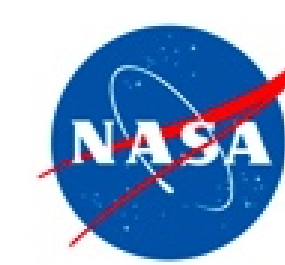


Using paleo-climate model/data comparisons to constrain future projections: Workshop summary



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Abstract

The CMIP5 archive includes three simulations associated with the Paleoclimate Modelling Intercomparison Project (PMIP3). Specifically, simulations of the Last Glacial Maximum (LGM), the Mid-Holocene (MH) and the last millennium (LM). The drivers of climate for these periods encompass many different physical mechanisms and large shifts in climate. In terms of the model calibrations (predominantly over the modern period), any model/paleo-data comparisons are 'out-of-sample' and so can provide unique evaluations (and constraints) on the future projections.

Are PMIP3 models detectably different from PMIP2?

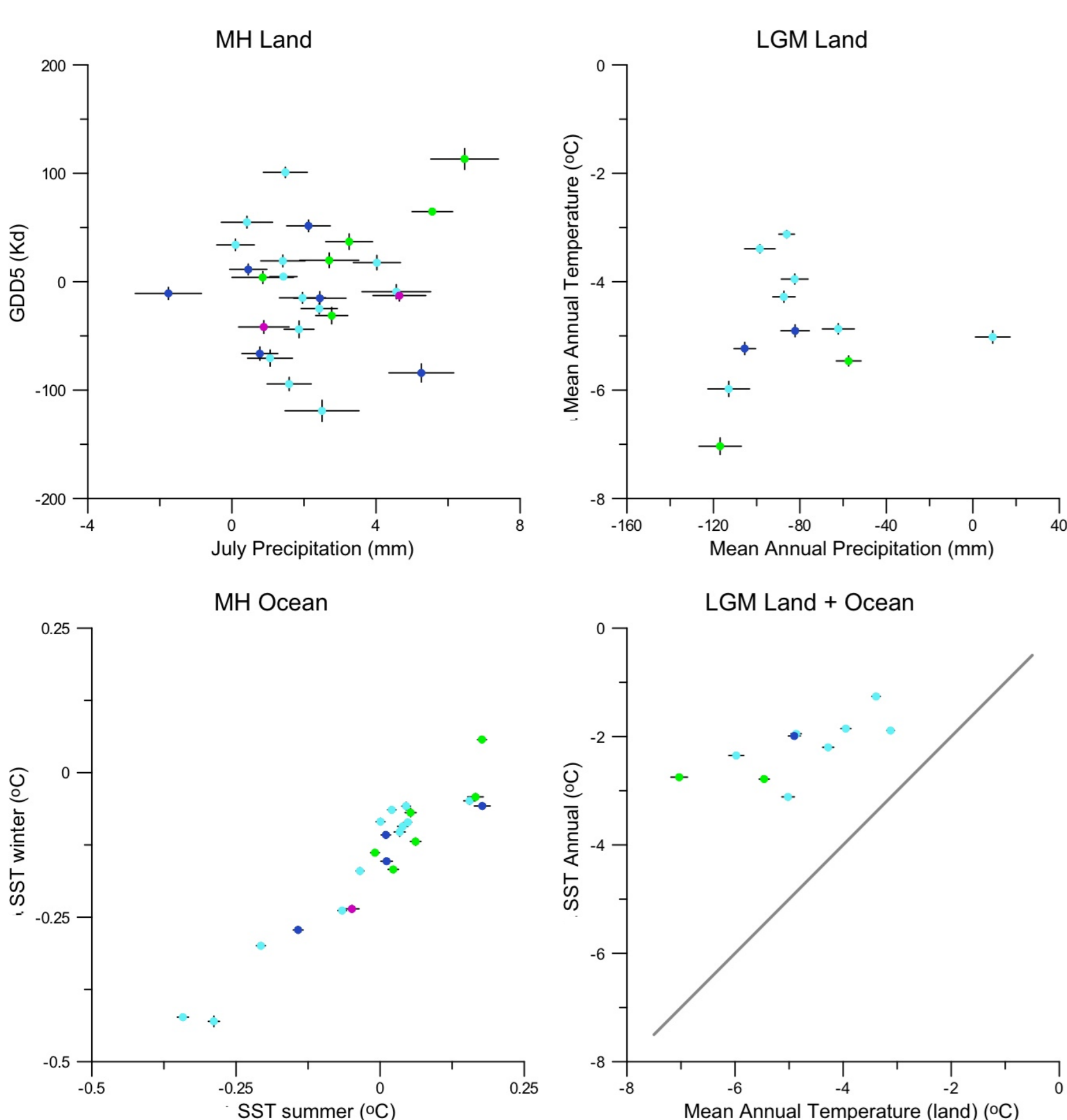


Figure 1: Collection of model relationships in the MH and LGM among PMIP2 (green (OAV) and light blue (OA)) and PMIP3 (magenta (OAC) and dark blue(OA)) (Bartlein et al, personal communication). Given the current state of the archive, there is no indication that the latest generation models show behaviour outside of previously archived ensembles.

Do LGM simulations encompass the observations?

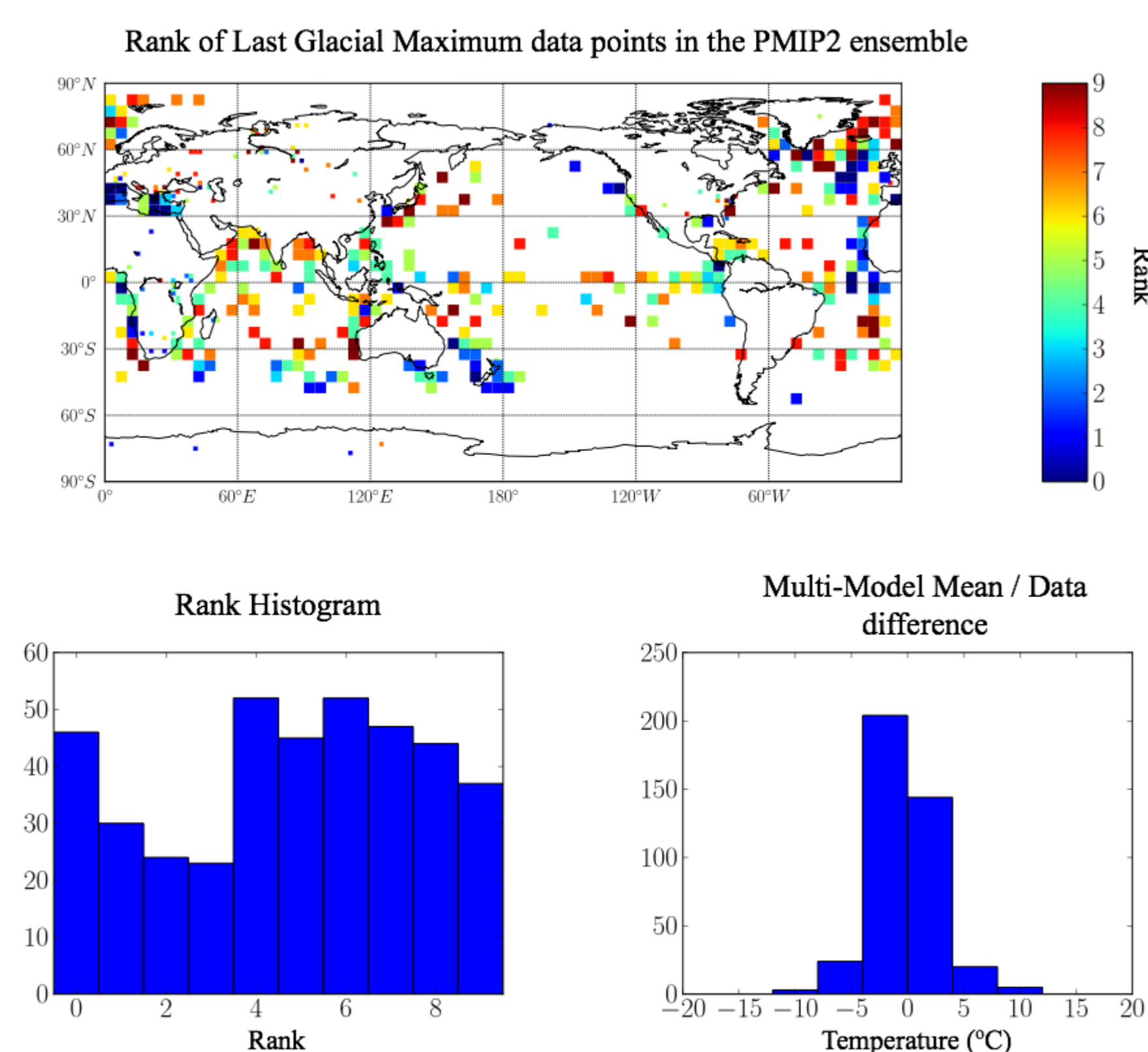


Figure 2: The rank histogram of the data is relatively flat, indicating that the ocean data points fall quasi-uniformly within the spread of the model ensemble. The mean of individual model-data differences is centered near zero, indicating a lack of systematic global bias (though biases regionally are apparent). (J. Hargreaves, personal communication)

PMIP3 Experimental design

Last Glacial Maximum: Equilibrium 21K BP, Ice sheets, reduced GHGs (CO₂, CH₄, N₂O), Orbital, Sea level 120m lower

Mid-Holocene: Equilibrium 6K BP, orbital forcing, CO₂, CH₄, N₂O, vegetation

Last Millennium: Transient 850-1850 CE, solar, volcanic, land use change, GHGs, orbital

Normalised Regional Temperature change

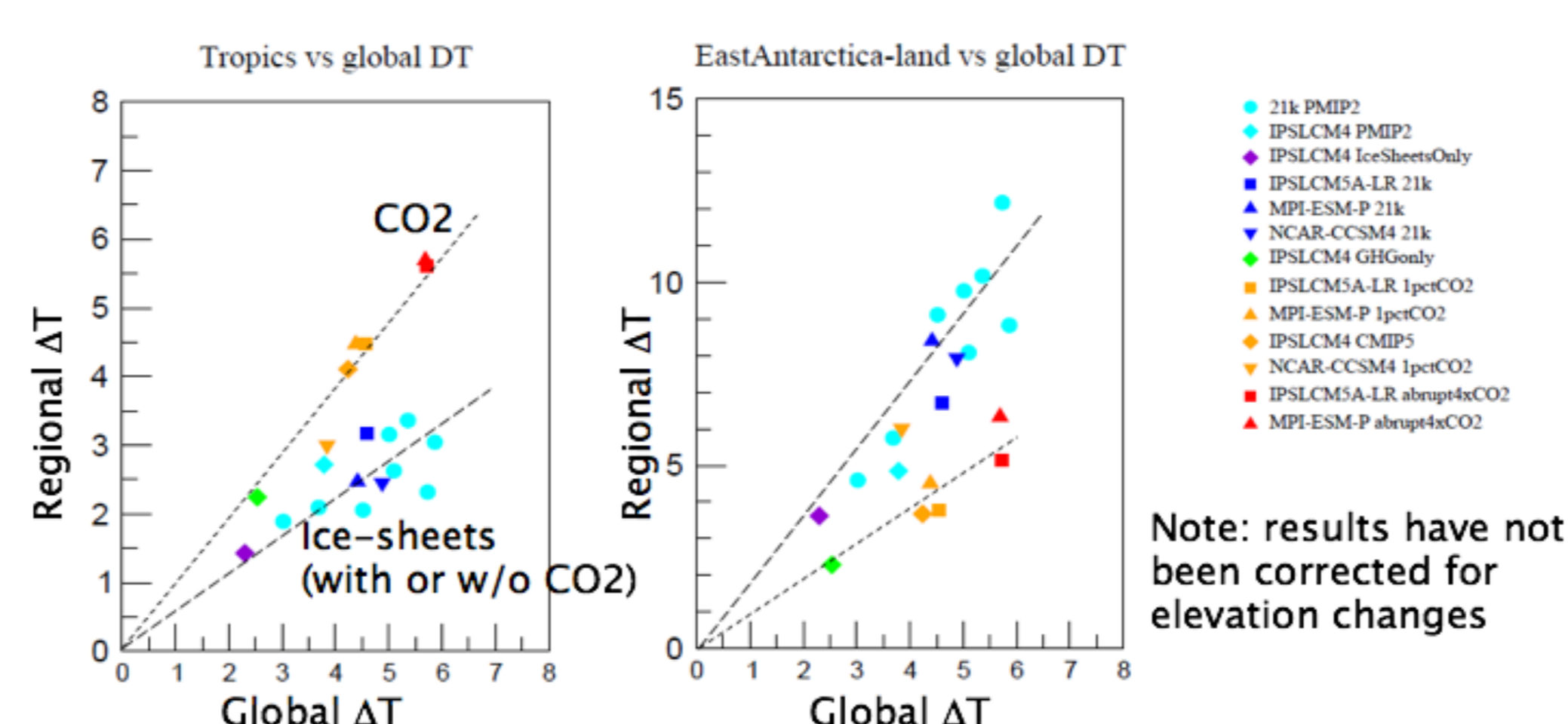


Figure 3: Relationships between regional temperatures and global mean in LGM and 1% inc. CO₂ runs indicate that there is a possibility of constraining regional future projections using paleo-data.

Polar Amplification

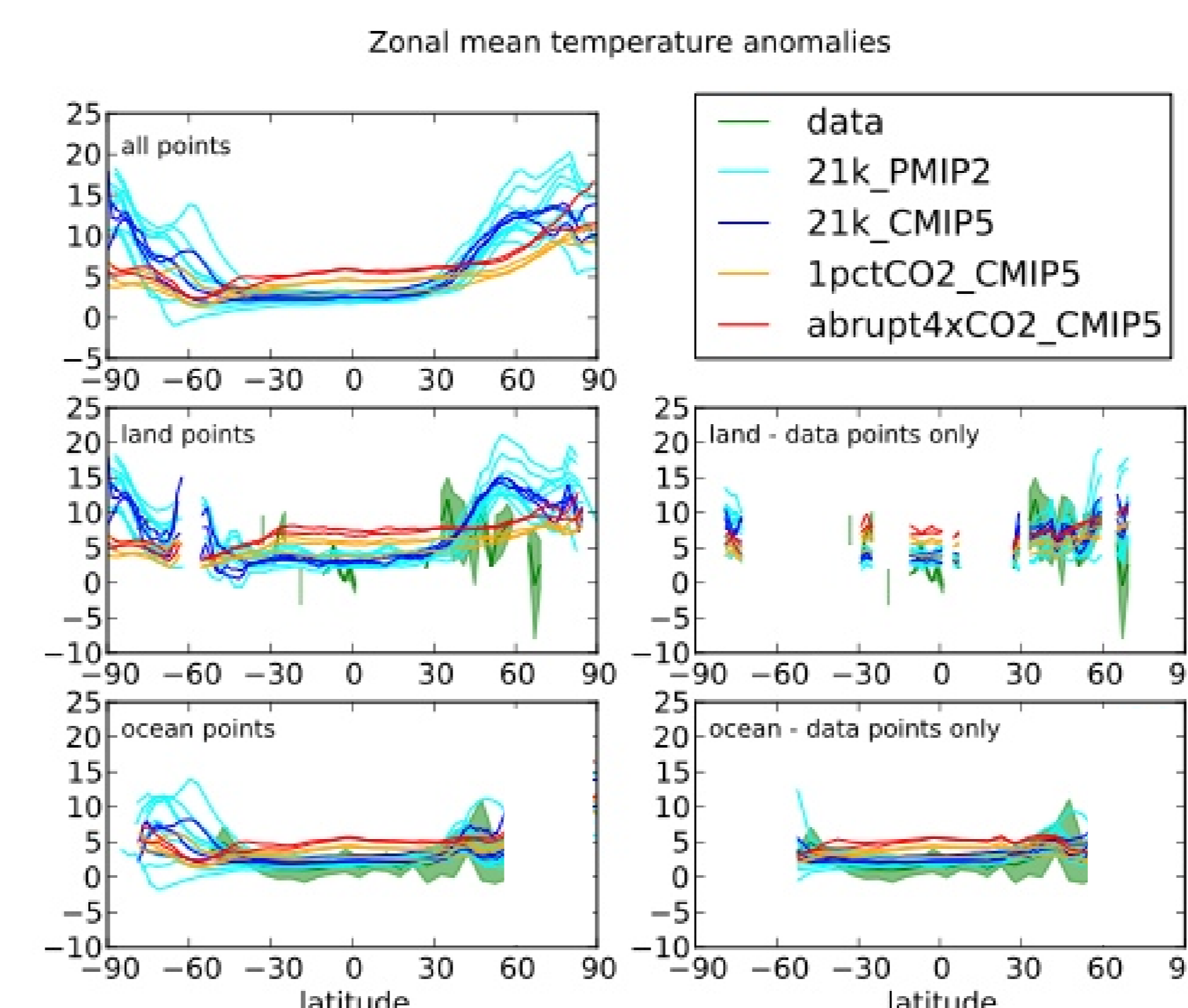


Figure 4: Latitudinal temperature anomalies normalised by the the mean global change in LGM and 1% inc. CO₂ and Instant 4xCO₂ simulations. Data points are from the Bartlein et al (2011), the MARGO Synthesis and V. Masson-Delmotte (personal communication)

Robustness of ITCZ shifts

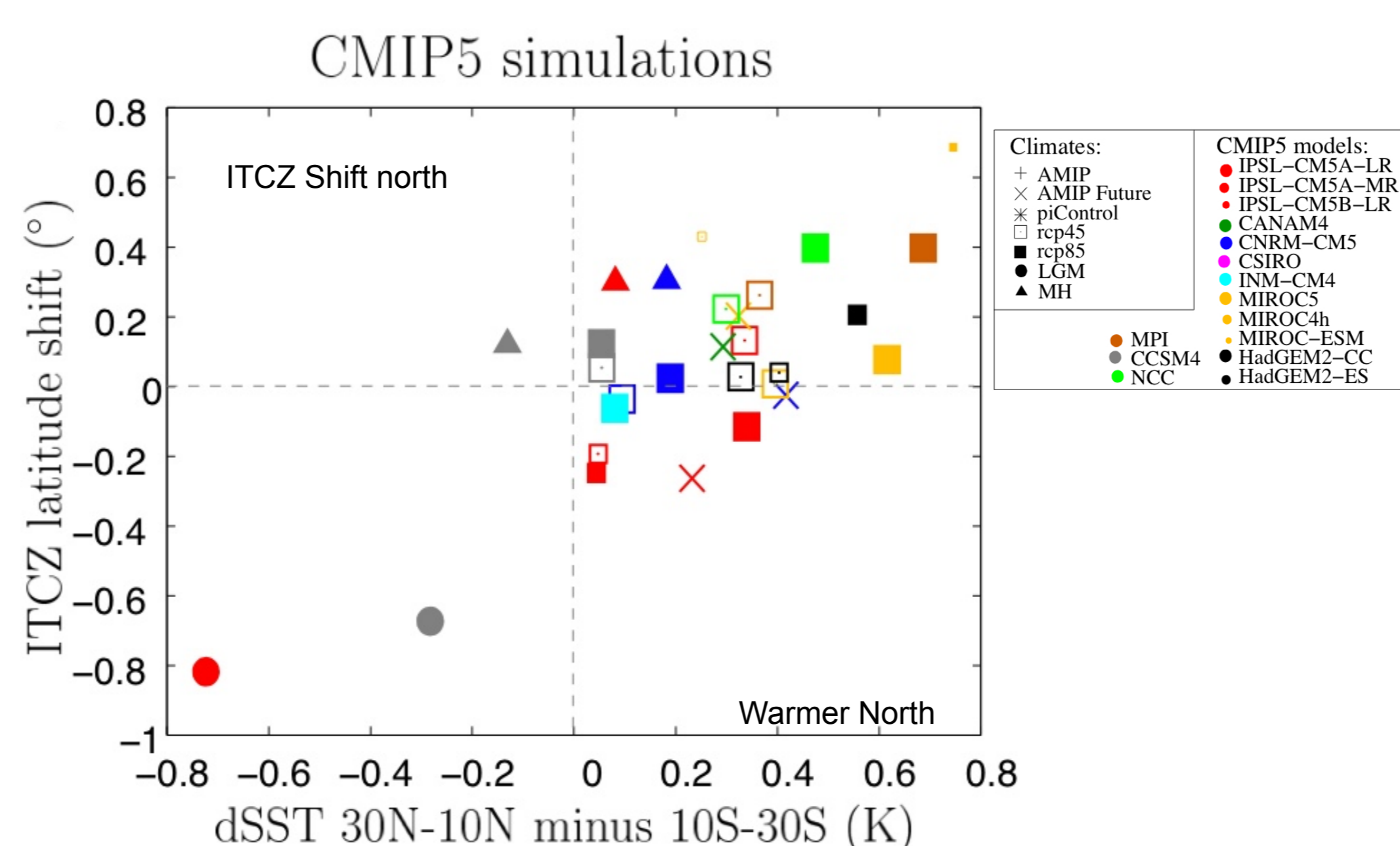
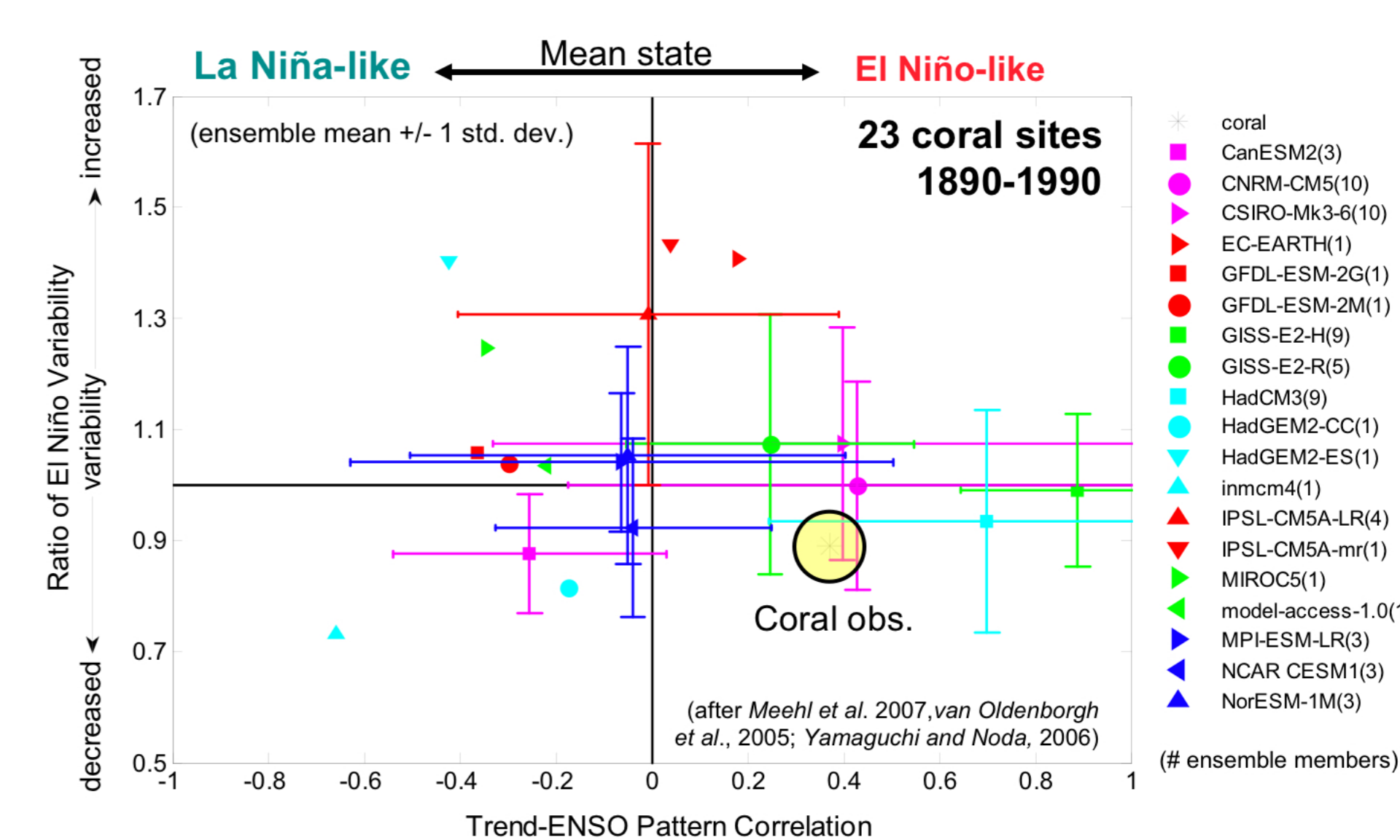


Figure 5: ITCZ shifts are robust with respect to the change of tropical SST gradients across models and over a wide range of climate simulations – past and future. (Camille Risi, personal communication)

ENSO/Tropical Pacific

Trend in mean state and ENSO variance: corals vs CMIP5 pseudocorals (modeled from simulated historical SST&SSS)



Projections for mean state and ENSO variance: CMIP5 pseudocorals (modeled from rcp4.5 simulated SST&SSS)

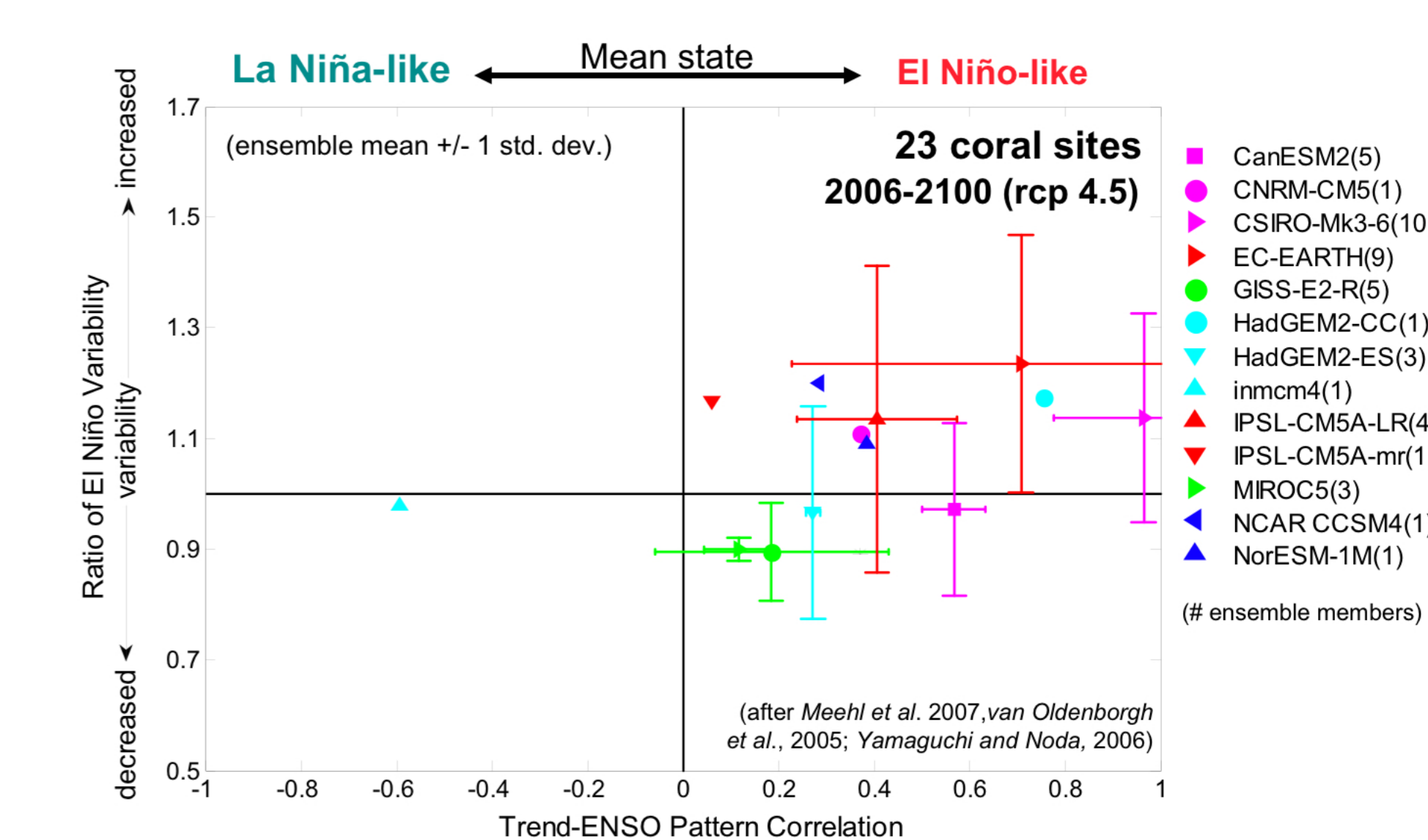


Figure 6: Coral proxy data can add additional data constraints to data-poor historical records for the tropical Pacific and provide a coherent metric for assessing future shifts (Diane Thompson, personal comm.).

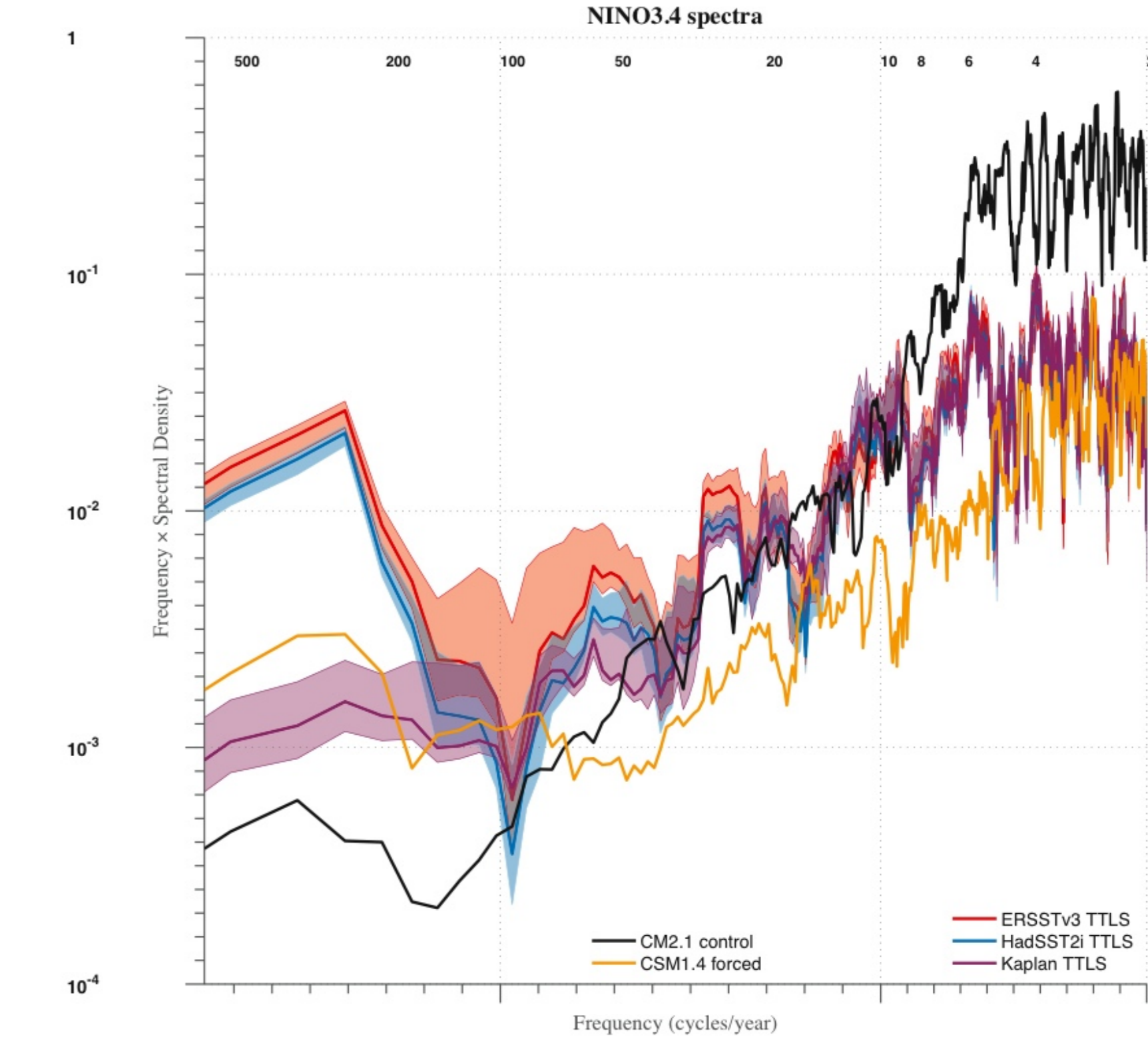


Figure 7: Spectra of NINO3.4 variability taken from 3 long-term reconstructions (using different observations SST targets, J. Emile-Geay, personal communication) and results from the NCAR CSM 1.4 LM, and the GFDL CM2.1 control simulations.

Conclusions

There are many model metrics that show similar behaviours (in pattern and scale) in past and future simulations. Constraints on those past changes from synthesis proxy-derived datasets or forward modelling of specific proxies, are therefore a promising methodology for weighting future projections. We strongly encourage more of the modelling groups to complete and submit their PMIP3 simulations to the archive.

Acknowledgements

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