An 800-year decadal-scale reconstruction of annual mean temperature for temperate North America

EUGENE R. WAHL \(^1\), H.F. DIAZ\(^2\), V. TROUET\(^3\) and E.R. COOK\(^4\)

\(^1\)National Climatic Data Center, National Oceanic and Atmospheric Administration, Boulder, USA; Eugene.R.Wahl@noaa.gov
\(^2\)Cooperative Institute for Research in Environmental Science, University of Colorado, Boulder, USA; \(^3\)Laboratory of Tree-Ring Research, University of Arizona, Tucson, USA; \(^4\)Tree-Ring Lab, Lamont-Doherty Earth Observatory, Palisades, USA

A tree-ring based reconstruction of decadal annual mean temperature over temperate North America for the period 1200–1980 is presented. Temperatures generally cool from the early 1300s to the early 1800s and are consistently above the long-term mean after the early 1900s, a unique feature in this record.

The PAGES 2k Network initiative aims to reconstruct basic climate variables for the last 2000 years. This article describes an effort to produce a long (1200-1980 AD) annual temperature reconstruction for temperate North America (30-55°N, 75-130°W) at decadal-average resolution based on tree-ring records primarily from western North America. We describe the methodology used in the reconstruction, briefly compare it with lower resolution regional temperature reconstructions based on fossil lake pollen records from upper midwestern and northeastern United States (Wahl et al. 2012; Viau et al. 2012), and offer a brief discussion of our results in the context of other climate reconstruction studies (e.g. Hughes et al. 2011).

Two semi-independent tree-ring data sets (approximately 30% overlap) are used in the reconstruction. One set extends from 1500-1980 AD covering an area in western mid-latitude North America bounded by 30°-55°N, 95°-130°W (with one additional chronology in west-central Mexico, Wahl and Smerdon 2012). The proxy data were calibrated and validated using the HadCRUT3v 5°x5° gridded surface temperature data for the selected region for the period 1875-1980. The resulting annual temperature reconstruction is hereafter referred to as the WS12 series. A second tree-ring data set covering a longer period (1200-1980 AD) and extending into eastern North America in the same latitude range and into Alaska and the Canadian Yukon was calibrated and validated against the western-region modern record in the same manner as WS12.

Similar to other reconstructions that use sequential calibrations going back in time, the longer time series (1200-on), while well validated, exhibits lower skill than the shorter WS12 reconstruction. WS12 exhibits validation grid-scale RE/spatial-mean RE/spatial-mean CE of 0.40/0.62/0.42, respectively, while the 1200-on reconstruction exhibits 0.13/0.53/0.31 for the same measures, respectively. We thus used WS12 as the reconstruction for 1500-1980 AD and joined the 1200-on reconstruction to it to cover the period 1200-1499 AD. To ensure comparability across the splice at 1500 AD, we regressed WS12 onto the 1200-on reconstruction over the 1500-1980 AD period, and then used this regression and the 1200-on reconstructed values to fit WS12-consistent values for the western region spatial mean during 1200-1499 AD. Decadal averages of this common 1200-1980 AD western temperate-reconstruction were then used as predictors in a calibration against instrumental decadal averages of annual temperatures over the larger mid-latitude region.
A pollen-based extension of the 800-year decadal-scale reconstruction of annual mean temperature for temperate North America dating back to 480 AD

VÉRIPÉTRouET1, H.F. DíAZ2, A.E. VIAU3, E.R. WAHL4

1Laboratory of Tree-Ring Research, University of Arizona, Tucson, USA; trouet@email.arizona.edu
2Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, USA; 3Department of Geography, University of Ottawa, Canada; 4National Climatic Data Center, National Oceanic and Atmospheric Administration, Boulder, USA

We present a tree-ring and pollen based mean annual temperature reconstruction for temperate North America (480-1980 AD) that shows two prominent low-frequency periods: the warmer Medieval Climate Anomaly (750-1100 AD) and the cooler Little Ice Age (1300-1850 AD).

The PAGES 2k Network initiative aims to reconstruct climate variables for the last 2000 years. In a parallel effort, the NAM2K project produced an 800-year (1200-1980 AD) decadal scale annual mean temperature reconstruction using a network of tree-ring records in western North America (Wahl et al. 2012a, this issue; Wahl and Smerdon 2012). That reconstruction is referred to henceforth as D1200 (for decadal 1200). Here we present a pollen-based 30-year resolution mean annual temperature reconstruction for the temperate region of North America (30°-55°N, 95°-130°W) extending D1200 back to 480 AD. In the following, we describe the methodology used for this reconstruction and briefly compare it with other regional temperature reconstructions.

We performed a principal component analysis (PCA) using four North American regional pollen-based temperature reconstructions (Viau et al. 2012); specifically those based on pollen sequences from deciduous, hardwood, boreal, and mountain ecoregions of North America. The prairie ecoregion reconstruction for the center of Northern America was not used as its vegetation is mainly controlled by precipitation (Viau et al. 2012). Mean annual temperature reconstructions were used instead of summer temperature anomalies as in Viau et al. (2012) for a more direct comparison of the pollen reconstructions to precipitation or related drought indices (e.g. Cook et al. 1999, 2007). We single out two recent articles (Kaufman et al. 2009; Ljungqvist et al. 2012) that present millennial length reconstructions for portions of the Northern Hemisphere, since they include some information regarding North American temperature changes. A direct comparison between these reconstructions and that of Figure 1 is not possible however, because of differing reference periods and data sources on the one hand (Ljungqvist et al. 2012) and a pan-Arctic regional focus on the other (Kaufmann et al. 2009). Nevertheless, some similarities are evident, particularly the cold periods of the 17th and 19th centuries, and warmer temperatures prevailing prior to the 15th century.

Selected references
Full reference list online under:

Kaufmann D-S et al. (2009) Science 325: 1236-1239

PAGES news • Vol 20 • No 2 • December 2012