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### **Attention all 2k Network Participants:**

Interest in the wrap-up PAGES 2k special issue has been excellent. Thirty-four papers are now planned for the journal *Climate of the Past*. Please communicate with the contact listed in the table of contents (below) if you are interested in contributing to any of the papers.

**We are soliciting input from the global 2k community to shape the future of the project.** Will there be another phase of the PAGES 2k project? If so, what will be the focus, outcomes, and organizational structure? We would really like to hear from you about the direction it should take.

This circular is sent to all 2k mailing lists subscribers. Feel free to forward it to interested colleagues with a link to the [PAGES 2k list](#) where they can sign up to receive future circulars. Also let Lucien know if you wish to be removed from the 2k mailing list. All previous circulars are available online on the [PAGES 2k Network](#) website.

Best wishes from the 2k coordinators,

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## 1 – FUTURE OF PAGES 2K PROJECT – YOUR INPUT NEEDED

Phase 2 of the PAGES 2k project closes at the end of 2016 with the publication of the *Climate of the Past* Special Issue and other regional and trans-regional synthesis products. We are soliciting input from the 2k community to guide the future of the project. Specifically, what themes, scientific questions, and outcomes do you envisage for a new phase of the project over the next two or three years? How would the project structured? Or is the primary goal for the next couple of years to complete the work that is already underway as part of Phase 2? Your input would be most useful if it was received before the upcoming PAGES SSC meeting, which begins 20 May. Please send your working group or individual ideas and comments to [Lucien von Gunten](#). Following input from the PAGES 2k community and discussion by the SSC, we will report back with ideas about the future of the 2k project in the next 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
Low-frequency hydroclimate synthesis – major century- to millennial-scale patterns and trends in hydroclimate in North America over the past 2000 years	B Shuman
North American borehole temperature reconstruction	F Saunter
Summer temperature and drought co-variability across Europe since 800 CE	FC Ljungqvist
Climate variability in the Iberian Peninsula during the Maunder minimum inferred from tree-ring records and documentary sources	E Tejedor
Revisiting Iberian climate variability during the last millennium	U Büntgen
European-scale cloud/sunshine reconstructions from the $\delta^{13}\text{C}$ records	M Gagen
A combined data-model assessment of seasonal differences in past climate variability	D Fleitmann
Combined high to low-frequency European climate variability of the Common Era	EuroMed2k
The impact radiocarbon age model uncertainty on the timing of ocean temperature change over the past 2000 years	D Reynolds
Temporal and spatial variability in global ocean $\delta^{18}\text{O}$ for the 0-2000 CE interval	D Thompson
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
Warm season temperature variation through 1000 years over East Asia	H Zhang,
Annual precipitation field variability for China over the past 500 years	F Shi
Geo-archeological evidence of climatic variability during LIA in North West Himalaya	R Saini
Deducing climate changes and hazards using Persian historical documents	HAK Lahijani
Precipitation variations over the Eastern Asian monsoon region during the past 1000 years	Z Hao
Multi-proxy analysis for palaeo-climate change review in pre-historic, proto-historic and historic Sri Lanka	P Yahampath

Indian summer monsoon history during the last 400 years: a regional synthesis based on 7 tree ring oxygen isotope chronologies around the Himalaya	C Xu
Last millenium climate modes as obtained from PAGES 2k SST proxy data: coherent patterns and possible mechanisms	M Ionita
Global features in atmospheric circulation and hydroclimate from water isotopes during the past 2000 years	B Konecky
Comparing data and model estimates of hydroclimate variability and change over the Common Era	J Smerdon
Hydroclimate variability in Scandinavia over the last millennium- insights from a climate model-proxy data comparison	K Seftigen

### 3 – UPDATE FROM THE 2K WORKING GROUPS

#### **Africa2k**

Work is progressing on a major review of African hydroclimate variability over the past 2000 years, which is to be submitted to *Quaternary Science Reviews*. Following on from the AfQUA Conference in Cape Town last year, discussions are still ongoing regarding the future direction of the Working Group. A subset of group members could use the key paleodata identified in the QSR review paper to generate a continental-scale statistically-derived synthesis of moisture variability over Africa for the last 2k. A teleconference to consider the future direction of the group will take place on 18, 19 or 20 May. Any researchers working on Africa2k-related themes are encouraged to sign up to the [Africa2k email list](#) to receive further details.

#### **Antarctica2k**

Using a greatly expanded dataset and new reconstruction methodologies, ice core isotope records have now been compiled for seven distinct climatic regions (Antarctic Peninsula, West Antarctic Ice Sheet, East Antarctic Plateau, and four coastal domains of East Antarctica). Continental-scale reconstructions will be made for temperature and for snow accumulation rates, where the resolution is sufficient. The ECHAM-wiso model, nudged to ERA, will be used to explore the relation between isotopes and temperature. This product will be used as a benchmark for isotope-enabled models and for comparison with paleoclimate evidence from other archives (borehole temperatures, inert gas isotopes, and marine and lake sediment records).

#### **Arctic2k**

In autumn 2015, Hans Linderholm took over the leadership from Anne Hormes and Jostein Bakke. The group thanks them for their leadership during the past couple of years. In December, the group held a meeting in association with the AGU in San Francisco, where some current research was presented and the group's contribution to the SI was discussed. There is high activity within the group, with several significant contributions now planned.

#### **Asia2k**

Asia2k is collecting data from tree rings, historical documents, and sediments in Asia, and working on the papers for the SI. The papers will focus on temperature and precipitation variability, changes in the Indian summer monsoon and Eastern Asian monsoon during the past a few hundred years, extending back to past 1000 years.

#### **Australasia2k**

The 4th Aus2k Working Group meeting was held on 27-29 October 2015 in Auckland, New Zealand. The aim of the group's final workshop was to review the group's progress and to identify research from the Australasian research community that will contribute to the completion of Phase 2 of the PAGES 2k project. The workshop showcased data synthesis, reconstruction methods and paleoclimate data-model inter-comparison projects. There was an increased representation of lake sediment and speleothem specialists at the meeting, adding to the recent consolidation of non-annually resolved data from Australasia. Two regional hydroclimate synthesis papers were identified, led by early career researchers Mandy Freund and Bronwyn Dixon, for the upcoming SI. The group also generated a table of contents for a regional special issue of the same journal to showcase the diversity of research by the Aus2k community. The submission timeframe is expected to span between around September 2016 to

March 2017. Please contact a member of the steering committee if you are interested in contributing your research as part of the group's legacy to the 2k Network.

### **EuroMed2k**

The EuroMed2k core group held an output-oriented meeting from 23-25 March 2016 in Hemmenhofen, Germany. Twelve participants catalyzed their interdisciplinary enthusiasm for consolidation, finalization and publication of the EuroMed2k database. Emphasis is on at least two contributions for the SI. The team discussed the paleoclimatic potential of the diverse high- to low-resolution, marine and terrestrial proxy records from the North Atlantic/European/Mediterranean sector. Strengthening of scientific linkages is foreseen with Ocean2k (Mediterranean and North Atlantic sector), Arctic2k (mainly Scandinavia) and Asian2k (western Russia including Kola, Polar Urals, Russian Plain, Caucasus, Black Sea region, and the Altai with respect to historical human-climate interaction and large-scale migration). The EuroMed2k group would like to maintain its current form and structure beyond 2016, mainly because of the various scientific challenges and opportunities associated with the growing database, as well as the positive and inspiring group dynamic.

### **LOTRED-South America2k**

Currently, the LOTRED-SA group is reconstructing the South American hydroclimate using 267 selected proxy and instrumental records (mostly tree rings, ice cores, pollen, instrumental precipitation and river flow), and 14 highly resolved speleothems covering the past 2000 year. The group plans to reanalyze the new and existing tree-ring data. In particular, water resources from mountainous regions of South America are vital to natural ecosystems and humans living in arid and semiarid regions of the continent. Considering recent paleoclimate advances, a new possibility of describing the South American paleoclimate has emerged.

### **North America2k**

Fifteen NAM2k group members met from 12-15 October at the USGS Powell Center in Fort Collins, USA. The meeting focused on advancing the two major themes of Phase 2 of NAM2k: 1) an update to the North American temperature reconstruction, and 2) multi-proxy investigations of hydroclimatic variability. Most of the week was dedicated to wrapping up the tree-ring database, investigating initial tree-ring and borehole based temperature reconstructions, and tracking down and formatting hydroclimate data. NAM2k has ambitious goals for publishing datasets and papers in the coming year. The group strongly supported publishing data products separately from paleoclimatic investigations, in data journals such as *Scientific Data*. NAM2k is planning on submitting publications describing temperature reconstructions and low-frequency hydroclimate variability to the SI in the second half of 2016.

### **Ocean2k**

Three community-wide themes and several sub-themes emerged from the first Ocean2k Workshop, October 2015, and are the foci for Ocean2k Phase 2. The community-wide themes are: 1) modernizing the metadatabase, 2) quantifying and reducing age-model uncertainties, and 3) understanding patterns of global ocean  $\delta^{18}\text{O}$ . Sub-themes include: past 2k changes in ENSO teleconnections; spatio-temporal AMOC dynamics; North Atlantic influences on the Mediterranean climate; and the oceanic response to volcanic forcing in proxy and model reconstructions. Ocean2k members have modernized the Ocean2k SST metadata by migrating the Ocean2k Phase 1 datasets to the Linked Paleo Data ([LiPD](#)) paleoclimate data framework, in turn contributing to the Global 2k Temperature Database. In addition, efforts with the Iso2k group are adding marine  $\text{d}^{18}\text{O}$  records to the Iso2k database. The updates will underpin the age model and ocean  $\text{d}^{18}\text{O}$  themes, expected to be Ocean2k contributions to SI.

### **Global Temperature Database v2**

Thanks to the tireless 2k participants who have helped get the database of temperature-sensitive proxies to the next level. Version 1.9.0 now gathers 682 records from 640 sites, with >150 records before 1000 AD. It incorporates the data recently published by 2k workgroups such as Ocean2k ([HR](#), [LR](#)), [Euro-Med2k](#), and now has roughly double the spatial coverage of Phase 1. The global

database is available in the [LiPD](#) format, with serializations in matlab, Python and R. A new draft of the data descriptor (manuscript for *Scientific Data*) was circulated to co-authors on 03/30. The analysis was accomplished using Matlab code to extract and treat records, analyze their temperature sensitivity, and generate composites under a variety of criteria. The code is available to project collaborators via [GitHub](#) and will be made public upon publication, as well as the database (which will then become version 2.0.0). In addition to the formats above, an archival version of the dataset will be stored on the website of NCDC paleoclimatology, using their signature text file format.

Contact: [Julien Emile-Geay](#)

### **Global gridded temperature reconstruction method comparisons**

This project will produce global gridded temperature reconstructions using a suite of climate field reconstruction (CFR) methods applied to the new PAGES 2k global temperature database. The aim is to assess how the results of the various methods agree and disagree, to better constrain the type of analysis that CRF products are best suited. Reconstructions from six different methods are currently under development.

Contact: [Raphael Neukom](#)

### **Water isotopes - Iso2k**

Iso2k members are in the final stages of compiling a database of water isotope ( $\delta^{18}\text{O}/\delta\text{D}$ ) records aimed at understanding regional and global-scale hydroclimate and atmospheric circulation during the past 2000 years. Over 800 records have been identified that meet various quality and duration criteria, and group members have entered extensive metadata about each study. The metadata encode the details that the Iso2k team recognized as essential to interpret each record correctly, including the processes that influence isotopic composition and the climate signal inferred by the original authors. The data format will adhere to the [LiPD](#) structure to facilitate re-use of this community resource and integration with the global temperature database. Preliminary results were presented at AGU in December 2015. The emerging database will be presented as part of the PAGES2k-PMIP3 joint workshop, “Comparing data and model estimates of hydroclimate variability and change over the Common Era,” in June 2016.

Contact: [Bronwen Konecky](#) and [Jud Partin](#)

### **AMOC and atmospheric circulation pattern estimations**

Marine sediment  $\delta^{18}\text{O}$  data have been compiled and added to temperature proxies included in Ocean2k Phase 1. With a subset of CMIP5 preindustrial control, past millennium and historical simulations, these data are being used to test the sensitivity of proxy surrogate reconstructions to various methodological choices (if/how weights are applied and data standardized, how skill is assessed, etc.) as well as the spatial and temporal resolution at which reconstructions may be achieved. New proxy data relevant to this effort are available, and an update of the marine metadatabase is anticipated in the near future.

Contact: [Casey Saenger](#)

## **4 – NEW 2K TRANS-REGIONAL PROJECTS**

### **Global mean temperature (index) reconstruction**

This collaborative group effort aims to use the PAGES 2k global temperature database to produce reconstructions of global mean surface temperature (GMST) over the past 2000 years. A range of state-of-the-art reconstruction techniques will be applied in coordinated reconstruction experiments to maximize comparability across the results. The index reconstructions will be used to identify and quantify features of global mean temperature change that stand up to a wide range of reconstruction choices and approaches.

Contact: [Raphael Neukom](#)

### **Hydroclimate data-model comparisons**

Hydroclimate is an increasing focus of the paleoclimate community and the last several years have seen important data products developed to study hydroclimate variability and change during the

Common Era. A growing collection of proxy records have been selected and discussed by the PAGES 2k regional working groups. At the same time, an explosion in the number of last-millennium simulations using fully coupled climate models has occurred over the last several years. In particular, the PMIP3 effort included a last-millennium protocol and multiple modeling centers performed the experiment, using the same configurations and resolutions adopted for the historical and future projection simulations in CMIP5. More recently, ensembles of last-millennium simulations have been performed that include single-forcing experiments. All of these developments make the time ripe for exploring how climate models simulate hydroclimate change and variability and whether they do so in ways that are consistent with the paleoclimate record. This project is devoted to the comparison of the hydroclimate reconstructions with the multi-model simulations of the past millennium, blending the PAGES 2k proxy communities and PMIP3 modeling communities. The comparative analyses emphasizes the methods appropriate for data-model comparisons that target hydroclimate in order to understand climate change at regional scales and the mechanisms of climate variability at decadal to centennial timescales.

Contact: [Jason Smerdon](#)

## 5 – NEW 2K PRODUCTS

McKay NP & Emile-Geay J (2016) *Technical Note: The Linked Paleo Data framework – a common tongue for paleoclimatology*, *Climate of the Past Discussions* 11: 4309-4327, DOI: 10.5194/cpd-11-4309-2015

Euro-Med2k consortium, led by Luterbacher J (2016) *European summer temperatures since Roman times*, *Environmental Research Letters* 11(2), DOI: 10.1088/1748-9326/11/1/024001

Ljungqvist FC, Krusic PJ, Sundqvist HS, Zorita E, Brattström G & Frank D (2016) *Northern Hemisphere hydroclimate variability over the past twelve centuries*, *Nature* 532: 94-98, DOI: 10.1038/nature17418

Büntgen U, Myglan VS, Ljungqvist FS, McCormick M, Di Cosmo N, Sigl M, Jungclaus J, Wagner S, Krusic PJ, Esper J, Kaplan JO, de Vaan MAC, Luterbacher J, Wacker L, Tegel W & Kirilyanov AV (2016) *Cooling and societal change during the Late Antique Little Ice Age from 536 to around 660 AD*, *Nature Geoscience* 9: 231-236, DOI: 10.1038/ngeo2652

PAGES 2k-PMIP3 group (2015) *Continental-scale temperature variability in PMIP3 simulations and PAGES 2k regional temperature reconstructions over the past millennium*, *Climate of the Past* 11(12), DOI:10.5194/cp-11-1673-2015

Zhang H, Yuan N, Esper J, Werner JP, Xoplaki E, Büntgen U, Treydte K & Luterbacher J (2015) *Modified climate with long term memory in tree ring proxies*, *Environmental Research Letters* 10(8), DOI: 10.1088/1748-9326/10/8/084020

To view all 2k products, visit the respective 2k website: [www.pages.unibe.ch/workinggroups/2k-network](http://www.pages.unibe.ch/workinggroups/2k-network) Please let us know if you see any gaps or errors, and send us any meeting documents (e.g. presentations and posters) to post on the PAGE 2k webpage to create a complete archive of an event or activity. See an example [here](#).

Don't forget to acknowledge PAGES or the 2k Network (e.g. "the ideas/data in this paper were assembled/developed/discussed by the <name> PAGES 2k working group") in publications that draw ideas arising from PAGES-funded meetings. Only articles with an acknowledgement can be considered PAGES products.

## **6 – UPCOMING PAGES 2K MEETINGS**

### **3-6 June 2016, Palisades, USA**

PAGES 2K network and PAST2K PMIP: Comparing data and model estimates of hydroclimate variability and change over the Common Era

[www.pages.unibe.ch/calendar/all-events/127-pages/1535-data-model-compare-hydroclimate](http://www.pages.unibe.ch/calendar/all-events/127-pages/1535-data-model-compare-hydroclimate)

### **22-23 June 2016, Boulder, USA**

Workshop on Paleoclimate Data Standards.

[www.pages.unibe.ch/calendar/all-events/127-pages/1576-linkedearth-noaa-workshop](http://www.pages.unibe.ch/calendar/all-events/127-pages/1576-linkedearth-noaa-workshop)

### **9-13 May 2017, Zaragoza, Spain**

5th PAGES Open Science Meeting

[www.pages-igbp.org/calendar/all-events/127-pages/1552-5th-pages-open-science-meeting](http://www.pages-igbp.org/calendar/all-events/127-pages/1552-5th-pages-open-science-meeting)

More upcoming meetings can be found at: [www.pastglobalchanges.org/calendar](http://www.pastglobalchanges.org/calendar)

## **7 - MEETING SUPPORT**

Regional 2k groups seeking support for meetings can submit a proposal to PAGES (visit [MyPAGES>Meeting Support](#)). **The next deadline for proposal submission is 1 May 2016.**