

Regional climate dynamics during the last 2000 years: the PAGES 2k Network



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Background

Research on the last 2000 years (2 ka) has resulted in multi-proxy reconstructions of global or hemispheric temperature. In addition, attempts have been made to reconstruct other climatic parameters at high spatial and temporal resolution. Despite this significant progress, we still do not sufficiently understand the precise sequence of changes related to regional climate forcings and internal variability. Furthermore, at the decadal to centennial timescale we are unsure of how sensitive the climate is to external forcings such as changes in solar activity, volcanic eruptions, or greenhouse gas concentration. The 2k Network of the Past Global Changes (PAGES) project aims to generate a globally encompassing, high-resolution regional synthesis of climate variability for the last 2ka. The 2k Network organized in nine regional Working Groups. Each regional group collects and processes the best time series to generate spatial reconstructions of important state variables of the climate system. The reconstructions in space and time will be analyzed in combination with ensemble runs of Earth System Models.

Regions

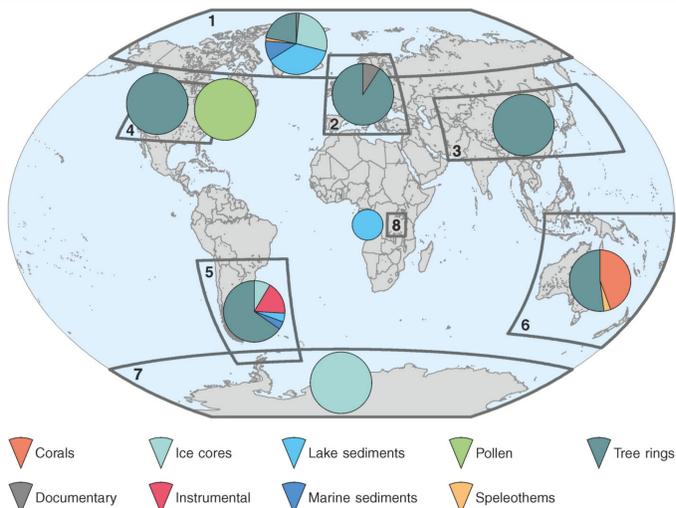


Figure 1: The PAGES 2k Network. Boxes delimit the continental-scale regions used in this study. The pie charts represent the fraction of proxy data types used for each regional reconstruction. The numbers correspond to those in figure 2.

Status

The current phase of the project, lead by the PAGES 2k Consortium (currently 76 scientists from 59 institutions worldwide), focuses on temperature reconstructions. Proxy series are reviewed for their quality and predictor potential, and climate reconstructions are generated using state-of-the-art statistical approaches. Figure 1 shows the reconstruction area for new temperature reconstructions from seven continental regions and the type of natural archives used; suitable records are currently too sparse in Africa for a reliable temperature synthesis, and analysis of paleoceanographic data by the recently formed Ocean2k group is in progress. In figure 2, we present the seven regional proxy based temperature reconstructions.

Preliminary results

- Reconstructed temperatures in all regions show an overall long-term cooling trend until around 1900 C.E., followed by strong warming during the 20th century.
- Solar and volcanic impacts do not induce globally consistent decadal shifts, although they do increase the probability of cooling or warming at the continental scale.
- The majority of extremely cold and warm decades in the regional reconstructions cannot be explained by changes in volcanic activity or solar forcing indicating that, prior to recent anthropogenic forcing, unforced internal variability of the climate system was the dominant control on these timescales.

Paleolimnological aspects

Lake sediment records are currently underrepresented in the proxy datasets used to reconstruct regional and continental temperature at high resolution. This is a consequence of a lack of time series that meet the requirements for the commonly used reconstruction methods: the proxy time series must be annually resolved, continuous and have regular time intervals, and the climate proxies must be expressed in quantitative terms of a climate variable (i.e. calibrated). These criteria are generally difficult to meet using lake sediments, particularly with non-varved sediments from remote areas, where local meteorological data are sparse or missing. An exception in our study is provided by the Arctic2k group, who developed a new multi-proxy reconstruction method (PaiCo) that can handle proxy data series that are non-continuous, have a non-annual resolution and are not calibrated to meteorological data. The Arctic2k temperature reconstruction uses 22 lake sediment records making up almost 40% of the total set of proxy records.

Participation

To participate, please contact the relevant 2k Working Group leader:

- 2k coordinators:** H. Wanner and C. Turney
- Africa2k:** D. Nash
- Antarctica2k:** T. van Ommen
- Arctic2k:** A. Korhola
- Asia2k:** T. Nakatsuka
- Aus2k:** J. Gergis
- Euro-Med2k:** J. Luterbacher
- LOTRED-SA:** M. Grosjean and R. Villalba
- NAM2k:** H. Diaz
- Ocean2k:** M. Evans
- PAGES contacts:** T. Kiefer and L. von Gunten

More information:

www.pages-igbp.org/workinggroups/2k-network

Regional Temperature Reconstructions

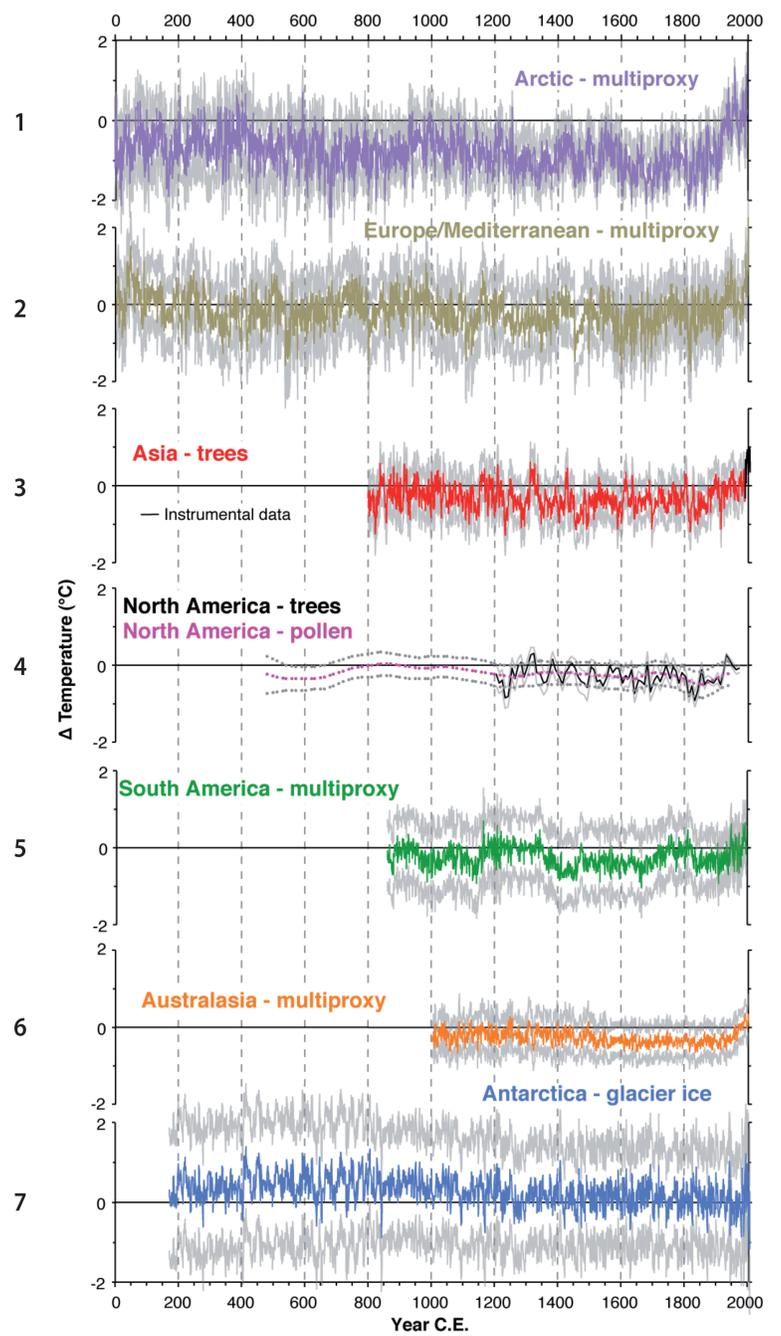


Figure 2: Proxy temperature reconstructions for seven regions of the PAGES 2k Network. Temperature anomalies relative to the 1961-1990 reference period. Grey envelopes are uncertainties as defined by each regional group.

Plans

During the next phase, the 2k Network will carry out regional spatial precipitation (Fig. 3) and geopotential reconstructions, and study relevant circulation patterns and modes. Data-model comparison will be an integral part of the final 2k synthesis.

Major anticipated products:

- Regional group papers and special issues
- 2k consortium synthesis papers
- Regional proxy databases

Data archiving

The Paleoclimatology branch at NOAA (National Oceanic and Atmospheric Administration) is preparing a dedicated archive site to host all the 2k datasets. See: ncdc.noaa.gov/paleo/paleo.html

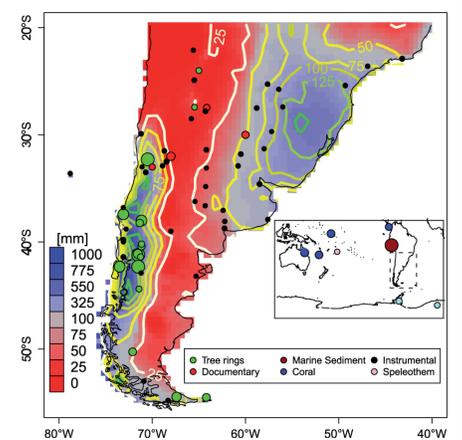


Figure 3: Example of a spatial winter precipitation reconstruction setup map for southern South America by Neukom et al. (2010, GRU). The colored circles show the location of the used proxy records, the color representing the type of proxy and the circle size the length of the series (90 to >1000 years). The shaded colors represent the standard deviations for 1931-1995.