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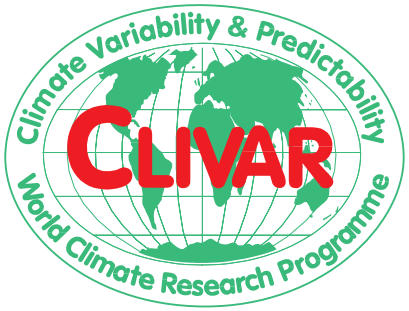

Workshop Report

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

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

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1 Introduction

A workshop organized by the PAGES[1]/CLIVAR[2] Working Group on using paleo-climate model/data comparisons to constrain future projections took place at the Bishop Museum in Honolulu, Hawaii, on 1-3 March, 2012.

The main objective of the workshop was to bring together modelers, theoreticians and paleo-climatologists to start to analyse results from the Coupled Model Intercomparison Project (Phase 5) (CMIP5) simulation database (see sections 3 and 4 for agenda and list of participants, respectively). The CMIP5 project is a community wide effort to provide standard protocols for climate model simulations covering the historical instrumental period, future projections and a number of idealized simulations to aid the understanding, detection and attribution of climate change. Significantly, and for the first time, there is a concurrent paleo-climate component (in collaboration with the Paleoclimate Model Intercomparison Project Phase 3: PMIP3) that uses the same models for three specific experiments covering the Last Glacial Maximum (LGM, 20,000 years ago), the Mid-Holocene (MH, 6000 years ago) and the Last Millennium (a transient simulation from 850 to 1850 CE) (Taylor et al., 2012).

Comparisons of paleo-climate simulations and proxy observation have a long history via earlier incarnations of PMIP and many individual studies, which motivated comprehensive data syntheses. However, it has been a challenge to quantitatively link the future simulations with skill or sensitivity in the paleo-climate simulations. There are a number of reasons for this, not least because paleo-simulations were often not performed with the same models being used for future projections and through a lack of suitable paleo-climate metrics, predominantly large scale syntheses of the proxy data. The workshop focused specifically on this missing step – how to make the quantitative connections, so that paleo-climate can become demonstrably useful for constraining future projections.

[1] Past Global Changes, a project of the International Geosphere-Biosphere Programme
[2] Climate Variability and Predictability, a project of the World Climate Research Programme

2 Discussion

The workshop began with a full discussion about the nature of the multi-model ensemble of opportunity and the techniques available for assessing model skill. Evidence was presented that indicated that the current models don't differ in kind from previous efforts (and so previous work can be analysed in the same framework) and that there is some reason to expect that, particularly for the LGM, the model spread likely encompasses the observations. It was widely acknowledged that finding metrics which can both be assessed given paleo-climate observations and distinguish between model projections of the future, remains a challenge.

The remainder of the workshop was focused on specific uncertainties highlighted in IPCC AR4[3] for which there are some clear indications that paleo-climate might help, specifically, patterns of regional rainfall, temperature seasonality, climate sensitivity, ocean-atmosphere modes in the tropical Pacific, the response of the North Atlantic Meridional Circulation, and spectra of climate variability.

Assessments of climate sensitivity using the LGM are very promising, with a large increase in available and relevant simulations over PMIP2, and in the preliminary data there appears to be a correlation of verifiable temperature patterns at the LGM to future projections (Figure 1). Large scale changes in rainfall patterns are also very promising targets, with a clear coherence of tropical rainband shifts in latitude as a function of equatorial sea surface temperature gradients across all the model simulations. Ocean circulation metrics – whether for the overturning circulation or the spectral character of tropical Pacific ocean-atmosphere dynamics, including El Niño/Southern Oscillation – are not quite at the same stage due to a lack of sufficiently constraining proxies, and continuing uncertainty of the sampling biases arising from the short time over which modern observations have been collected.

Participants at the workshop are working on a full white paper describing the approaches that can be taken and highlighting the preliminary results, but one conclusion is already clear: paleo-climate simulations have come of age as part of the suite of evaluations any model must undergo.

References

Taylor, K.E., R.J. Stouffer, G.A. Meehl, 2012: An Overview of CMIP5 and the Experiment Design. *Bull. Amer. Meteor. Soc.*, (in press).

[3] The Intergovernmental Panel on Climate Change's Fourth Assessment Report

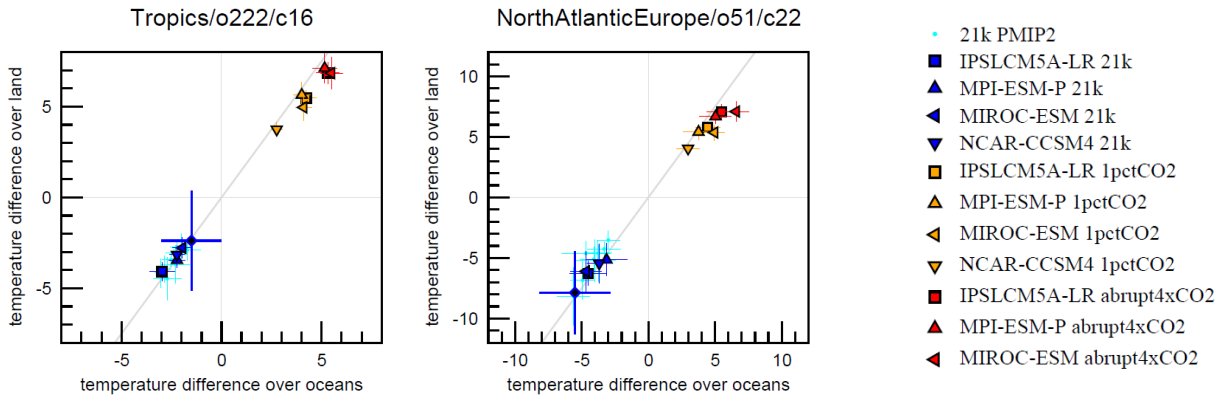

Figure 1: Preliminary results from the CMIP5 archive showing the multi-model ensemble for temperature differences at the LGM and in idealized increased CO_2 experiments. Left-hand panel shows the robust relationship between the tropical ocean and tropical land temperatures in both cold and warm climates (data averaged only where there are observations). Right hand panel shows equivalent results for the North Atlantic and Europe. The blue crosses indicate the results (with uncertainties) from the observational data syntheses from the LGM (figure courtesy of Masa Kageyama).

3 Agenda

Thursday 1st March:

Morning Session: Discussion of general issues

1 The nature of the multi-member ensemble
2 Role of out-of-sample evaluation of climate models
3 Statistical framework – inference, inverse/forward models, initial condition/structural uncertainty
4 Paleo-climate simulations in PMIP3/CMIP5
5 Data syntheses

Afternoon Session: Hydrological climate test case

1 Regional rainfall
2 ENSO variability and changes in mean state

Evening: Public event at Bishop Museum

Friday 2nd March:

Morning Session: Other AR4 uncertainties

1 Sea level rise/ice sheet sensitivity
2 Meridional overturning circulation/sea ice

Afternoon Session: AR4 uncertainties (cont.)

1 Climate sensitivity, lessons from volcanic/solar perturbations, polar amplification
2 Biogeochemical feedbacks (carbon cycle, methane, dust, aerosols, ozone etc.)
3 Extreme events (i.e. paleo-tempestology, historical climate)

Workshop dinner

Saturday 3rd March:

Morning session: Breakout groups

1 Breakout groups on progress so far and needed work

Afternoon session: Drafting

1 Reports from breakout groups
2 Drafting discussion of "best practice" white paper/hydrological climate example

End of meeting

4 Participants

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Andreas Schmittner
Andrew Schurer
Andrey Ganopolski
Axel Timmermann
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Ben Cook
Bette Otto-Bleisner
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Jason Smerdon
Jeff Kiehl
Jessica Tierney
Jesus FIDEL GONZALEZ ROUCO
Johann Jungclaus
Johannes Werner
Jozef Syktus
Julia Cole
Julia Hargreaves
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Kim Cobb
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Michelle Tigchelaar
Mike Mann
Naomi Harada
Nils Fischer
Pascal Yiou
Pascale Braconnot
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