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A 1052-year tree-ring proxy for Alpine summer temperatures

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Abstract A June–August Alpine temperature proxy series is developed back to AD 951 using 1,527 ring-width measurements from living trees and relict wood. The reconstruction is composed of larch data from four Alpine valleys in Switzerland and pine data from the western Austrian Alps. These regions are situated in high elevation Alpine environments where a spatially homogenous summer temperature signal exists. In an attempt to capture the full frequency range of summer temperatures over the past millennium, from inter-annual to multi-centennial scales, the regional curve standardization technique is applied to the ring width measurements. Correlations of 0.65 and 0.86 after decadal smoothing, with high elevation meteorological stations since 1864 indicate an optimal response of the RCS chronology to June–August mean temperatures. The proxy record reveals warm conditions from before AD 1000 into the thirteenth century, followed by a prolonged cool period, reaching minimum values in the 1820s, and a warming trend into the twentieth century. This latter trend and the higher frequency variations compare well with the actual high elevation temperature record. The new central Alpine proxy suggests that summer temperatures during the last decade are unprecedented over the past millennium. It also reveals significant similarities at inter-decadal to multi-centennial frequencies with large-scale temperature reconstructions, however, deviating during certain periods from H.H. Lamb's European/North Atlantic temperature history.

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1 Introduction

Reconstructions of longer term, regional temperature variability (e.g., Cook et al. 2003; Esper et al. 2003a; Luckman and Wilson 2005) are key to develop larger scale networks (e.g., Briffa 2000; Cook et al. 2004; Esper et al. 2002; Mann et al. 1999), assess spatial patterns of climatic change (e.g., Wanner et al. 1997), and study the influence of natural and anthropogenic forcings on temperature variations (e.g., Crowley 2000; Houghton et al. 2001). In Central Europe, significant progress has been made in reconstructing climatic variations over recent centuries (e.g., Jacobeit et al. 2003) including analyses of long instrumental records (Böhm et al. 2001; Camuffo and Jones 2002; Jones and Lister 2004; Moberg et al. 2003), documentary evidence (Brázdil 1996; Glaser 2001; Pfister 1999), tree-ring records (Briffa et al. 2002a, b) and multi-proxy compilations (Casty et al. 2005; Luterbacher et al. 2004). For the Alps, several dendroclimatic studies assessed temperature signals in local tree-ring chronologies (Carrer and Urbinati 2001, 2004; Meyer and Bräker 2001; Rolland et al. 2000; Wilson and Topham 2004) and regional scale networks (Briffa et al. 1988; Frank and Esper 2005a, b; Rolland 2002; Schweingruber and Nogler 2003) spanning the past couple of centuries. However, a millennial-long, high-resolution Alpine temperature reconstruction that could potentially place the recent warming trend in a longer term context, and would allow a comparison with conditions during the putative medieval warm period (Lamb 1965) is broadly missing.