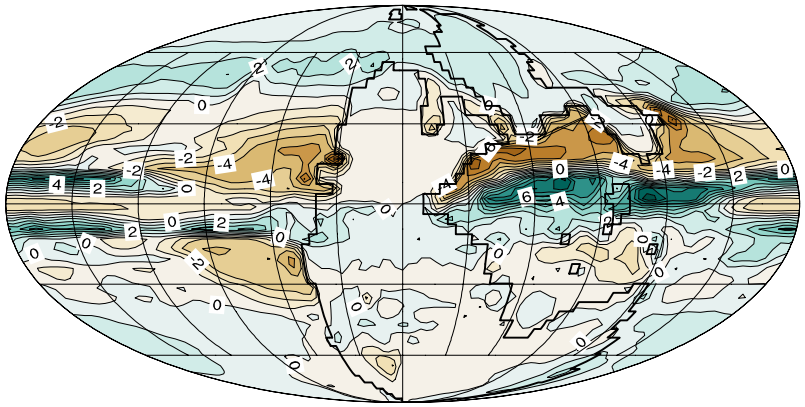


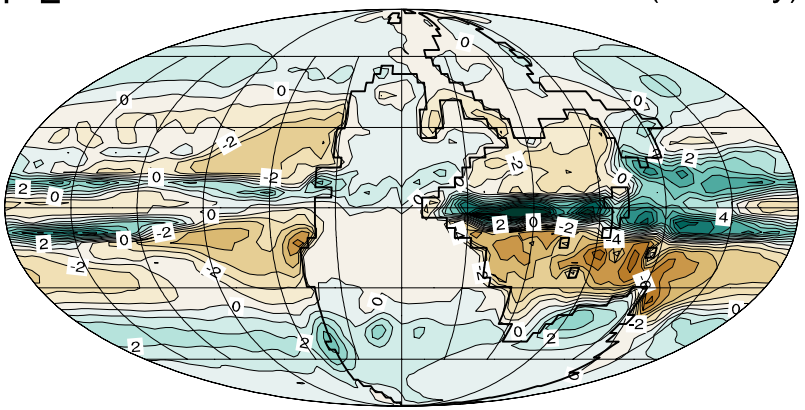
DJF

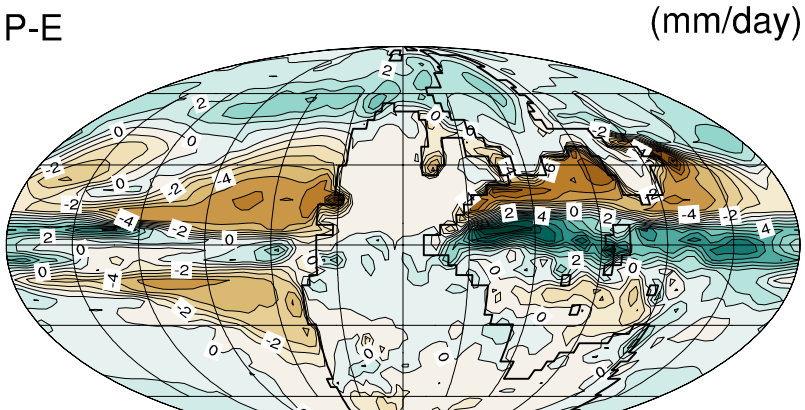
JJA

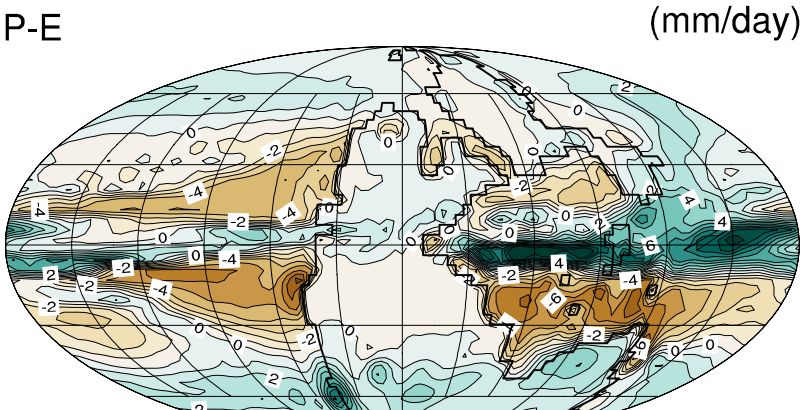
4x CO_2

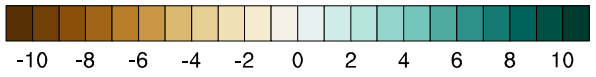
12.7x CO_2 Warm Climate

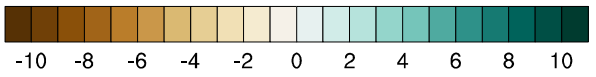


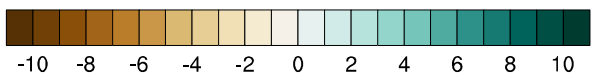


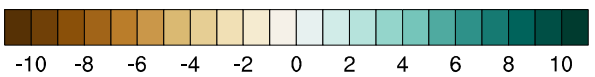




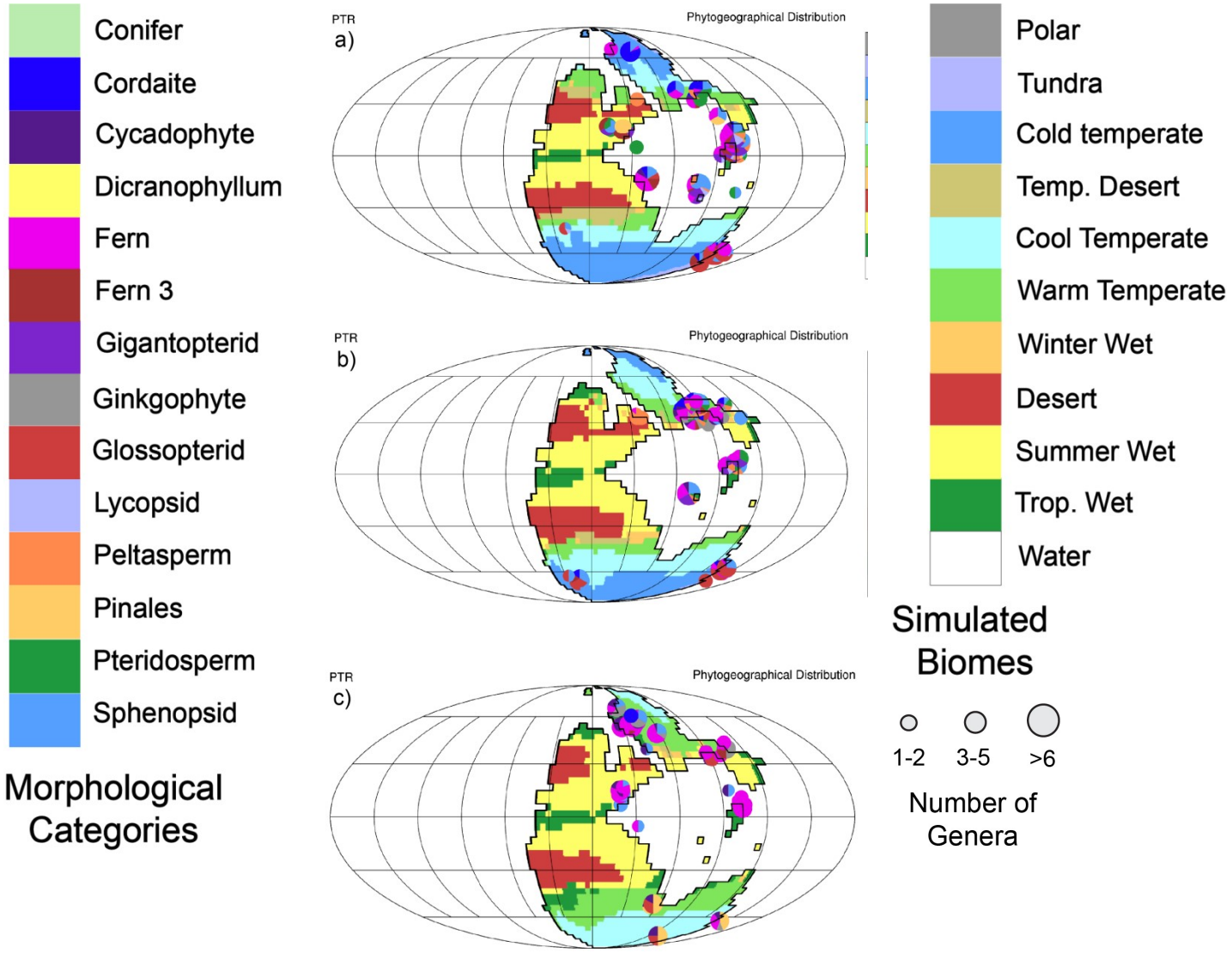








4.2 Phyto-geographical Distribution and CCSM3 simulations

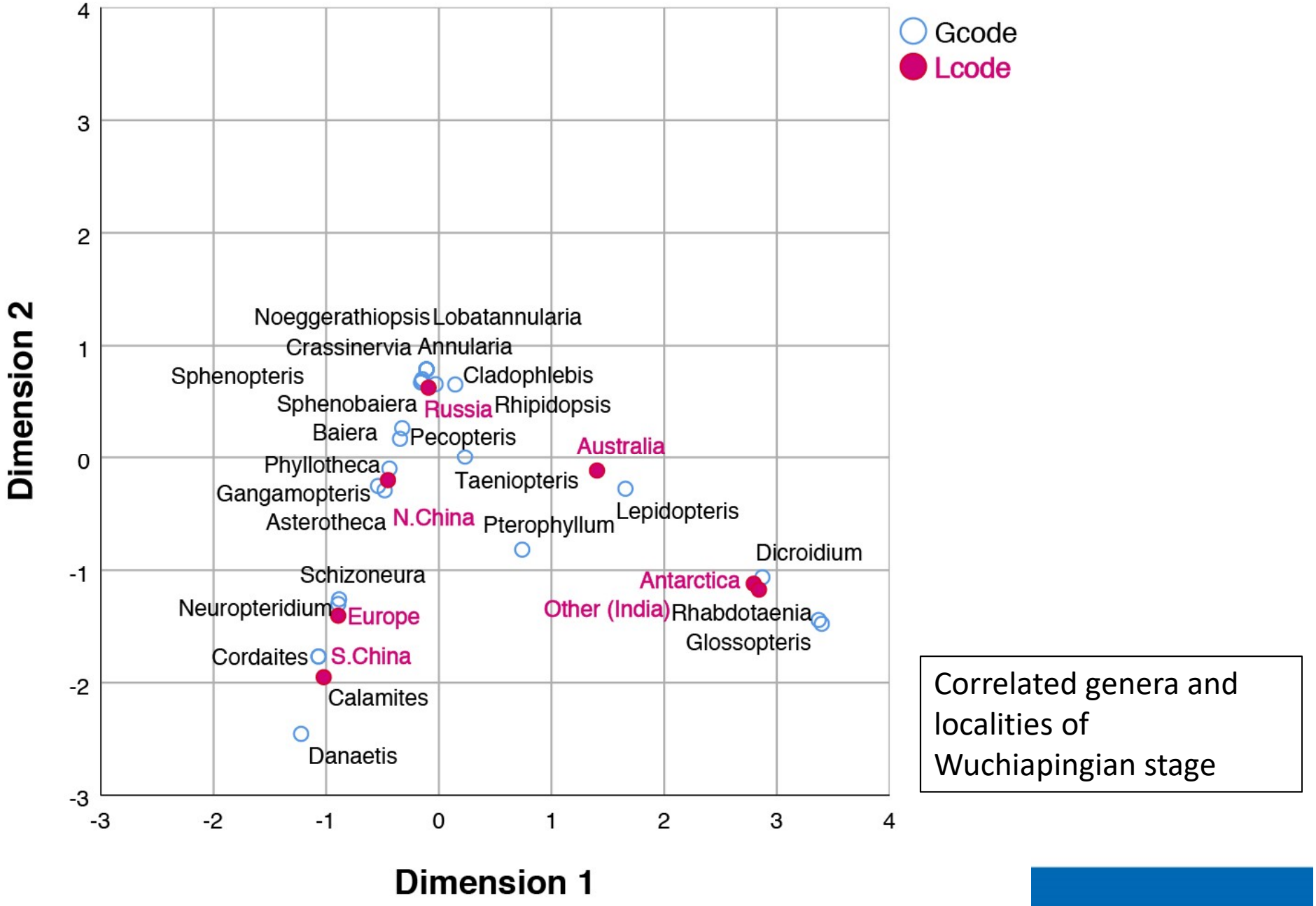


Phytogeographic distribution during Wuchiapingian (a), Changhsingian (b) and Early Triassic (c) derived using plant-fossil data. The pie-charts are overlain on the biomes simulated from CCSM3 for 4x CO_2 (a), 12.7x CO_2 (b) and 12.7x CO_2_WC (c) respectively. The size of the pie-charts represents the diversity of the flora.

4.3 Correspondence Analysis

(Wuchiapingian Stage)

Summary						
					Proportion of Inertia	
Dimension	Singular Value	Inertia	Chi Square	Sig.	Accounted for	Cumulative
1	0.913	0.833			0.361	0.361
2	0.734	0.539			0.234	0.594
3	0.702	0.492			0.213	0.808
4	0.423	0.179			0.077	0.885
5	0.397	0.157			0.068	0.953
6	0.328	0.108			0.047	1.000
Total		2.308	1008.588	0.000[a]	1.000	1.000



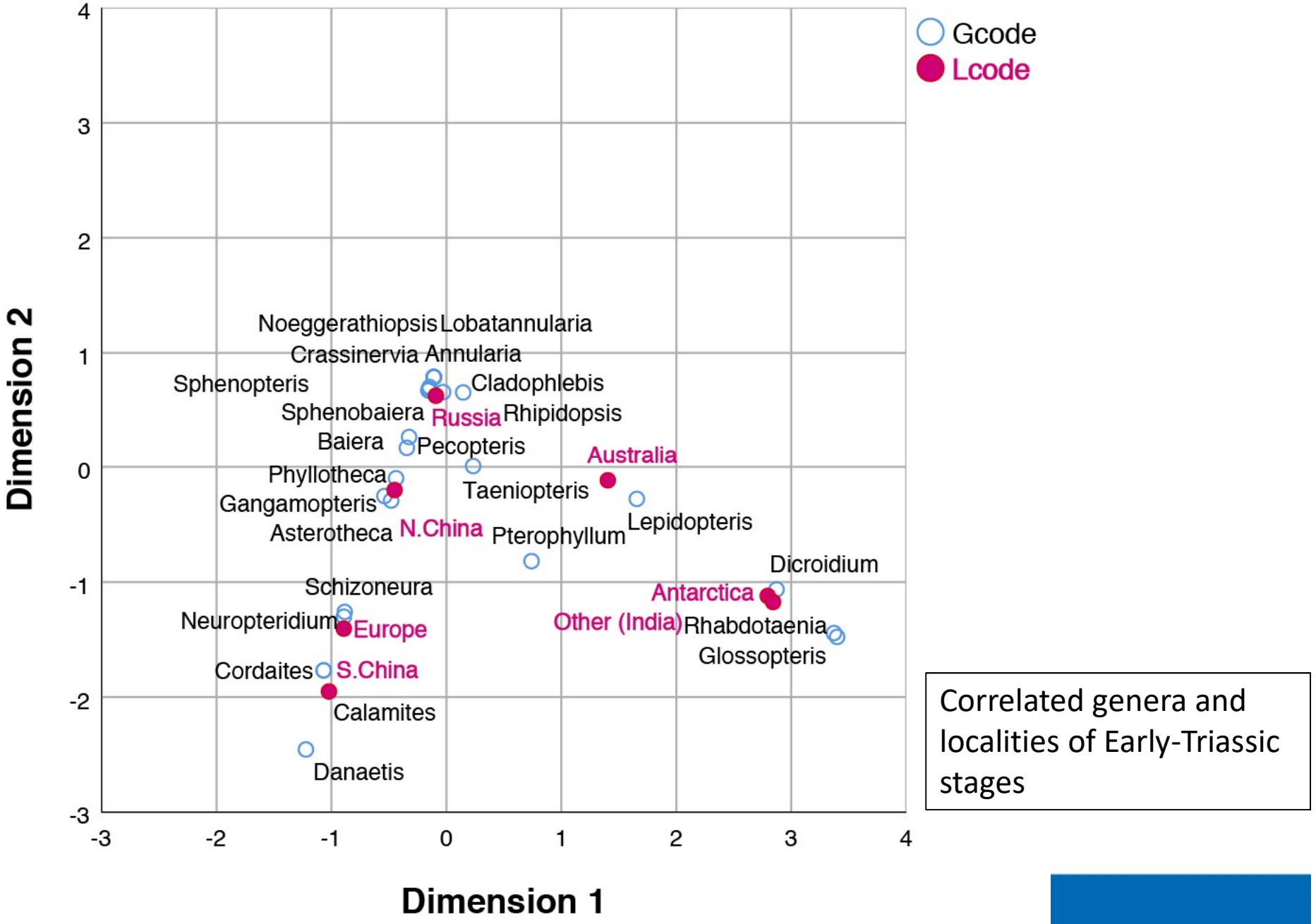
Correlated genera and localities of Wuchiapingian stage

4.3 Correspondence Analysis

(Early-Triassic Stages)

Summary

Dimension	Singular Value	Inertia	Chi Square	Sig.	Proportion of Inertia	
					Accounted for	Cumulative
1	0.836	0.699			0.314	0.314
2	0.795	0.632			0.284	0.598
3	0.770	0.593			0.266	0.865
4	0.390	0.152			0.068	0.933
5	0.298	0.089			0.040	0.973
6	0.246	0.061			0.027	1.000
Total		2.225	440.550	0.000[a]	1.000	1.000



Correlated genera and localities of Early-Triassic stages

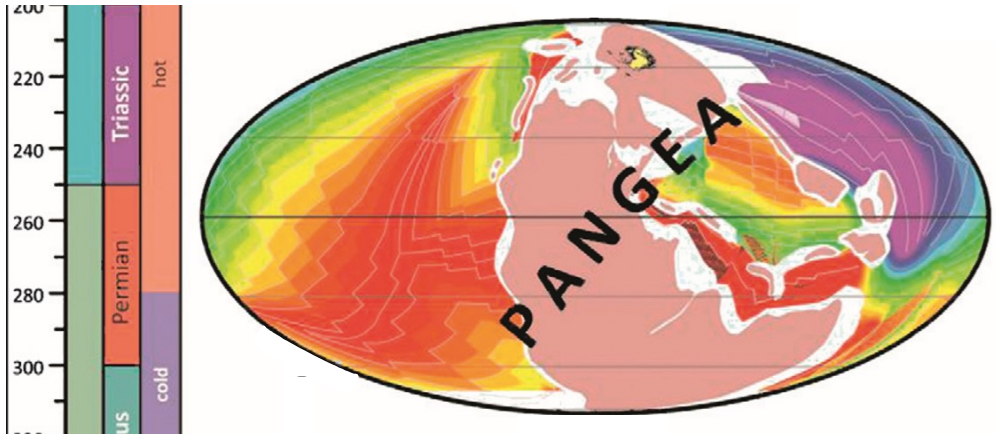
5. Conclusions

- The modeling results show significant seasonality in temperature over the interior of the continents, whereas seasonality of precipitation is much smaller.
- As we moved towards a hothouse climate, there was a significant decline in the diversity. However, it is still not clear whether it was an extinction or an evolutionary succession of tolerant species.
- The multivariate statistical analysis ensures a consistent interpretation of floristic patterns which can be used to compare with or validate climate simulations.

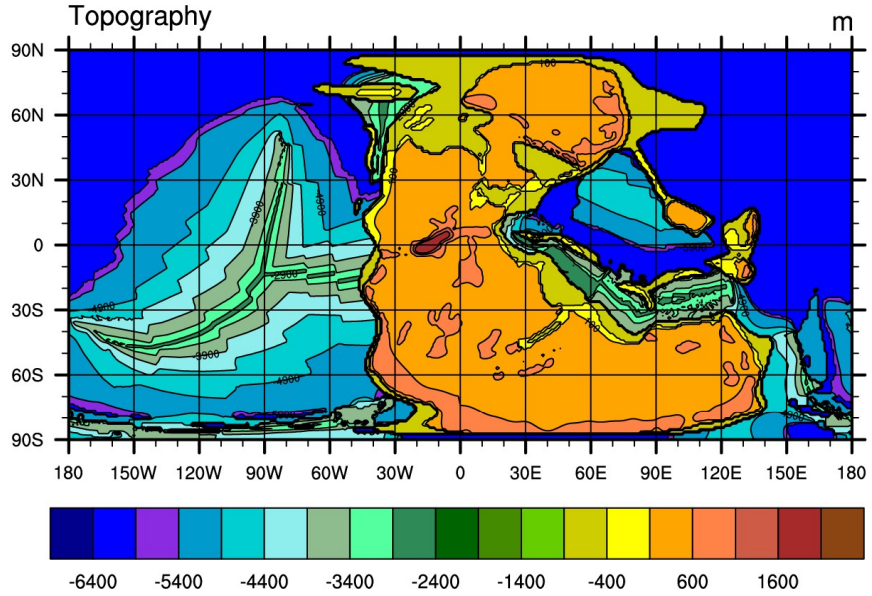
6. Current Work and Future Outlook

- Set up paleo boundary conditions CESM 1.2 simulation with FV1.9_2.5 and nominal 1° ocean .
- Update PTB topography using Torsvik et al.,(2012) reconstruction.
- Update the aerosol forcing for PTB in collaboration with Ben Black.
- Update the land surface parameterization by incorporation of reconstructed biomes based on plant fossil data.
- Solar and orbital forcing will be taken from Kiehl and Shields (2005).
- The CO_2 radiative forcing will be set to 4x PAL and 12x PAL.

PTB Topography smoothening



Torsvik et al.(2012)



Acknowledgements

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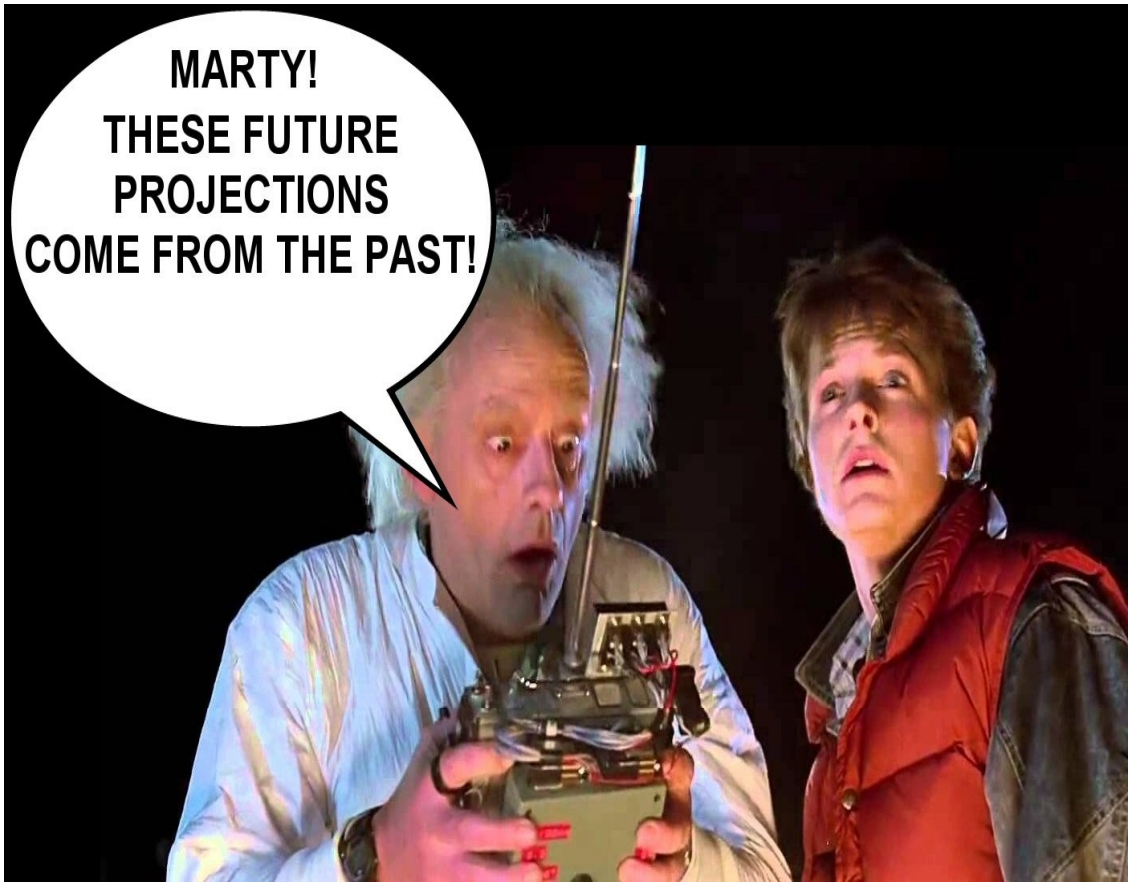
- A special thanks to Angela Osen for downloading the data from the Paleobiological database.

- A special thanks to Dr. John Connolly, Data Scientist from the office of Information and Technology for his expert guidance and help with the statistical analyses using SPSS.



THANK YOU FOR ATTENTION.