

# Some papers with a focus on evaluating PMIP models

Chronological by publication date, most recent first:

## **A cloud feedback emulator (CFE, version 1.0) for an intermediate complexity model**

Ullman, D. J. and Schmittner, A. (2017) *Geosci. Model Dev.*, 10, 945-958. [open access](#)

from the abstract: Here, we describe and evaluate a method for applying GCM-derived shortwave and longwave cloud feedbacks from 4xCO<sub>2</sub> and Last Glacial Maximum experiments to the University of Victoria Earth System Climate Model. The method generally captures the spread in top-of-the-atmosphere radiative feedbacks between the original GCMs, which impacts the magnitude and spatial distribution of surface temperature changes and climate sensitivity. These results suggest that the method is suitable to incorporate multi-model cloud feedback uncertainties in ensemble simulations with a single intermediate complexity model.

## **Terrestrial biosphere changes over the last 120 kyr.**

Hoogakker BAA, Smith RS, Singarayer JS, Marchant R, Prentice IC, Allen J, Anderson RS, Bhagwat SA, Behling H, Borisova O, and Bush M, et al. (2015). *Clim. Past*, 12, 51-73, 2016, doi:10.5194/cp-12-51-2016 <http://www.clim-past.net/12/51/2016/cp-12-51-2016.html> (open access)

From the conclusions, We have used a new global synthesis and biomization of long pollen records in conjunction with model simulations to analyse the sensitivity of the global terrestrial biosphere to climate change over the last glacial–interglacial cycle. Model output and biomized pollen data generally agree, lending confidence to our global-scale analysis of the carbon cycle derived from the model simulations. We used the models to estimate changes in global terrestrial net primary production and carbon storage. Carbon storage variations have a strong 23kyr (precessional) cycle in the first half of the glacial cycle in particular.

## **Evaluation of CMIP5 palaeo-simulations to improve climate projections.**

Harrison, S.P., Bartlein, P.J., Izumi, K., Li, G., Annan, J., Hargreaves, J., Braconnot, P.B., and Kageyama, M., 2015. *Nature Climate Change* 5: 735-743. <http://www.nature.com/nclimate/journal/v5/n8/full/nclimate2649.html>

from abstract: Past climate changes provide a unique opportunity for out-of-sample evaluation of model performance. Palaeo-evaluation has shown that the

large-scale changes seen in twenty-first-century projections, including enhanced land–sea temperature contrast, latitudinal amplification, changes in temperature seasonality and scaling of precipitation with temperature, are likely to be realistic. Although models generally simulate changes in large-scale circulation sufficiently well to shift regional climates in the right direction, they often do not predict the correct magnitude of these changes. Differences in performance are only weakly related to modern-day biases or climate sensitivity, and more sophisticated models [within the CMIP model ensembles] are not better at simulating climate changes. Although models correctly capture the broad patterns of climate change, improvements are required to produce reliable regional projections.

## **Glacial Atlantic overturning increased by wind stress in climate models**

Juan Muglia and Andreas Schmittner, 2015, *Geophys. Res. Lett.*, 42, doi:10.1002/2015GL064583, <http://people.oregonstate.edu/~schmita2/pdf/M/muglia15grl.pdf>

excerpts from conclusions: Since LGM wind stress, closure of Bering Strait [Hu et al., 2010], and increased tidal mixing [Schmittner et al., 2015] all tend to increase the strength and depth of the AMOC, a countering effect has to be invoked to reproduce observations of a weaker and shallower overturning during the LGM.” ... “It will be an important task for future work to resolve the apparent inconsistency between PMIP models’ LGM circulation and reconstructions. This inconsistency casts doubt on future AMOC projections with these models [e.g., Weaver et al., 2012]. One possible explanation may be that not all PMIP3 models were in equilibrium [Zhang et al., 2013].

## **Model benchmarking with glacial and mid-Holocene climates.**

Harrison, S.P., Bartlein, P.J., Brewer, S., Prentice, I.C., Boyd, M., Hessler, I., Holmgren, K., Izumi, K., and Willis, K., 2013. *Climate Dynamics* 43: 671-688. DOI 1007/s00382-013-1922-6, <http://link.springer.com/article/10.1007%2Fs00382-013-1922-6>

We present a comprehensive evaluation of state-of-the-art models against Last Glacial Maximum and mid-Holocene climates, using reconstructions of land and ocean climates and simulations. Newer models do not perform better than earlier versions despite higher resolution and complexity. Differences in climate sensitivity only weakly account for differences in model performance. In the glacial, models consistently underestimate land cooling (especially in winter) and overestimate ocean surface cooling (especially in the tropics). In the mid-Holocene, models generally underestimate the precipitation increase in the northern monsoon regions, and overestimate summer warming in central Eurasia. Models generally capture large-scale gradients of climate change but have more limited ability to reproduce spatial patterns. Despite these common biases, some models perform better than others.

## Introduction: Warm climates of the past—a lesson for the future?

D. J. Lunt, H. Elderfield, R. Pancost, A. Ridgwell, G. L. Foster, A. Haywood, J. Kiehl, N. Sagoo, C. Shields, E. J. Stone, and P. Valdes, *Phil. Trans. R. Soc. A.* 2013 371 20130146; doi:10.1098/rsta.2013.0146 (published 16 September 2013) [open access](#)

An introduction to a special issue related to the Discussion Meeting ‘Warm climates of the past—a lesson for the future?’ compiled and edited by Daniel J. Lunt, Harry Elderfield, Richard Pancost and Andy Ridgwell. It is focussed towards emphasising the potential usefulness of the warm climates of the past. Most of the papers seem (I can't read most of them, as only a few are open access and it seems that even mighty JAMSTEC does not subscribe to *Phil Trans*) focussed towards understanding the past, but there is also one on climate sensitivity by J. Hansen et al, [open access](#)

## Precipitation scaling with temperature in warm and cold climates: an analysis of CMIP5 simulations.

Li, G., Harrison, S. P., Bartlein, P. J., Izumi, K., & Prentice, I. C. *Geophysical Research Letters*. doi:10.1002/grl.50730, [open access](#), 2013.

*keywords: CMIP, PMIP, model ensemble, LGM*

Abstract, “We investigate the scaling between precipitation and temperature changes in warm and cold climates using six models that have simulated the response to both increased CO<sub>2</sub> and Last Glacial Maximum (LGM) boundary conditions. Globally, precipitation increases in warm and decreases in cold climates by between 1.5 to 3%/ °C. Precipitation sensitivity to temperature changes are lower over land than ocean and lower over tropical land compared to extratropical land, reflecting the constraint of water availability. The wet tropics get wetter in warm and drier in cold climates, but the changes in dry areas differ among models. Seasonal changes of tropical precipitation in a warmer world also reflect this “rich get richer” syndrome. Precipitation seasonality is decreased in the cold-climate state. The simulated changes in precipitation per degree temperature change are comparable to the observed changes in both the historical period and the LGM.”

## Statistical framework for evaluation of climate model simulations by use of climate proxy data from the last millennium

**Part 1: Theory**, Sundberg, R., A. Moberg and A. Hind, *Clim. Past*, 8, 1339-1353, [open access](#), doi:10.5194/cp-8-1339-2012, 2012.

**Part 2: A pseudo-proxy study addressing the amplitude of solar forcing** A. Hind, A. Moberg, and R. Sundberg, *Clim. Past*, 8, 1355-1365, [open access](#)

*keywords : last millennium, test statistics, evaluation, detection / attribution*

Pseudo-proxy experiment to distinguish between high and low solar forcings from model output run over the Last Millennium

## Evaluation of climate models using palaeoclimatic data

Pascale Braconnot, Sandy P. Harrison, Masa Kageyama, Patrick J. Bartlein, Valerie Masson-Delmotte, Ayako Abe-Ouchi, Bette Otto-Bliesner & Yan Zhao, *Nature Climate Change* 2, 417–424, [paywall](#), doi:10.1038/nclimate1456, 2012

*keywords: review/prospective, PMIP, evaluation*

Review paper focused on PMIP efforts, displaying relationships between (a) land temperature change and ocean temperature change and (b) global and regional changes and elaborating on how carefully evaluation of modelling of past climates may provide insights / constraints on future climate change.

## Skill and reliability of climate model ensembles at the Last Glacial Maximum and mid-Holocene

J. C. Hargreaves, J. D. Annan<sup>1</sup>, R. Ohgaito, A. Paul, and A. Abe-Ouchi, *Clim. Past*, 9, 811–823, [open access](#) doi:10.5194/cp-9-811-2013 2013. and **Are paleoclimate model ensembles consistent with the MARGO data synthesis?** J. C. Hargreaves, A. Paul, R. Ohgaito, A. Abe-Ouchi, and J. D. Annan *Clim. Past*, 7, 917–933, [open access](#) doi:10.5194/cp-7-917-2011, 2011

*keywords: PMIP, LGM, evaluation, temperature (SAT over land, SST for ocean)*

Show that PMIP2 and available PMIP3 models are reliable and have skill for air and surface ocean temperatures on broad scales, for the LGM. On the other hand, the MIROC single model ensemble is under-dispersive (a result common for single model ensembles - see Yokohata et al 2010). Additionally the models have no skill and are not reliable for the mid-Holocene interval.

## Assessment of the use of current climate patterns to evaluate regional enhanced greenhouse response patterns of climate models

Penny Whetton, Ian Macadam, Janice Bathols, and Julian O'Grady *GRL*, VOL. 34, L14701, [paywall](#), doi:10.1029/2007GL030025, 2007

*keywords: evaluation, CMIP3, regional climate*

One of several papers from around 2007-2009, looking for “metrics”. The idea was that if a relationship may be found in the multi-model ensemble between a measurable quantity in the present and a feature of the climate in the future projections, then this may in principle be use to constrain the ensemble. In this study the globe was split into the land-based “Giorgi regions”. The metric is a measure of model similarity. Combining temperature, precipitation and sea level pressure seems to provide the best correlations for future performance both regionally and globally.

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