ELSEVIER

Quaternary Science Reviews 26 (2007) 3298–3310

QSR

Warmer early instrumental measurements *versus* colder reconstructed temperatures: shooting at a moving target

David Frank[a,*], Ulf Büntgen[a], Reinhard Böhm[b], Maurizio Maugeri[c], Jan Esper[a]

[a]*Swiss Federal Research Institute WSL, Zürcherstrasse 111, 8903 Birmensdorf, Switzerland*
[b]*Central Institute for Meteorology and Geodynamics, Hohe Warte 38, 1190 Vienna, Austria*
[c]*Istituto di Fisica Generale Applicata, via Brera, 28, 20121 Milan, Italy*

Received 28 September 2006; received in revised form 12 August 2007; accepted 24 August 2007

Abstract

Comparison of tree-ring-based warm-season temperature reconstructions and their instrumental target data reveals substantial divergence between (warmer) early instrumental measurements and (colder) proxy estimates. Here we detail this systematic misfit for the Northern Hemisphere before ~1900 and the European Alps before ~1850. Five hypotheses related to both proxy and target uncertainties are presented towards explaining this phenomenon. These include: (1) tree-ring detrending methods, (2) biological persistence in the proxy time-series, (3) uncertainties and instabilities in the growth response to given climatic parameters, (4) reduced instrumental station availability back in time, and (5) instrumental data homogeneity. We suggest that uncertainties in the choice of instrumental targets at the hemispheric scale, and instrumental data inhomogeneities at the Alpine and possibly also the hemispheric-scale are the most important factors in explaining this offset. Assessment of homogeneity at larger scales remains challenging. Attention is drawn to possible warm biases in early thermometer shelters and the relevance of proxy/target discrepancies for understanding and quantifying the amplitude of both recent anthropogenic and past natural forced climate fluctuations.
© 2007 Elsevier Ltd. All rights reserved.

1. Introduction

To understand and quantify past variations in the earth's climate system and its forcing agents, millennial-long proxy reconstructions (e.g., Jones et al., 1998; Mann et al., 1999; Briffa, 2000; Esper et al., 2002; Moberg et al., 2005; D'Arrigo et al., 2006) and model simulations (e.g., von Storch et al., 2004; Hegerl et al., 2006) have been used to assess changes in temperature. A widely accepted conclusion from these various approaches is the unprecedented warmth within the past few decades, relative to a prolonged cooling from ~1350 to 1850, and most likely widespread warmth during medieval times (Esper et al., 2005b). Both proxy reconstruction and model parameterization are often, however, fundamentally linked with relationships to instrumental measurements during a portion of their overlapping period. Time-series of proxy data are generally fit to suitable instrumental records (targets) in a process known as calibration. Implicit to this approach is that the relationship inferred over the calibration interval—roughly the past century or so—is clearly defined, remains stable over time, and that the target is without bias in both the higher and lower frequency domains.

In this regard, recent studies have addressed the importance of properly calibrating to the 'correct' instrumental target, including exact specification of seasonality, spatial representation, and frequency domains for a realistic representation of past climate variability (Osborn and Briffa, 2000; von Storch et al., 2004; Rutherford et al., 2005; Esper et al., 2005a). Despite such general awareness, discussion still exists on proxy/instrumental misfits at regional (Wilson et al., 2005; Frank and Esper, 2005b; Büntgen et al., 2006a) to large scales (Wilson et al., 2007). In the European Alpine region, tree-ring-based reconstructions of past temperature variability (Büntgen et al., 2005, 2006a; Frank and Esper, 2005b) indicated potential discrepancies between "cooler" proxy and "warmer" instrumental data during the 19th century. Such divergence affects the magnitude of inferred past climatic changes as

*Corresponding author. Tel.: +41 44 739 2282; fax: +41 44 739 2215.
E-mail address: frank@wsl.ch (D. Frank).

0277-3791/$ - see front matter © 2007 Elsevier Ltd. All rights reserved.
doi:10.1016/j.quascirev.2007.08.002