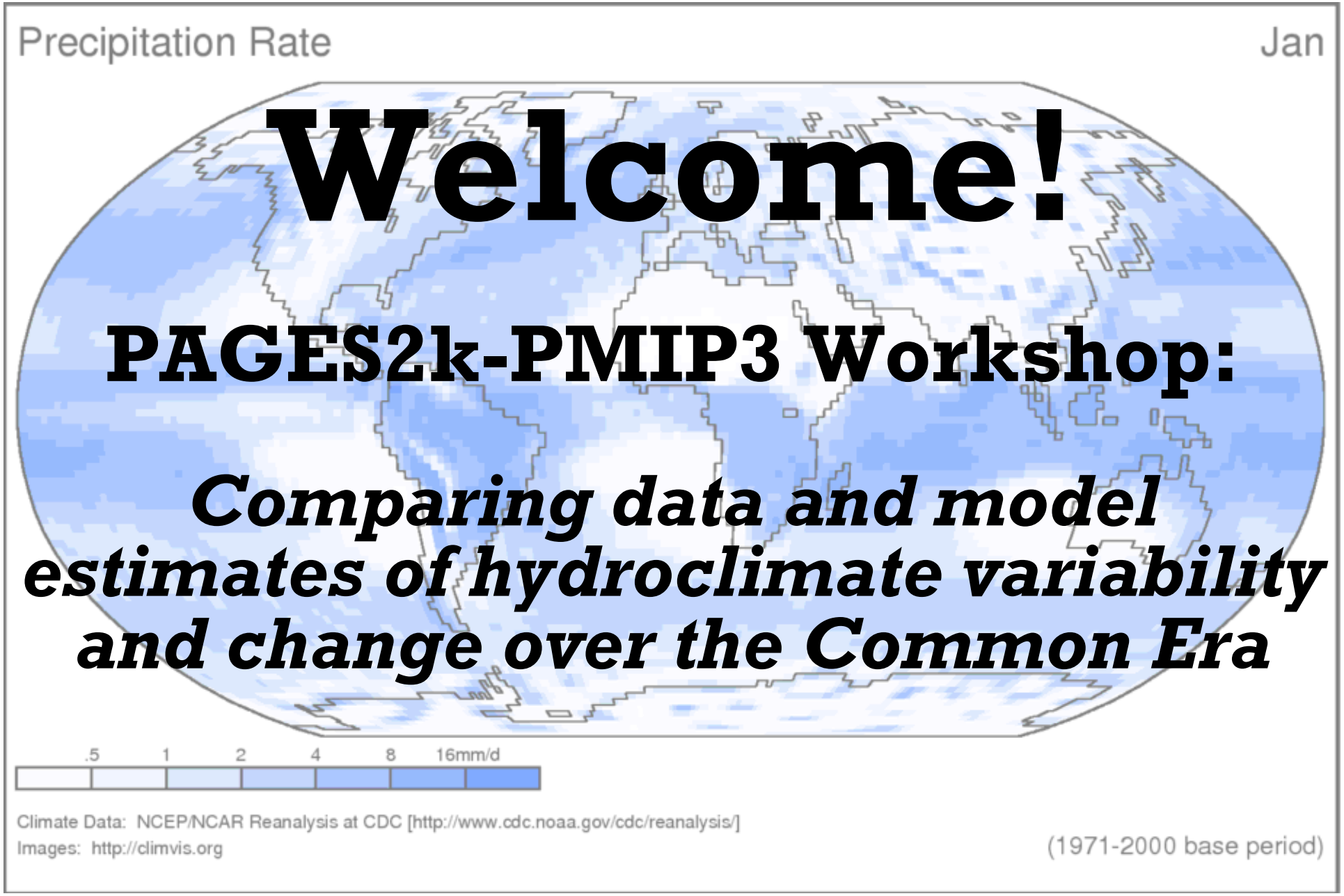



# Welcome!

## PAGES2k-PMIP3 Workshop:

## *Comparing data and model estimates of hydroclimate variability and change over the Common Era*

# In Gratitude...

PAGES
PAST GLOBAL CHANGES

Lamont-Doherty Earth Observatory
COLUMBIA UNIVERSITY | EARTH INSTITUTE

## International Co-Chairs:

*Juerg Luterbacher and Steven Phipps*

## Local Organizing Committee:

*Laia Andreu Hayles, Brendan Buckley, Rosanne D'Arrigo, Yochanan Kushnir, Justin Mankin, Richard Seager and Deepti Singh*

## Administrative Support:

*Mercedes Paulino*

## All Speakers and Participants

# Agenda Review (Today)

| | |
|---|---|
| 09:00-09:30 AM | ARRIVAL AND COFFEE |
| 09:30-10:30 AM | ***Introductory Remarks*** |
| 10:30-10:45 AM | COFFEE BREAK |
| 10:45-11:45 AM | ***Scoping Exercises*** |
| 11:45-12:45 PM | CATERED LUNCH |
| 12:45-02:45 PM | ***Hydro Proxies and Large-Scale Synth. I***<br>***Chair: Kim Cobb*** |
| 02:45-03:00 PM | COFFEE BREAK |
| 03:00-05:00 PM | ***Hydro Proxies and Large-Scale Synth. II***<br>***Chair: Juerg Luterbacher*** |
| 05:00-05:45 PM | ***Review hydroclimate proxies*** |
| 05:45-07:30 PM | CATERED BBQ AT LAMONT |

# For Speakers

**20 Minutes**

**30 Minutes**

# Agenda Review (Tomorrow)

| | |
|---|---|
| 09:00-09:30 AM | ARRIVAL AND COFFEE |
| 09:30-10:30 AM | ***Model Simulations of the Common Era I***<br>***Chair: Steven Phipps*** |
| 10:30-10:45 AM | COFFEE BREAK |
| 10:45-12:15 AM | ***Model Simulations of the Common Era II***<br>***Chair: Steven Phipps*** |
| 12:15-1:15 PM | CATERED LUNCH |
| 01:15-03:15 PM | ***Data-Model Comparisons I***<br>***Chair: Kevin Anchukaitis*** |
| 03:15-03:30 PM | COFFEE BREAK |
| 03:30-04:30 PM | ***Data-Model Comparisons II***<br>***Chair: K. Anchukaitis*** |
| 04:30-05:30 PM | ***Review of Modeling and Data-Model Comparisons*** |
| 7:00 PM | DINNER AT IL FRESCO |

# Agenda Review (Friday)

| | |
|---|---|
| 09:00-09:30 AM | ARRIVAL AND COFFEE |
| 09:30-11:00 AM | ***Proxy System Modeling and Proxy Comparisons I***<br>***Chair: Toby Ault*** |
| 11:00-11:15 AM | COFFEE BREAK |
| 11:15-12:15 AM | ***Data-Model Comparisons with Data Assimilation***<br>***Chair: Toby Ault*** |
| 12:15-1:15 PM | CATERED LUNCH |
| 1:15-1:45 PM | ***Review of Proxy Modeling and Data Assimilation*** |
| 1:45-2:30 PM | ***Discussions and Group Breakout Sessions*** |
| 2:30-3:00 PM | ***Reports From Breakout Groups*** |
| 03:00-03:15 PM | COFFEE BREAK |
| 03:15-04:15 PM | ***Summary*** |
| 04:30-07:00 PM | ***Outreach Event With High School Teachers***<br>***Speakers: Gavin Schmidt and Kim Cobb***<br>***All Workshop Participants: Round Robin Exchange*** |

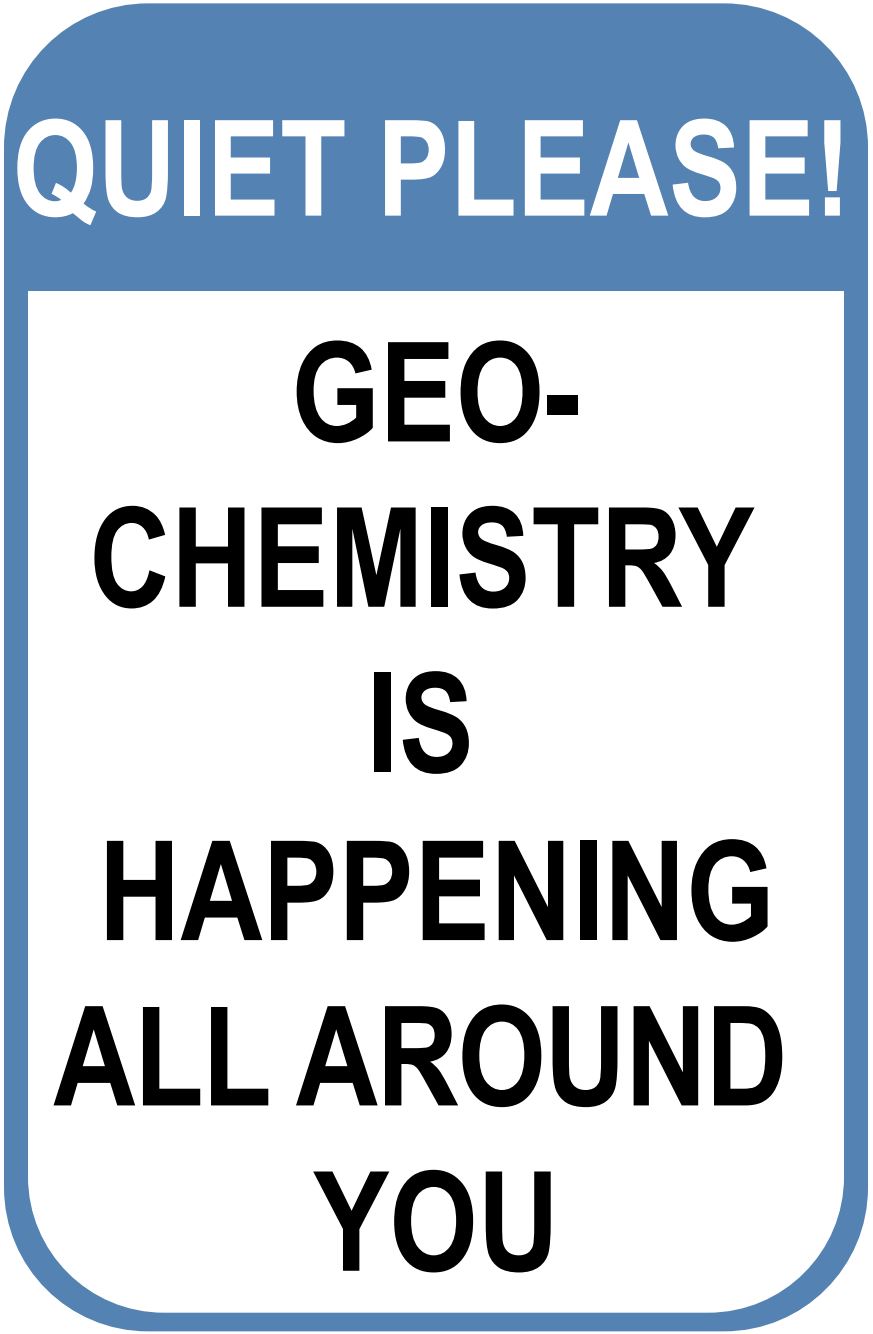
# Shuttle Schedule from the Holiday Inn

- Departure every morning at 8:45 AM from the hotel lobby
- Returns:
  - 7:30 PM on tonight
  - 5:30 PM on tomorrow
  - 4:30 PM and 7:00 PM on Friday

# Reimbursements

If you have any reimbursements (charges not billed through our accounts at Lamont), you will need to file paperwork before you leave.

**Please see me at lunch…**


QUIET PLEASE!
GEO-
CHEMISTRY
IS
HAPPENING
ALL AROUND
YOU

# This workshop is yours. It will be what you make it…

# There is plenty of time for discussion…

# Use it!

# Many different voices

# Many different perspectives

# Introduce Your Neighbor

- Name
- Affiliation
- **One sentence** description of their area of expertise

# An Historical Perspective

# There are too many relevant PAGES workshops to review, but…


Using Paleo-Climate Model/
Data Comparisons to Constrain
Future Projections
March 1- 3, 2012

# Workshop Aims

Given that the co-locations of the paleo-simulations and future projections **is a novelty in CMIP5**, the successful use of this kind of information does not have much of a track record. Thus a workshop whose aims are to a) ***ensure that the community is aware of how suitable techniques should be assessed right from the start***, b) ***highlight the rich range of possible analyses***, and c) ***produce timely and informative summaries of the state of these analyses, is both welcome and necessary***.

Clim. Past, 10, 221–250, 2014
www.clim-past.net/10/221/2014/
doi:10.5194/cp-10-221-2014


Climate of the Past
Open Access

# Using palaeo-climate comparisons to constrain future projections in CMIP5

**G. A. Schmidt[1], J. D. Annan[2], P. J. Bartlein[3], B. I. Cook[1], E. Guilyardi[4,5], J. C. Hargreaves[2], S. P. Harrison[6,7], M. Kageyama[8], A. N. LeGrande[1], B. Konecky[9], S. Lovejoy[10], M. E. Mann[11], V. Masson-Delmotte[8], C. Risi[12], D. Thompson[13], A. Timmermann[14], L.-B. Tremblay[10], and P. Yiou[8]**

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[3]University of Oregon, Eugene, OR 97403, USA
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[5]Laboratoire d'Océanographie et du Climat: Expérimentation et Approches Numériques/Institut Pierre Simon Laplace, CNRS-IRD-UPMC – UMR7617, 4 place Jussieu, 75252 Paris Cedex 05, France
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[7]Macquarie University, Sydney, NSW 2109, Australia
[8]Laboratoire des Sciences du Climat et de l'Environnement, Institut Pierre Simon Laplace, CEA-CNRS-UVSQ – UMR8212, CE Saclay l'Orme des Merisiers, 91191 Gif-sur-Yvette, France
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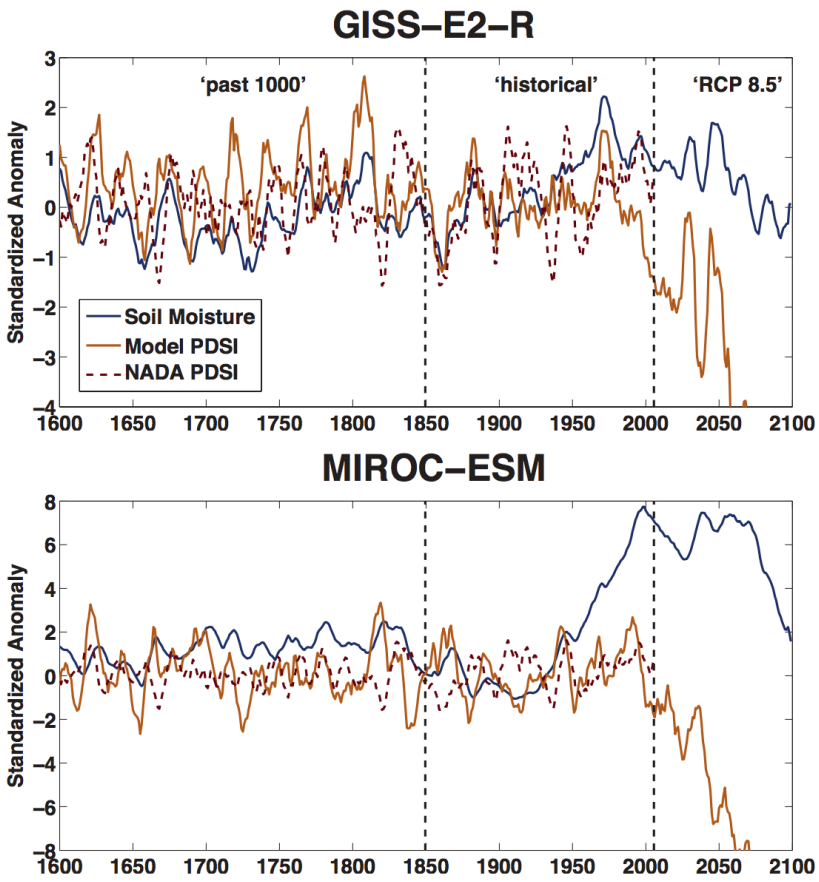
[12]Laboratoire de Météorologie Dynamique/Institut Pierre Simon Laplace, 4, place Jussieu, 75252 Paris Cedex 05, France
[13]University of Arizona, Department of Geosciences, Gould-Simpson Building #77, 1040 E 4th St., Tucson, AZ 85721, USA
[14]University of Hawaii, 2525 Correa Road, Honolulu, HI 96822, USA

*Correspondence to:* G. A. Schmidt (gavin.a.schmidt@nasa.gov)

Received: 11 January 2013 – Published in Clim. Past Discuss.: 11 February 2013
Revised: 19 December 2013 – Accepted: 19 December 2013 – Published: 5 February 2014

**Abstract.** We present a selection of methodologies for using the palaeo-climate model component of the Coupled Model Intercomparison Project (Phase 5) (CMIP5) to attempt to constrain future climate projections using the same models. The constraints arise from measures of skill in hindcasting palaeo-climate changes from the present over three periods: the Last Glacial Maximum (LGM) (21 000 yr before present, ka), the mid-Holocene (MH) (6 ka) and the Last Millennium (LM) (850–1850 CE). The skill measures may be used to validate robust patterns of climate change across scenarios or to distinguish between models that have differing outcomes in future scenarios. We find that the multi-model ensemble of palaeo-simulations is adequate for addressing at least some of these issues. For example, selected benchmarks for the LGM and MH are correlated to the rank of future projections of precipitation/temperature or sea ice extent to indicate that models that produce the best agreement with palaeo-climate information give demonstrably different future results than the rest of the models. We also explore cases where comparisons are strongly dependent on uncertain forcing time series or show important non-stationarity, making direct inferences for the future problematic. Overall, we demonstrate that there is a strong potential for the palaeo-climate simulations to help inform the future projections and urge all the modelling groups to complete this subset of the CMIP5 runs.



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# WORKSHOP ON INTEGRATED ANALYSES OF RECONSTRUCTIONS AND MULTI-MODEL SIMULATIONS FOR THE PAST TWO MILLENNIA

Círculo de Bellas Artes de Madrid, 4th-6th November 2013

# Workshop Aims

The workshop will be devoted to the analysis of reconstructions and multi-model simulations of the **past two millennia** and will blend the **PAGES 2K** and the **PMIP3** communities. It will focus on the comparison between reconstructions and the new suite of *past1000* simulations developed within PMIP3.

The comparative analyses will give a particular emphasis to the **continental/regional scales**, to the understanding of **physical mechanisms**, and to link past and future climate evolution to help **constrain uncertainty in future climate projections**.

Clim. Past, 11, 1673–1699, 2015
www.clim-past.net/11/1673/2015/
doi:10.5194/cp-11-1673-2015


Climate of the Past
Open Access
EGU

# Continental-scale temperature variability in PMIP3 simulations and PAGES 2k regional temperature reconstructions over the past millennium

**PAGES 2k–PMIP3 group**

A full list of authors and their affiliations appears at the end of the paper.

*Correspondence to:* H. Goosse

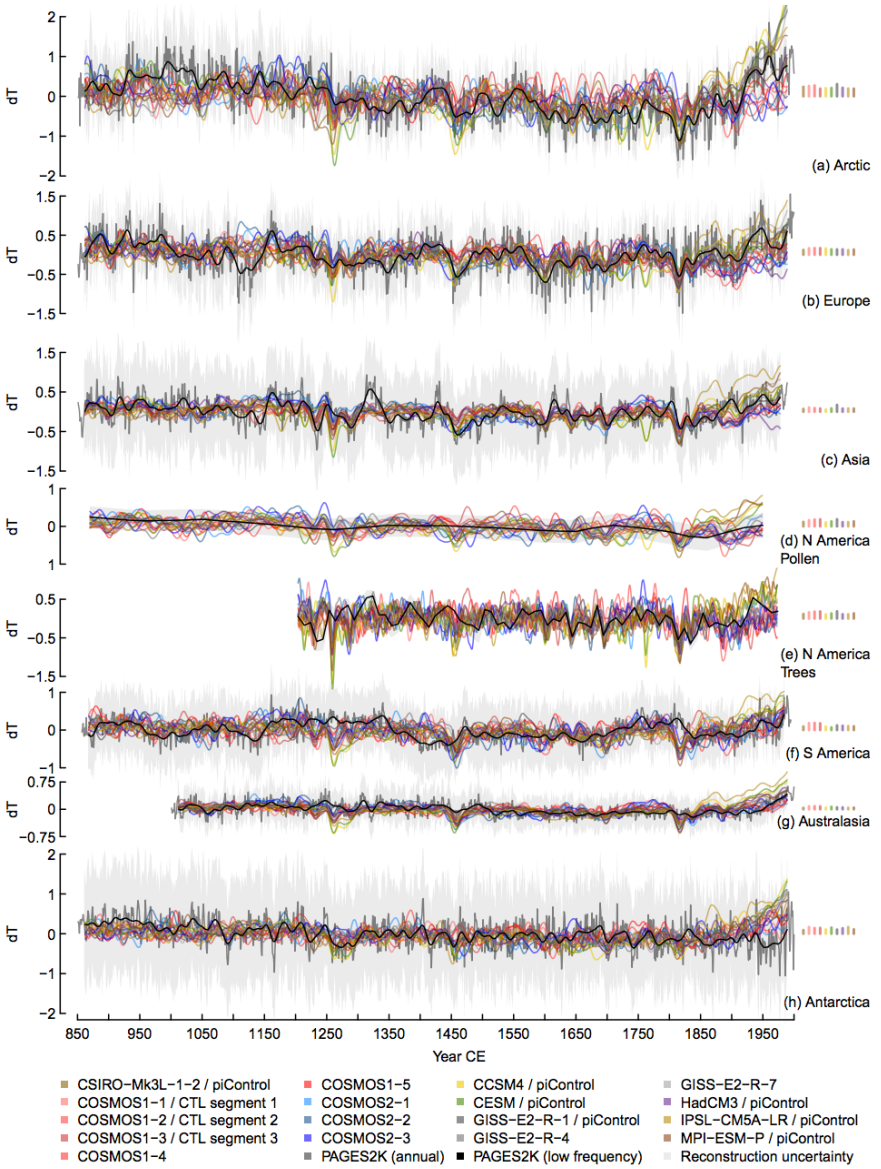
Received: 6 May 2015 – Published in Clim. Past Discuss.: 29 June 2015
Revised: 12 November 2015 – Accepted: 22 November 2015 – Published: 16 December 2015

**Abstract.** Estimated external radiative forcings, model results, and proxy-based climate reconstructions have been used over the past several decades to improve our understanding of the mechanisms underlying observed climate variability and change over the past millennium. Here, the recent set of temperature reconstructions at the continental-scale generated by the PAGES 2k project and a collection of state-of-the-art model simulations driven by realistic external forcings are jointly analysed. The first aim is to estimate the consistency between model results and reconstructions for each continental-scale region over the time and frequency domains. Secondly, the links between regions are investigated to determine whether reconstructed global-scale covariability patterns are similar to those identified in model simulations. The third aim is to assess the role of external forcings in the observed temperature variations. From a large set of analyses, we conclude that models are in relatively good agreement with temperature reconstructions for Northern Hemisphere regions, particularly in the Arctic. This is likely due to the relatively large amplitude of the externally forced response across northern and high-latitude regions, which results in a clearly detectable signature in both reconstructions and simulations. Conversely, models disagree strongly with the reconstructions in the Southern Hemisphere. Furthermore, the simulations are more regionally coherent than the reconstructions, perhaps due to an underestimation of the magnitude of internal variability in models or to an overestimation of the response to the external forcing in the Southern Hemisphere. Part of the disagreement might also reflect large uncertainties in the reconstructions, specifically in some Southern Hemisphere regions, which are based on fewer palaeoclimate records than in the Northern Hemisphere.

## 1 Introduction

The past millennium is an important period for testing our understanding of the mechanisms that give rise to climate system variability (e.g. Masson-Delmotte et al., 2013). Constraints on, and uncertainties in, external radiative forcings that drive climate change have been extensively documented (e.g. Schmidt et al., 2011, 2012). Such radiative forcing data sets can be used to drive climate simulations using the same model versions that are applied to simulate future climate changes. This allows an evaluation of the relative importance of the various forcings over time, while comparisons of past and future climate simulations place 20th century climate variability within a longer context (e.g. Schmidt et al., 2014a; Cook et al., 2015). Additionally, the availability of high-quality palaeoclimatic observations for the last 1000 years permits the reconstruction of regional-, hemispheric-, and global-scale climate variability (e.g. Mann et al., 1999, 2009; Cook et al., 1999, 2004, 2010; Jones et al., 2009; PAGES 2k Consortium, 2013, 2015; Masson-Delmotte et al., 2013; Neukom et al., 2014). As a result, the past millennium has become a useful test case for evaluating climate and Earth system models used within the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (Flato et al., 2013; Bindoff et al., 2013).

Palaeoclimate reconstructions provide opportunities to test the fidelity of modelled processes and their role in explaining past climatic variations. Reconstructions and simulations can




Lamont Campus
Columbia University

# Our workshop aims are to:

① Promote discussion `and collaboration across the PAGES2k and PMIP3 communities.

② Review Common-Era proxy archives appropriate for hydroclimate assessment.

③ Review the current ensemble of coupled model simulations of the Common Era.

④ Review and refine best practices for model-data comparisons of hydroclimate over the Common Era.

⑤ Advance understanding of model assessments and constraints on future projections using model-data comparisons of hydroclimate over the Common Era.

⑥ Define future goals, products and timelines for collaborations between the PAGES2k and PMIP3 communities.

# (Why) is this workshop timely?

# From the PAGES April 2016 Circular

## 2 – SPECIAL PAGES 2K ISSUE OF *CLIMATE OF THE PAST*

Interest in the PAGES 2k special issue (SI) has been outstanding, with 34 titles submitted. Our proposal to the journal *Climate of the Past* to host the SI has now been accepted. Manuscripts for the SI will be submitted between 1 July and 31 December 2016. The SI will be guest edited by volunteers Helen McGregor, Hans Linderholm, Pierre Francus, and the 2k coordinators. Feel free to communicate with the contact listed below if you are interested in contributing to any of the papers, or contact the 2k coordinators if you would like to propose additional contributions to the PAGES 2k SI.

| Manuscript Title | Contact |
|---|---|
| A review of available low-resolution proxy data for Australasian palaeoclimate variability over the past 2000 years | B Dixon |
| A spatial rainfall reconstruction for Australia using paleoclimate data covering the last 1000 years | M Freund |
| Forcing of subarctic climate variability during the last two millennia | M Nicolle |
| Patterns of precipitation changes in the Arctic during the last 2000 years | J Werner |
| 2000 years of spatial variability of surface temperature in the Arctic | D Divine |
| Arctic hydroclimate – a review | H Linderholm |
| Review of dead vegetation records of ice cap fluctuations, Svalbard, West Greenland, Baffin Island | G Miller |
| Reconstructing Antarctic climate over the last 2000 years | B Stenni |
| Snow accumulation rate variability in Antarctica over the last 2000 years | M Frezzotti |
| Trends and variability of the South American hydrological cycle for the last 2000 years | H Evangelista |
| 300 years of precipitation and extreme weather events from the Pacific coast of Central America | A Guevara-Murua |
| Tree-ring-based North American temperature reconstruction | K Anchukaitis |

*Working Title:*

# Comparing data and model estimates of hydroclimate variability and change over the Common Era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1 fl oz / 30 ml
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# Some Workshop Goals for the Paper

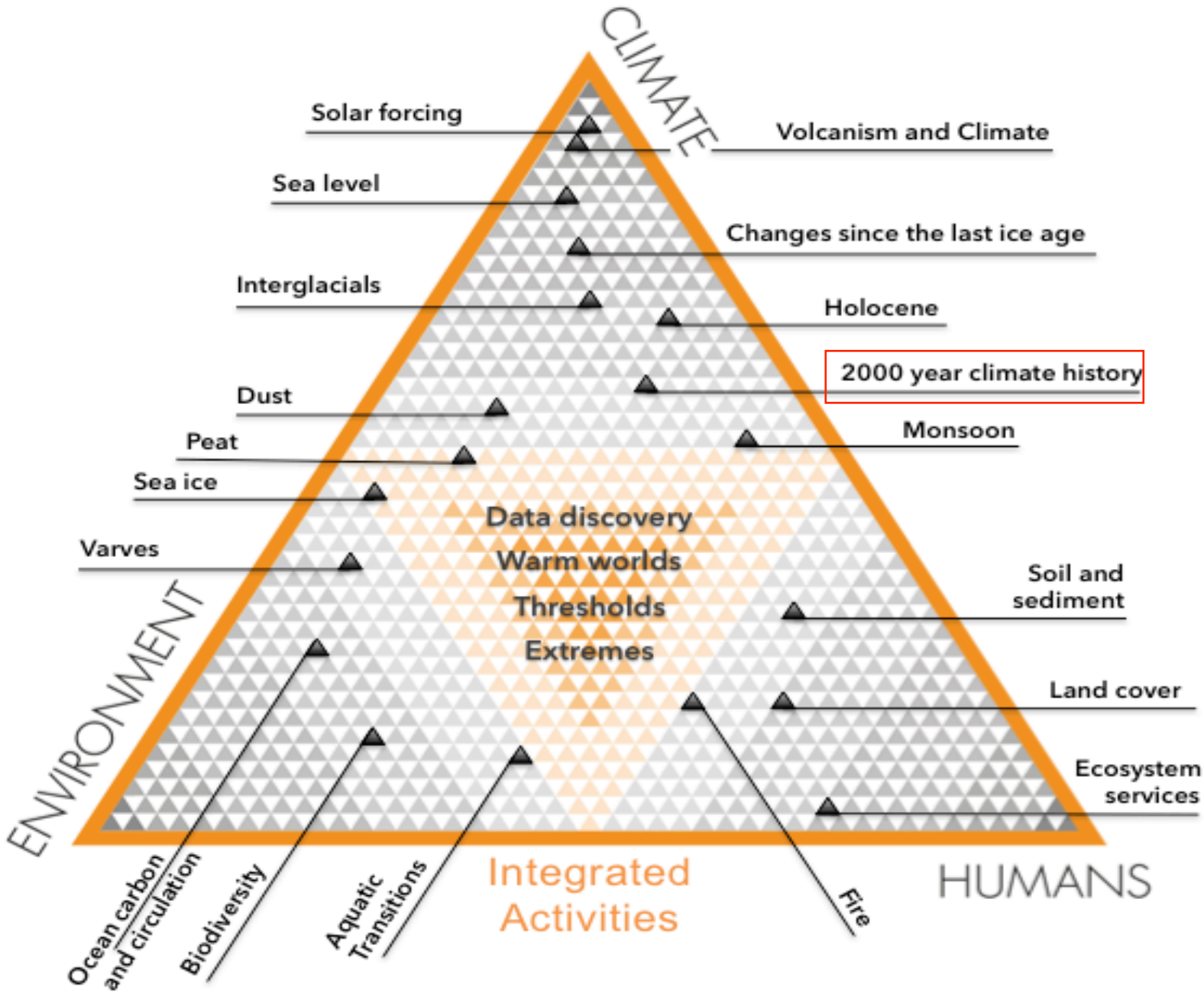
- Identify principal questions or areas we want to address
- Identify guidance on proxies and syntheses to use
- Identify hydroclimate variables of interest and utility
- Identify specific events of interest
- Identify relevant analyses for data-model comparisons

# Updates on PAGES 2k hydroclimate efforts

*J. Luterbacher, University of Giessen, Germany*
*juerg.luterbacher@geogr.uni-giessen.de*
*courtesy: M. Evans, L. von Gunten, J. Smerdon, B. Konecky, N. McKay*


*http://pastglobalchanges.org/index.php/ini/wg/2k-network/intro/*

# The 2k initiative within the PAGES structure

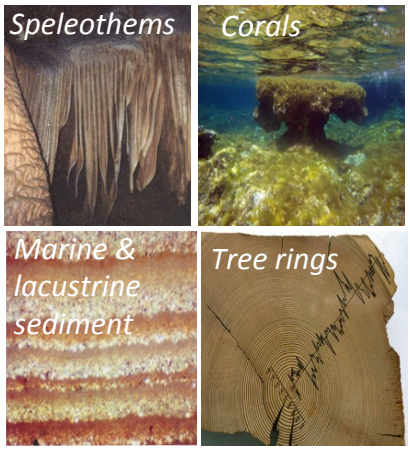


# What is the PAGES 2k initiative?

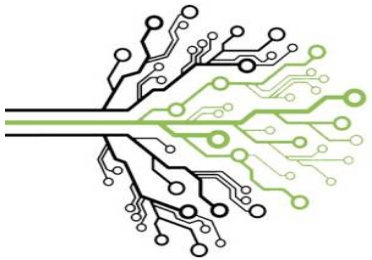
- The PAGES 2k initiative/network is a structure by which the climate community can come together to study problems requiring expertise beyond individual groups or institutions.
- Originally organized around geographic regions, transregional initiatives focused on synthesis, dataset development, and intercomparisons of observations and simulations.
- First 2 year phase: Continental temperature reconstructions
  Second 2 year phase (currently running): Hydroclimatic reconstructions at regional, continental and hemispheric scales
- The future of the 2k projects includes a special issue of Clim of the Past, bringing together these results (>30 papers planned).
- Active input from the community is needed to define and justify the value of a possible phase 3 of the program (after 2016).
- More information at:
  *http://pastglobalchanges.org/index.php/ini/wg/2k-network/intro/*

# PAGES 2k Project — Goals

Understanding paleoclimatic observations

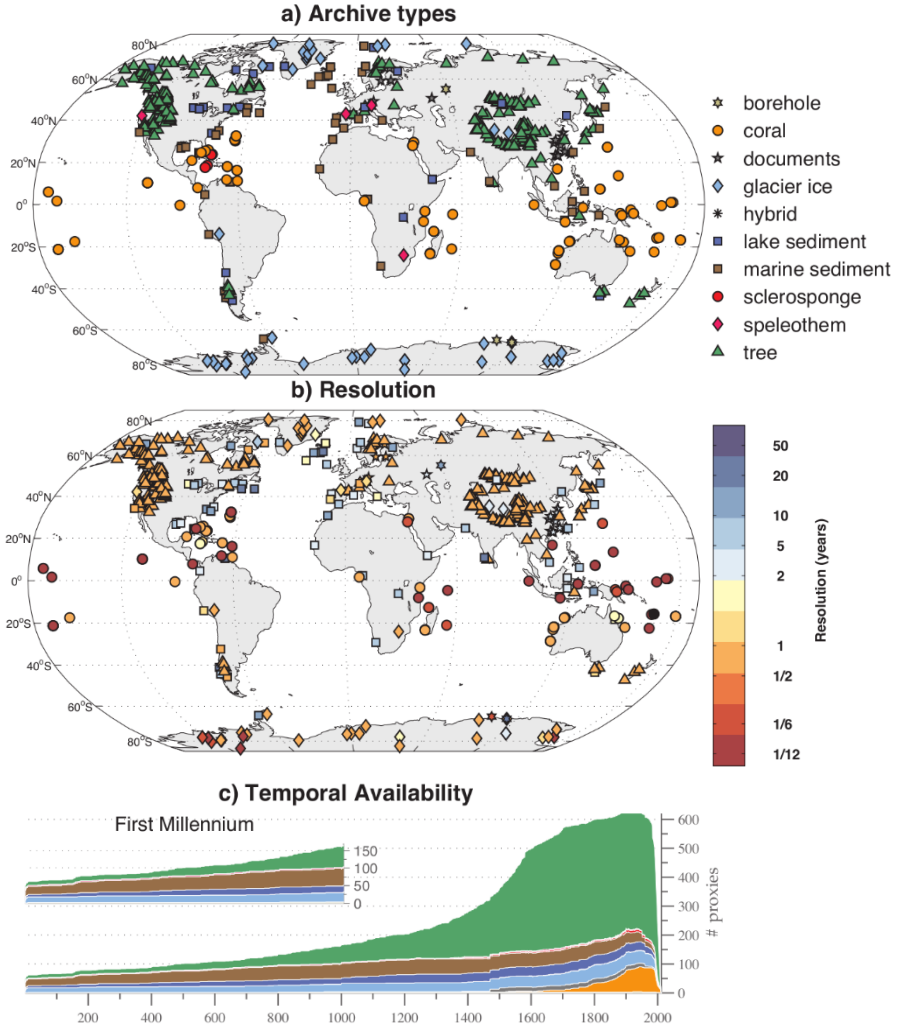



**Observations:**
Integration of time-uncertain, multivariate and multi-resolution records into climate reconstructions

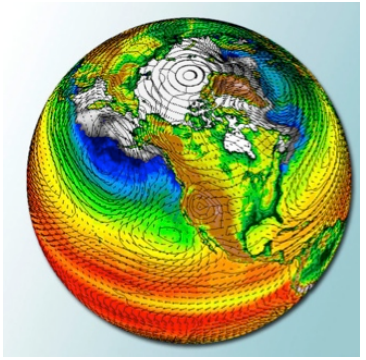


**Forward models:**
Process-based understanding of paleoclimatic observations

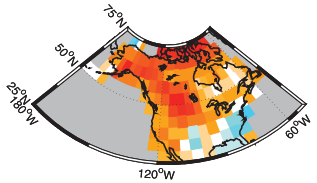
## PAGES2k observations: T (M, $\delta^{18}O$)




Understanding climate variation and change



**Climate simulations:**
Comparisons with paleo data/reconstructions, for understanding mechanisms, testing models, guiding observing network development, basis for data assimilation



$$P(A|B) = \frac{P(B|A)\,P(A)}{P(B)}.$$

**Methodologies:**
Test bed for climate reconstructions

*Modified/updated from Kaufman et al (2014)*

# PAGES 2k Project — Phase I

The **synthesis goal** for Phase I was to produce regional temperature reconstructions for all 2k regions in time for inclusion in AR5.

Phase 1 of the project ended with the publication of the first synthesis publication:

PAGES 2k consortium (2013) Continental-scale Temperature Variability During the Past Two Millennia, *Nature Geoscience* 6: 339-346

# PAGES 2k Projects

## Trans-regional projects

- Data-Model Comparison (PAGES2k and PMIP3)
- Reconstruction Methods Development
- Global 2k Open-Access Proxy Climate Database
- Onset of Industrial Warming in Terrestrial and Marine records
- …

Full list on the PAGES website

www.pages-igbp.org/workinggroups/2k-network/trans-regional-projects

# PAGES 2k Project — Phase I

## Gaps after Phase I

**Temperature**

- Some regions not covering full 2k period
- Reconstruction not always spatial
- Some regions not multi-proxy
- Selection criteria not uniform

→ Global T Database

**Hydroclimate!**

→ Focus for regional groups for Phase 2

**Trans-regional analyses**

- ➢ Data-model comparison
- ➢ Uniform synthesis products

→ Synthesis products

# PAGES 2k Phase II

# PAGES 2k Project — Phase II

## GOALS

- Regional 2000 year long **Temperature** and **Precipitation/ drought/etc. fields**
- Trans-regional synthesis products
- **Data-model comparison** and diagnostic analyses
- Completion of a central **2k database for Temperature and Precipitation**

# PAGES 2k Project — Phase II

## GOALS – practically

**Data base:** For T 2k regional working groups include all records that meet the common criteria.

**Field reconstructions:** Climate field reconstructions is the goal. But where data coverage is less dense index reconstructions for sub-regions should be made.

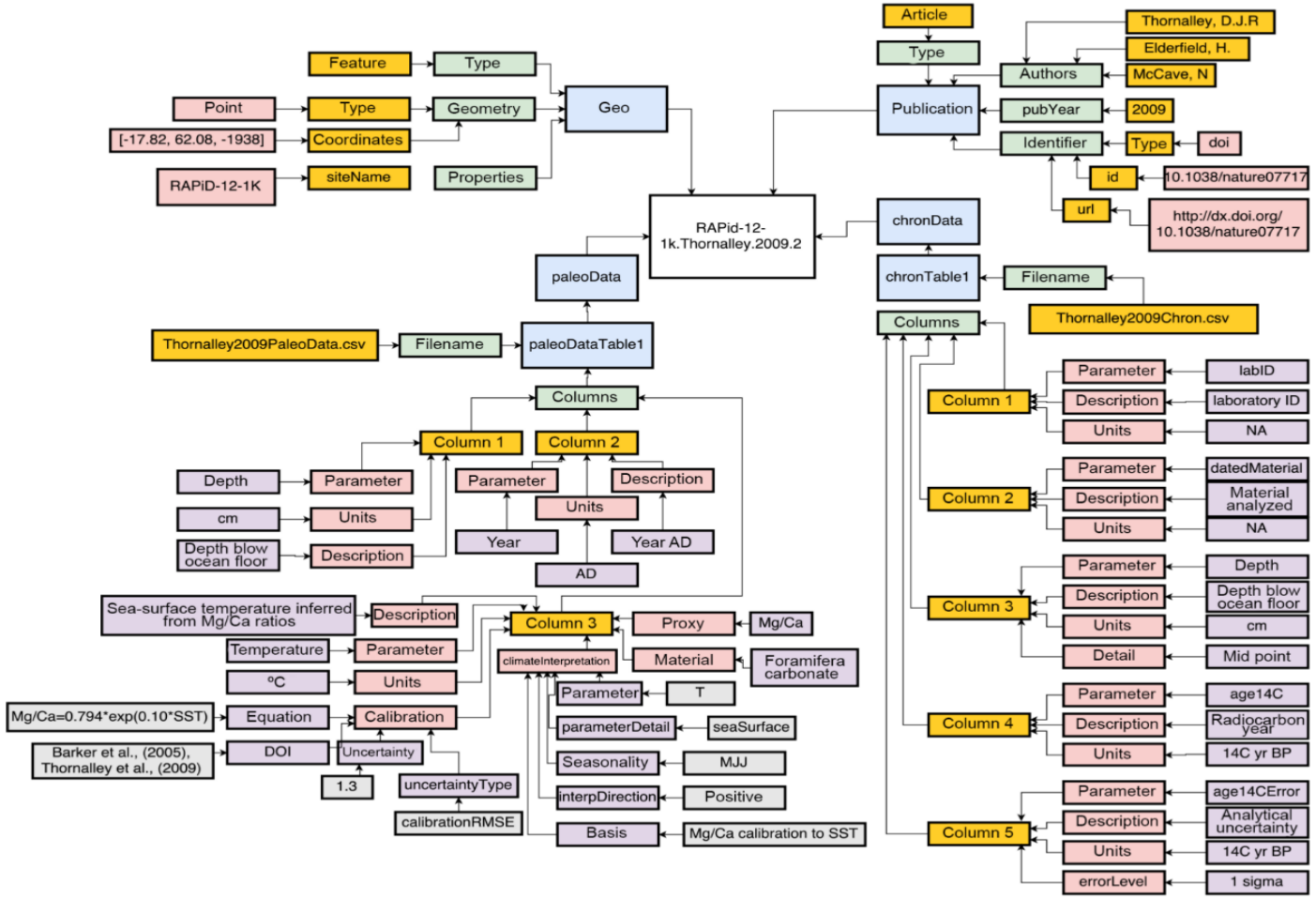
**High vs low resolution:** Fusing annual-scale and lower-resolution time series remains an important goal, but given the methodological difficulties, separate annually resolved and lower-resolution reconstructions can be targeted.

**Precipitation:** To avoid the problem of co-linearity of temperature and moisture, it might be necessary to reconstruct targets that combine multiple climatic influences.

# PAGES 2k Project — Phase II

- **Special issue** (e.g. Climate of the past). Opening in mid 2016, closing at the **end of 2016**. Regional papers and Trans-Regional studies
- Hydroclimate reconstructions with **regional focus**. Each region decides what HC parameter to reconstruct and what data and methods best suited.
  → *European_Med Drought Atlas (Cook et al. 2015)*
  → *Northern Hemisphere hydroclimate variability over the past twelve centuries (Ljungqvist et al. 2016)*
- **Isotope data collection** as trans-regional synthesis product. B. Konecky volunteered to co-lead and is looking for co-leaders and **regional experts**. To be used for Data-model exercises
- **Data quality control** crucial. Quality control procedures should be implemented for all 2k studies before publication

# A linked paleodata framework for data stewardship



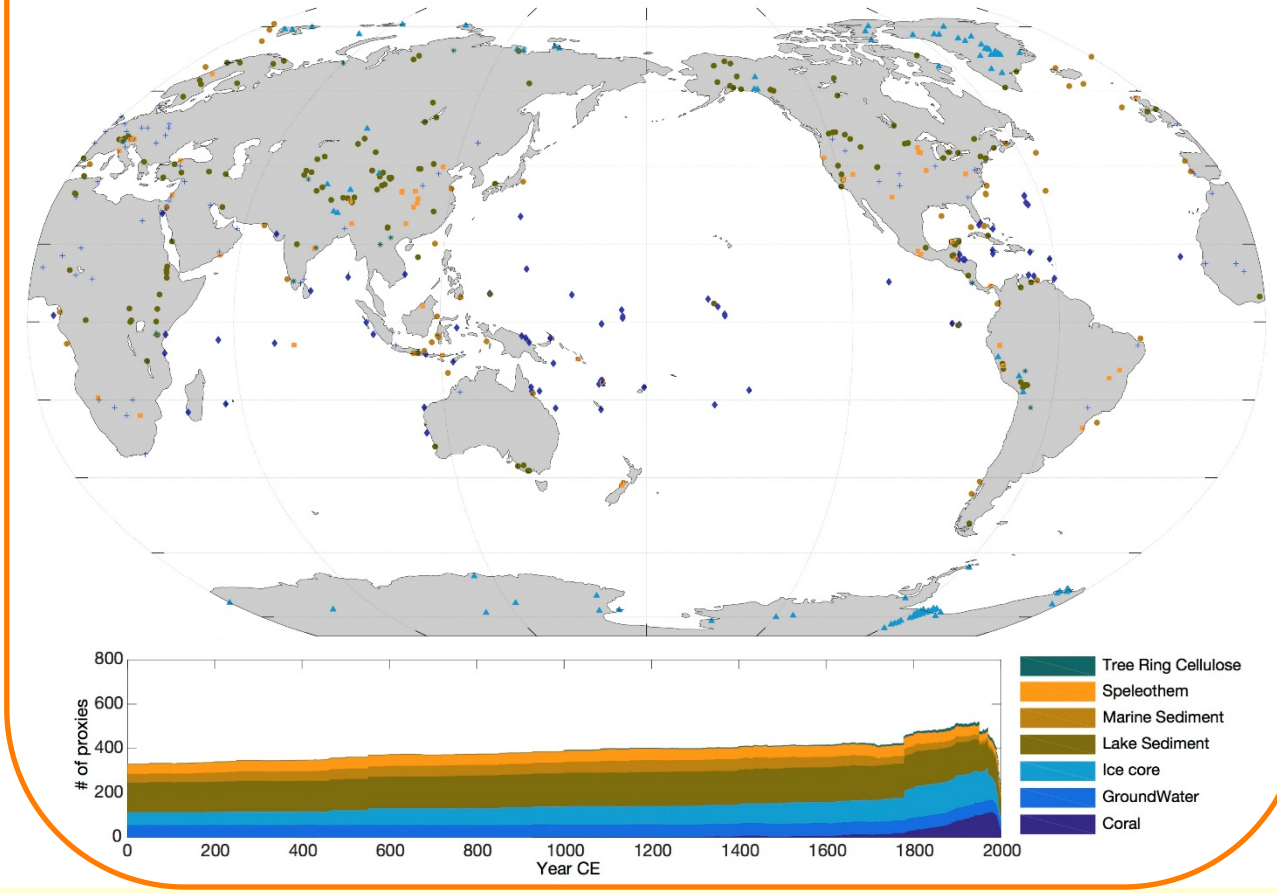

- Geolocation, references, chronology, data model, data all kept in a cross-platform, standard, open source and flexible format
- Allows new queries to emerge from existing databases like 2k.

*McKay and Emile-Geay (2016)*

# Regional circulation and hydroclimatology: Iso2k

**The Iso2k database v.0 (12/2015)**

(v.1 expected ~end of summer 2016)




- Water isotope observations in multiple archives
- Metadata, data models and linked identifiers for cross-cutting applications
- More info: Bronwen Konecky (bronwen.konecky@colorado.edu), Jud Partin (jpartin@ig.utexas.edu), overview talk this afternoon at 3 pm

# PAGES 2k Project — Phase II

## Timeline

***2016***

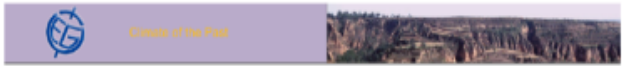
- Precip/drought/etc field reconstructions by regional groups
- Reconstruction and analysis of inter-regional Precip patterns
- Data-model Precip/drought/moisture comparison as a PMIP/2k collabor.
- Trans-regional products finalized

**Final synthesis** (synthesis papers and special issue in *Climate of the Past*)
*(for inclusion in PAGES proposals to the US and Swiss NSF to be written in 2017)*

***2017?***

*Large 2k conference? Possibly 3rd phase of PAGES 2k*

# PAGES 2k Project — Phase II, Synt. Papers and special issue Clim Past



Climate of the Past,
an international journal dedicated on the Climate History of the Earth



Upon manuscript registration, please indicate that your submission is part of the special issue

**"Climate of the past 2000 years: global and regional syntheses"**

In the manuscript registration form there will be a field (drop-down menu) to enter this information right after the manuscript title and authors.

The deadline window for submissions to the special issue is July 1st, 2016 and December 31st, 2016.

Special issue editors:
Helen McGregor mcgregor@uow.edu.au
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Nerilie Abram nerilie.abram@anu.edu.au
Michael Evans mnevans@umd.edu
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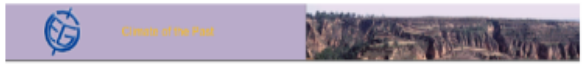
Raphael Neukom raphael.neukom@giub.unibe.ch
Chris Turney c.turney@unsw.edu.au

**Special Issue in Climate of the Past (CP), Additional Rules**

(1) The special issue (SI) and all manuscripts to be published in it must be within the journal scope and comply with the same quality standards as regular submissions to CP:
http://www.climate-of-the-past.net/index.html

(2) Since the publication costs of CP are covered by service charges rather than subscription charges (open access publishing), there are no prefixed restrictions with respect to the number and length of papers. The only relevant criteria are the quality and relevance of the individual manuscripts.

(3) The service charges (page charges) for special issue papers are the same as for regular papers: http://www.climate-of-the-past.net/submission/service_charges.html
Color figures as well as the addition of electronic supplementary material (movies etc.) are included without additional cost. For each paper, the service charges have to be paid when the paper is published in the discussion stage. We editors expect the payment is performed directly by the authors.



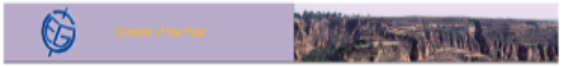
Climate of the Past,
an international journal dedicated on the Climate History of the Earth

Co-Editors in chief: Carlo Barbante, Nerilie Abram, Thorsten Kiefer, Marie-France Loutre, Denis-Didier Rousseau

**"Climate of the past 2000 years: global and regional syntheses"**

**Authors contributing to the SI (paper #, provisional title, provisional authors)**

| | Provisional Title | Lead author(s) |
|---|---|---|
| 1 | A review of available low-resolution proxy data for Australasian palaeoclimate variability over the past 2000 years | Bronwyn Dixon, Jonathan Tyler, Russell Drysdale |
| 2 | A spatial rainfall reconstruction for Australia using paleoclimate data covering the last 1000 years | M. Freund |
| 3 | Forcing of subarctic climate variability during the last two millennia | Marie Nicolle, Maxime Debret, Nicolas Massei, et al. |
| 4 | Patterns of precipitation changes in the Arctic during the last 2K | Johannes Werner, Dmitry Divine et al. |
| 5 | 2000 years of spatial variability of surface temperature in the Arctic | Johannes Werner, Dmitry Divine et al. |
| 6 | Arctic hydroclimate – a review | Hans Linderholm et al. |
| 7 | Review of dead vegetation records of ice cap fluctuations, Svalbard, West Greenland, Baffin Island | Giff Miller, Jason Briner |
| 8 | Reconstructing Antarctic climate over the last 2000 years | Barbara Stenni, Nerilie Abram, Dmitry Divine, Hugues Goosse et al. |
| 9 | Snow accumulation rate variability in Antarctica over the last 2000 years | Massimo Frezzotti, Dmitry Divine, Daniel Dixon, et al. |
| 10 | Trends and variability of the South American Hydrological Cycle for the last 2 kyr | Heitor Evangelista, Catalina Gonzalez Arango, Myriam Khodri et al. |
| 11 | 300 years of precipitation and extreme weather events from the Pacific coast of Central America | Alvaro Guevara-Murua (lead), Caroline Williams, Erica Hendy |
| 12 | Tree-ring-based North American temperature reconstruction | Kevin Anchukaitis, Greg Pedersen |
| 13 | Low-frequency hydroclimate synthesis – major century-to millennial-scale patterns and trends in hydroclimate in North America over the past 2 kyr | Bryan Shuman, Nick McKay |
| 14 | North American borehole temperature reconstruction | Fernando Sauntero, Hugo Beltrami |
| 15 | Summer temperature and drought co-variability across Europe since 800 CE | Fredrik Charpentier Ljungqvist |



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| | | |
|---|---|---|
| 16 | Climate variability in the Iberian Peninsula during the Maunder minimum inferred from tree-ring records and documentary sources | Ernesto Tejedor |
| 17 | Revisiting Iberian climate variability during the last millennium | Ulf Büntgen |
| 18 | European-scale cloud/sunshine reconstructions from the d13c records | Mary Gagen / Danny McCarroll |
| 19 | A combined data-model assessment of seasonal differences in past climate variability | Dominik Fleitmann |
| 20 | Combined high to low-frequency European climate variability of the Common Era | EuroMed2k Consortium |
| 21 | The impact radiocarbon age model uncertainty on the timing of ocean temperature change over the past 2000 years | David Reynolds (alternate contact Helen McGregor) |
| 22 | Temporal and spatial variability in global ocean d18O for the 0-2000 CE interval | Diane Thompson (alternate contact Helen McGregor) |
| 23 | A new window for probing tropical climate variability during the LIA and MWP: a regional synthesis based on muddy shelf sediment records from western Pacific marginal seas | Chen, Min-Te |
| 24 | Warm season temperature variation through 1000 years over East Asia | Huang Zhang, Juerg Luterbacher |
| 25 | Annual precipitation field variability for China over the past 500 years | Feng Shi, Zhengtang Guo, Chenxi Xu and Asia2k members |
| 26 | Geo-archeological evidence of climatic variability during LIA in North West Himalaya | Rakesh Saini, Milap Chand Sharma, Sanjay Deswal, Parvendra kumar |
| 27 | Deducing climate changes and hazards using Persian historical documents | Hamid A. K. Lahijani, Majid Naderi Beni |
| 28 | Precipitation variations over the Eastern Asian monsoon region during the past 1000 years | Zhixin Hao, Quansheng Ge, Xuemei Shao |
| 29 | Multi-proxy analysis for palaeo-climate change review in pre-historic, proto-historic and historic Sri Lanka | Poorna Yahampath, G.M.Bandaranayake |
| 30 | Indian summer monsoon history during the last 400 years: a regional synthesis based on 7 tree ring oxygen isotope chronologies around the Himalaya | Chenxi Xu, Masaki Sano, Takeshi Nakatsuka |
| 31 | Last Millenium climate modes as obtained from PAGES 2k SST proxy data: coherent patterns and possible mechanisms | Monica Ionita, Norel Rimbu, Gerrit Lohmann |

Active input from the community is needed to define and justify the value of a possible phase 3 of the program (after 2016).

# PAGES 2k Project — Phase II

## Where are we now?

*Summary of criteria for proxy records included in the PAGES 2k database*

| | | Annually banded | | Non-annually banded | |
|---|---|---|---|---|---|
| | | Terrestrial | Marine | Terrestrial | Marine |
| Record duration | Minimum during the past 2 kyr: | 300 yr | 50 yr | 500 yr | 500 yr |
| Resolution | Average of at least one analysis every: | ≤ 50 yr | ≤ 50 yr | ≤ 50 yr | ≤ 200 yr |
| Relation between proxy value and climate | Either quantitative or qualitative | Described in a peer-reviewed publication | | | |
| Chronological accuracy | | Cross-dated or layer counted | | At least one control point near the end (most recent) part of the record and one near the oldest part, or 1 AD, whichever is younger. Records >1ka must include min. 1 additional age midway between the other two. | |

# Contribution of this workshop to the 2nd and possibly 3rd Phase of PAGES 2k

① Promote discussion and collaboration across the PAGES2k and PMIP3 communities

② Review Common-Era proxy archives appropriate for hydroclimate assessment

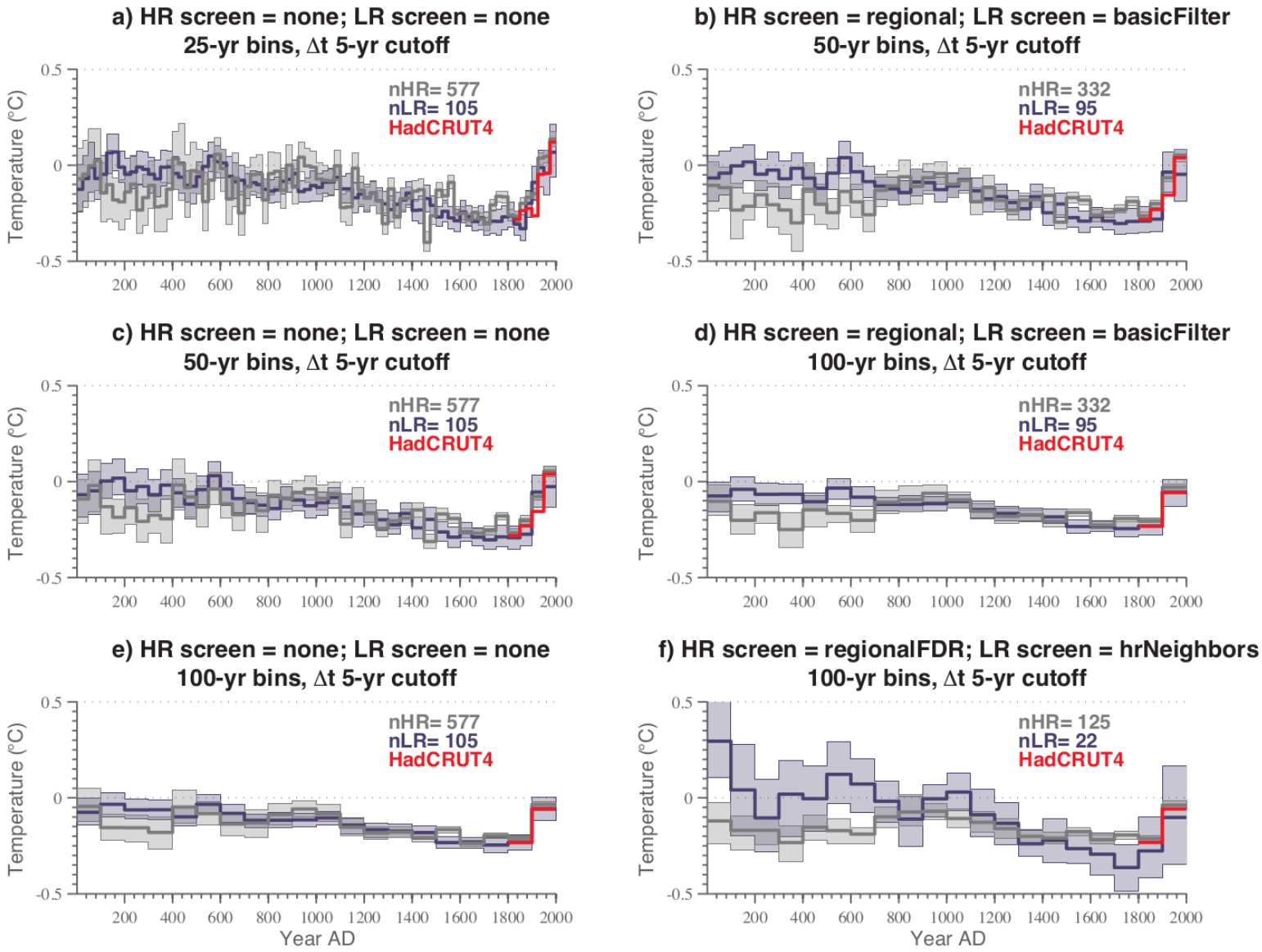
③ Review the current ensemble of coupled model simulations of the Common Era

④ Review and refine best practices for model-data comparisons of hydroclimate over the Common Era

⑤ Advance understanding of model assessments and constraints on future projections using model-data comparisons of hydroclimate over the Common Era

⑥ Define future goals, products and timelines for collaborations between the PAGES2k and PMIP3 communities

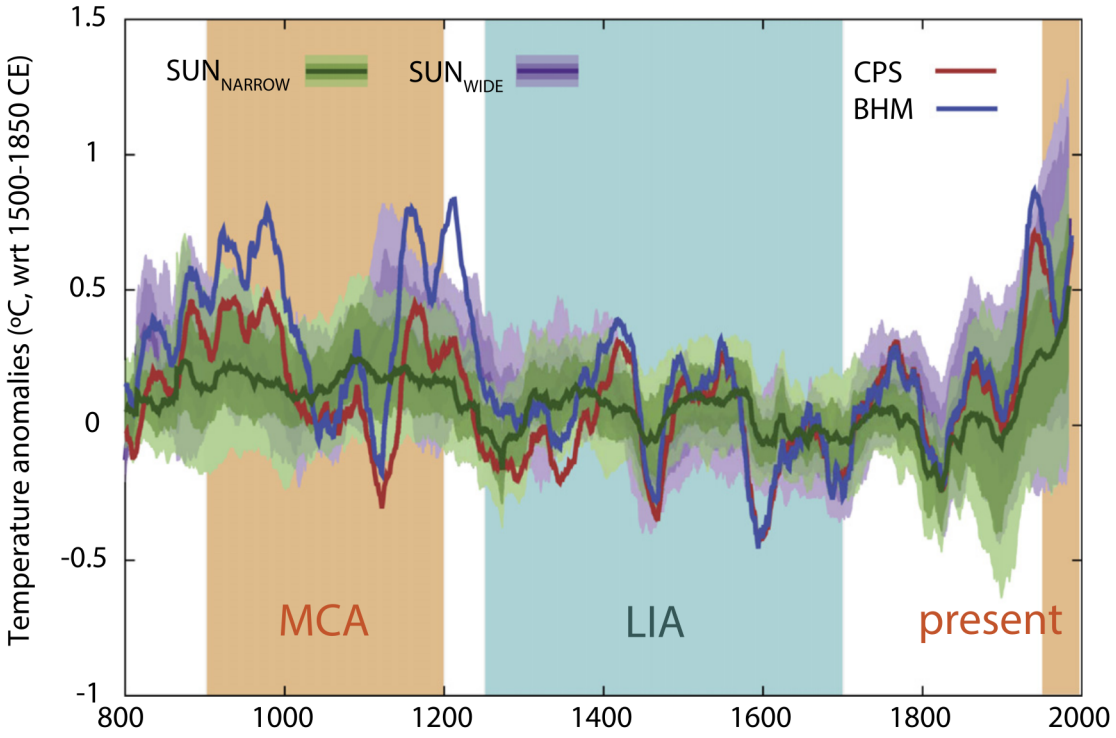
# Revised temperature-sensitive paleo database

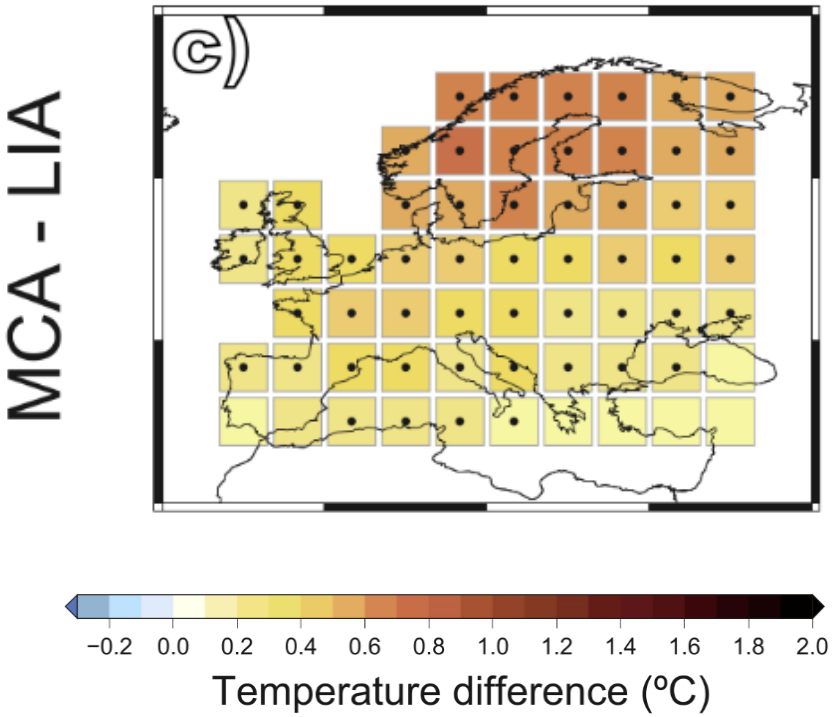



*PAGES2k Working Group (2016 in prep)*

- High and low resolution composite global means robust to screening, filtering and binning choices.

# Spatiotemporal temperature reconstruction for Europe

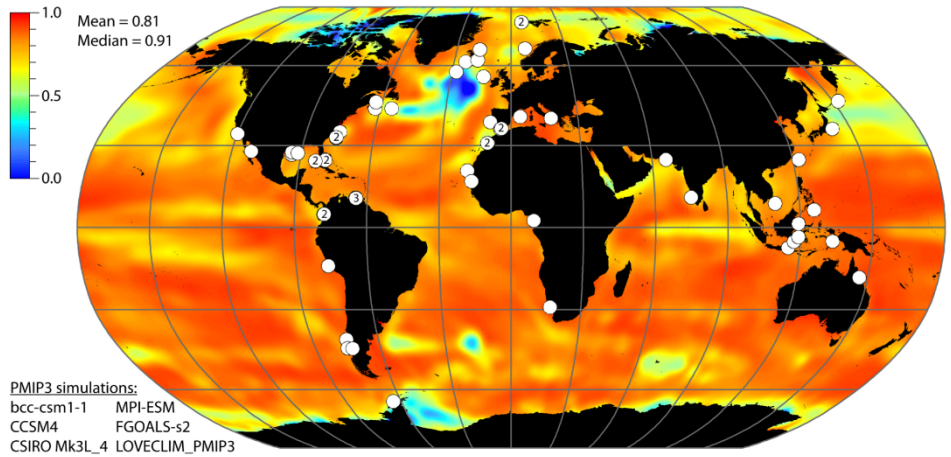


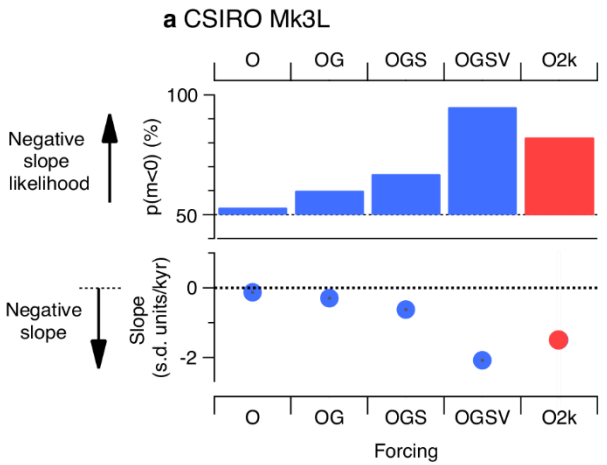



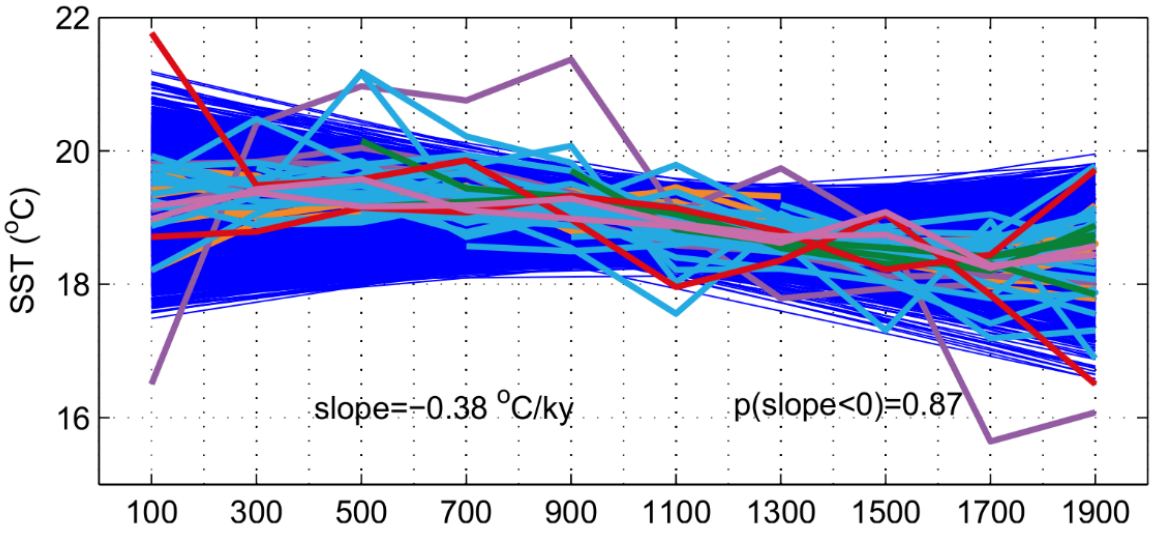

*Luterbacher et al (2016)*

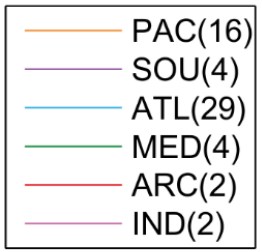
- Spatial structure of recent warm-cold cycle resolved
- Reconstructions more variable than realistically forced simulations – why?

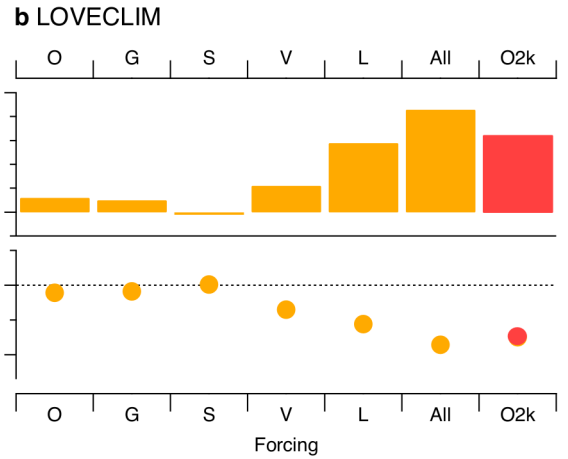
# Global SST at bicentennial resolution



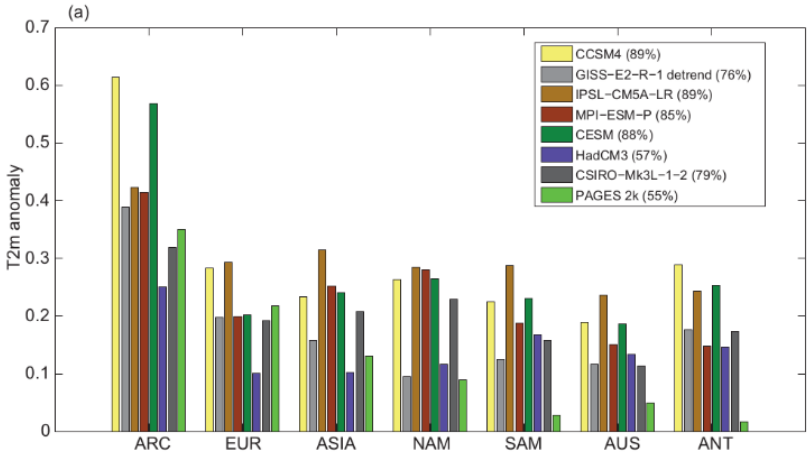




McGregor et al (2015)

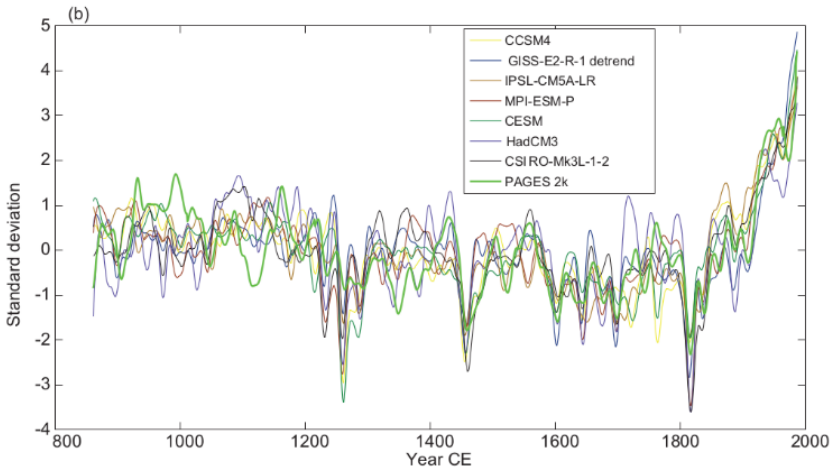
- Pre-anthropogenic last millennium: small global surface ocean cooling
- Observations most consistent with an increase in frequency of explosive volcanism or land use change in recent centuries

# Comparisons of reconstructions and simulations

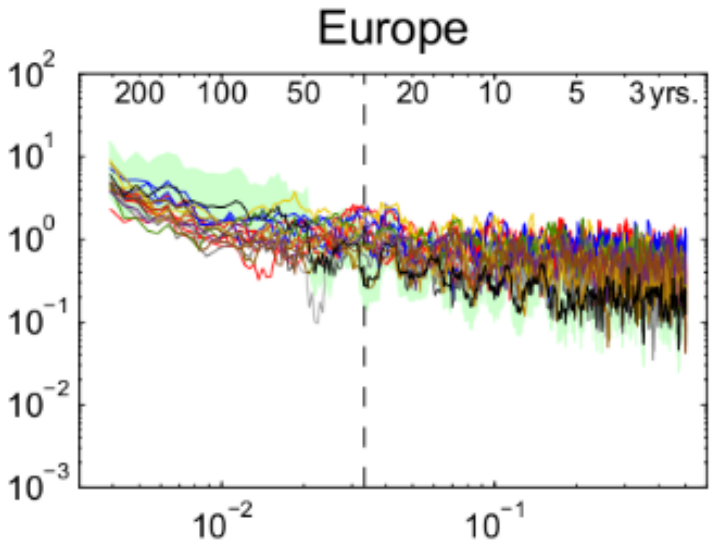
1st EOF ampl. (scaled to T2m)




1st PC (standardized)



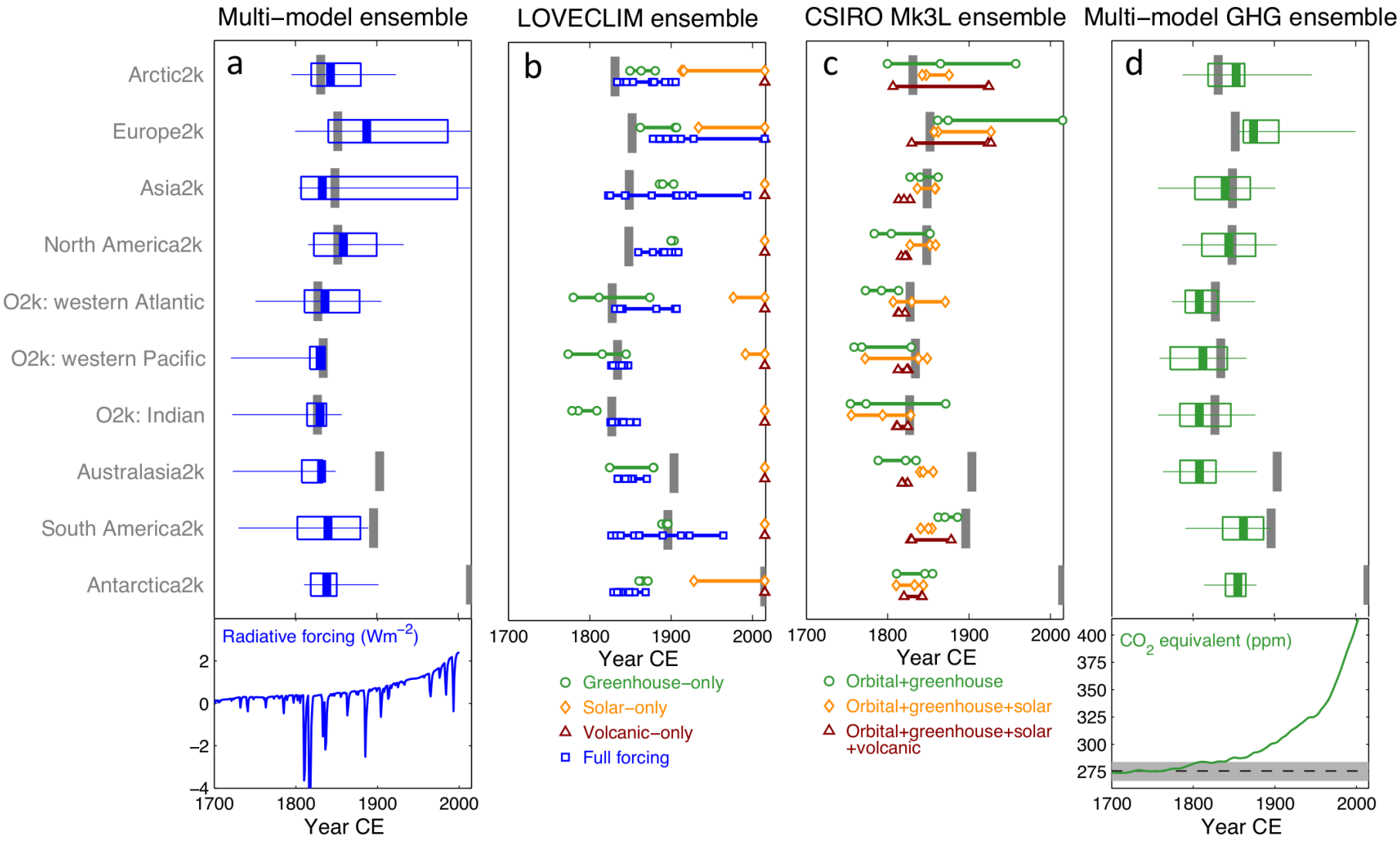

Power (normalized)




Pages2k Consortium (2013); Pages2k-PMIP3 Group (2015)

- If leading patterns in reconstructions and realistically forced simulations are in agreement, we can interrogate the simulations to understand mechanisms most likely underlying reconstructed variance.

# An early start to anthropogenic global warming?




*Abram et al (2016, revised)*

- Tropical and NH regions warmed as early as early – mid 19$^{th}$ c in reconstructions and simulations; time of emergence ~100y later.
- SH regions warm later in reconstructions but not simulations.

# How do the 2k projects function?

- Community-driven
- Mutual respect
- Healthy skepticism
- Transparency
- In-person milestoned workshops
- Frequent communications and virtual meetings
- Consensus decisionmaking
- Support from the International Program Office (Bern)
- Stimulating drinks

http://www.futureearth.org/blog/2015-aug-18/virtually-ocean2k

# Summary (Haiku version)

Obs, sims agreeing.
pre-Anthropocene cooling.
Warming starts early?

Context is needed.
Community, consensus.
Coffee, whiskey, wine.

*Special thanks to: Darrell Kaufman, Lucien von Gunten, Nerilie Abram, Bronwen Konecky, Joerg Luterbacher, Raphi Neukom, Julien Emile-Geay, Jason Smerdon, David Nash, Helen McGregor, Ulf Buentgen, Joelle Gergis*

Join us! Learn more at:
http://pastglobalchanges.org/index.php/ini/wg/2k-network/intro/

# Scoping Exercise

***A means by which we identify the things we do and do not know…***

# What do you want to learn from the workshop?

# What proxies are available?

*I hope to learn more about the reliability of hydrological sensitive proxy data and the challenges in generating reconstructions.*

*To learn what high and low resolution proxy data exist from the different areas of the world to spatially reconstruct hydroclimatic fields over the CE.*

*If I have to pick one reason to go to the workshop, it wold be that I'd like to learn more about the available hydroclimate data over the CE: what sorts of spatial coverage we have worldwide and what caveats are involved with using it quantitatively.*

*How hydroclimate is being approached by the paleo community.*

# CE Hydroclimate Proxies

- Trees – PDSI, Precip, Snow Cover, Soil Moisture, Runoff, Fire
- Corals – SST, O18 Seawater
- Sediments – Pollen, Laminated Seds, Lake Levels, Rainfall Iso composition, Runoff
- Speleothems – Rainfall, Groundwater O18, Snowcover
- Documentary Evidence – Floods, Droughts, Extremes, Impacts (Famine/Crop failure)
- Icecores – O18, Precip, Fire, Dust, Aerosols, Deuterium, Methane
- Peat - Fire

# CE Hydroclimate Large-Scale Syntheses

- Drought Atlases
- Iso2k
- PAGES2k
- Global Lakes Status DB
- SedDB

# Availability of model simulations and their performance

*More about the limitations of the PMIP models when it comes to representing past hydroclimate, which seems to be (to my untrained eye) quite significant.*

*As a data person, I'm interested in learning more about how well models perform in reproducing observation of hydroclimate and how biases in the models can be addressed in the context of proxy/model comparisons.*

A better understanding about the different models and how paleo-data might be incorporated.

# ~CE Climate Simulations

- PMIP3 (GISS Ensemble)
- NCAR CESM Last Millennium Ensemble
- COSMOS
- VOLMIP

# How should data-model comparisons be done?

*I'm especially interested in learning about the methods behind data-model comparisons.*

*A better understanding of how proxies and models can help each other to overcome their own limitations. To overcome my impression that many times we are comparing apples and oranges. Do proxies and models exhibit similar temporal and spatial variability that accurately represent natural climate variability?*

*I hope to learn some strategies for powering through the major obstacles to hydroclimate data-model comparisons, especially (1) maximizing the gain from proxies that are NOT annually resolved and (2) using the 'right' level of complexity for proxy system models so we can translate multiple proxy types into variables that can be meaningfully compared with climate model output.*

# How should data-model comparisons be done?

*How do we do these comparisons? This is less obvious than temperature, since the models perform worse at reproducing hydroclimate observations, the unforced component of precipitation variability is higher, and the spatial scales involved finer.*

# What is the most important question that can be answered with hydroclimate data-model comparisons over the CE?

# Mutual Checks on Uncertainties and Biases

*Do we understand the uncertainties and limitations of simulated and reconstructed hydroclimate data, and how can we then build confidence when comparing or cross-validating both tools?*

*Hopefully we can use such comparisons to better understand the limits of climate models in providing useful hydroclimate information, but also how to use the mechanisms implemented in the models to assess uncertainties in the proxy data.*

*I think constraining decadal variability and closing the gaps between what the proxies are saying is our truth vs. what the models predict is a major source of concern. We can move closer to understanding the mismatch between paloclimate data and modeling efforts with new techniques such as proxy system modeling and paleoclimate data assimilation.*

# Understanding CE Climate Changes

*In my opinion, identifying the spatial pattern and the extent of dryness during any particular climatic interval (e.g. Medieval Climate Anomaly, Little Ice Age, Modern Period) is the most crucial question that needs immediate and precise answers.*

*Is there evidence for coherent large-scale hydroclimate changes during the C.E. that are externally forced? Where and through what mechanisms did these forced hydroclimate responses occur?*

*Hydroclimate data-model comparisons can provide insight into the dynamics and processes of reconstructed and observed changes, trends, variability and extremes of precipitation and drought on different space and time scales.*

*If observations, reconstructions, simulations are accurate and precise enough, and are consistent with each other within uncertainty: what are the mechanisms by which we obtain long-term, continental scale drought in both the pre and post anthropogenic periods? (e.g. before and after 1700 CE)?*

*Is it possible to robustly constrain large-scale modes of hydroclimate variability during the C.E. using the available network of proxy records? If not, where and what type of additional proxy data and/or proxy system models are needed?*

# Separating Forced and Internal Variability

*The most important research direction is understanding the magnitudes of forced and internal climate variability on decadal-to-centennial timescales.*

*What are the relative roles of internal and forced variability in hydroclimate on different spatial and temporal scales, and what are the probabilities for extreme events?*

*What are the relative contributions of internal variability versus external forcings on hydroclimatic variability, and how has this changed through time?*

*Which time variations in the proxy records are externally forced, which come from ocean-related internal variability, and which are explainable by weather variability alone?*

*I think the question of diagnosing the extent of and mechanisms for forced changes in the hydrological cycle is a key target for CE data/model comparisons.*

# Understanding the Full Spectrum of Variability

*I'm really interested in the question of what forcing does to hydroclimatic variability with different frequencies, particularly in regions sensitive to lower-frequnecny (and thus not well-characterized) variability. Establishing model skill for different parts of the hydroclimate spectra regionally could be key to understanding if/how and or why such frequencies (don't) change in a forced regime.*

*What is the ability of models to simulate hydroclimate on decadal and longer time scales in various regions, just how much they underestimate (or overestimate, but unlikely) the magnitude of that variability. Are there any regions where they are "better" and if so, can we glean any information as to why? (e.g. regions where teleconnection patterns are well/poorly captured).*

# Constraining the Future

*Can hydroclimate data-model comparisons over the C.E. be used to inform projections of anthropogenic hydroclimate changes?*

*It would answer if ongoing droughts in certain parts of the world are truly exceptional and represent a shift change in the soil moisture, thus, the permeant drought idea for CA or the Mediterranean.*

*How proxy data can effectively help to constrain model uncertainty in future climate projections.*

*As for most important questions/outcomes from hydroclimate data-model comparisons more broadly, I think this is centered around understanding modern extremes and processes beyond the instrumental records. What future changes in hydroclimatic extremes might we expect?*

# Can we set an order of preference?

① Mutual Checks on Uncertainties and Biases

② Understanding CE Climate Changes

③ Separating Forced and Internal Variability

④ Understanding the Full Spectrum of Variability

⑤ Constraining the Future

⑥ Others?