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TEMPERATURE AND PRECIPITATION VARIABILITY IN THE EUROPEAN ALPS SINCE 1500

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ABSTRACT

High-resolution temperature and precipitation variations and their seasonal extremes since 1500 are presented for the European Alps (43.25–48.25 °N and 4.25–16.25 °E). The spatial resolution of the gridded reconstruction is given by $0.5^\circ \times 0.5^\circ$ and monthly (seasonal) grids are reconstructed back to 1659 (1500–1658). The reconstructions are based on a combination of long instrumental station data and documentary proxy evidence applying principal component regression analysis. Annual, winter and summer Alpine temperatures indicate a transition from cold conditions prior to 1900 to present day warmth. Very harsh winters occurred at the turn of the seventeenth century. Warm summers were recorded around 1550, during the second half of the eighteenth century and towards the end of the twentieth century. The years 1994, 2000, 2002, and particularly 2003 were the warmest since 1500. Unlike temperature, precipitation variation over the European Alps showed no significant low-frequency trend and increased uncertainty back to 1500. The years 1540, 1921 and 2003 were very likely the driest in the context of the last 500 years.

Running correlations between the North Atlantic Oscillation Index (NAOI) and the Alpine temperature and precipitation reconstructions demonstrate the importance of this mode in explaining Alpine winter climate over the last centuries. Winter NAOI correlates positively with Alpine temperatures and negatively with precipitation. These correlations, however, are temporally unstable. We conclude that the Alps are situated in a band of varying influence of the NAO, and that other atmospheric circulation modes controled Alpine temperature and precipitation variability through the recent past.

KEY WORDS: European Alps; principal component regression; temperature; precipitation; climate variability; reconstructions; North Atlantic Oscillation

1. INTRODUCTION

Improved understanding of long-term, natural climate variability on different spatio-temporal scales is crucial to place the recent, potentially anomalous, changes in a longer term context (e.g. Jones and Mann, 2004 and references therein; Luterbacher *et al*., 2004; Moberg *et al*., 2005). It is therefore important to extend existing climatic records, such as temperature, precipitation, and circulation patterns, as far back in time as possible (e.g. Jones *et al*., 2001). A number of previous studies have focused on global to hemispheric temperature reconstructions over the past few centuries to millennia, based on both empirical proxy data (Bradley and Jones, 1993; Overpeck *et al*., 1997; Jones *et al*., 1998; Mann *et al*., 1998, 1999; Crowley and Lowery, 2000; Briffa *et al*., 1998, 2001, 2002, 2004; Esper *et al*., 2002; Cook *et al*., 2004; Huang, 2004; Pollack and Smerdon, 2004; Moberg *et al*., 2005; Oerlemans, 2005) and model simulations including forcing data (e.g. Crowley, 2000; Bauer *et al*., 2003; Gerber *et al*., 2003; González-Rouco *et al*., 2003; Rutherford *et al*., 2003,

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