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European Alpine moisture variability for 1800–2003

G. van der Schrier,* D. Efthymiadis, K. R. Briffa and P. D. Jones
Climatic Research Unit, School of Environmental Sciences, UEA, Norwich NR4 7TJ, UK

Abstract:

Moisture availability for the European Greater Alpine region (GAR) (43 °N–49 °N and 4 °E–19 °E) for the period 1800–2003 is analyzed on the basis of maps of monthly self-calibrating Palmer Drought Severity Index (scPDSI) with a $10' \times 10'$ spatial resolution.

To represent the impact of seasonal snow cover on the water budget, a simple snow-accumulation and snowmelt model is added to the water balance calculations on which the (self-calibrating) Palmer Drought Severity Index is based.

Over the region as a whole, the late 1850s into the 1870s and the 1940s to the early 1950s stand out as persistent and exceptionally dry periods, whereas the first two decades of the nineteenth century and the 1910s were exceptionally wet periods. Dividing the Greater Alpine Region into four subregions, with the subregions based on coherence of precipitation variability, we find a large degree of heterogeneity in the behavior of the drought index over the subregions. The driest summers on record, in terms of the amplitude of the index averaged over the Alpine region, are 1865 and 2003. In these years, 75.6% and 85.1% of the region was suffering from a moderate drought (or worse). The areas northwest of the high mountains were affected most severely in the 1865 drought, whereas the 2003 drought impacted all subregions more equally.

By substituting climatological monthly mean temperatures, from the period 1961–1990, for the actual monthly means in the parameterization for potential evaporation, an estimate is made of the direct effect of temperature on drought. It is observed that a major cause for the vast areal extent of the area affected by the summer drought in the last decade is the high temperatures. Temperatures in the 12 months preceding and including the summer of 2003 explain an increase in the area percentage with moderate (or worse) drought of 31.2%. Copyright © 2006 Royal Meteorological Society

KEY WORDS Alpine region; drought; PDSI; waterbalance model

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INTRODUCTION

The Palmer Drought Severity Index (PDSI) is a measure of regional soil moisture availability that has been used extensively to study droughts and wet spells in contiguous United States, particularly as the primary indicator of the severity and extent of recent droughts (Palmer, 1965; Heim, 2002; van der Schrier *et al*., 2006b) with applications on other parts to the world emerging in the past decade (Briffa *et al*., 1994; Dai *et al*., 1998; Dai *et al*., 2004; van der Schrier *et al*., 2006a). This paper uses a recent improvement of the PDSI, the self-calibrating PDSI (Wells *et al*., 2004), as the metric to quantify droughts or wet spells in the European Greater Alpine Region (GAR, 43 °N–49 °N and 4 °E–19 °E) in the period 1800–2003.

This work has been prompted largely by the extensive nature of dry conditions that affected the GAR in recent years, especially 2003. In this study, we present a detailed long-term analysis of soil moisture variability in this region. A study of scPDSI allows us to place the recent dry summers in the context of a long record. We will also use this drought index to estimate the impact of high surface temperatures on the areal extent of the drought in this region.

The computation of the PDSI involves a classification of relative soil moisture conditions within 11 categories as defined by Palmer (1965) (Table I), which range from −4 (extremely dry) to +4 (extremely wet). The index is based on water supply and demand, which is calculated using a rather complex water-budget system based on historic records of precipitation and temperature and the soil characteristics of the site being considered.

The PDSI has been criticized for a variety of reasons of which most significant is perhaps that it is not comparable between diverse climatological regions, and that it produces values that are ≥ 4 or ≤ -4 up to 15% or more of the time (Wells *et al*., 2004): hardly corresponding to the classification 'extreme'. Moreover, the PDSI tends to have a slightly bimodal distribution (Wells *et al*., 2004, fig. 8), with maxima in the distribution outside the 'near normal' category.

The scPDSI as put forward by Wells *et al*. (2004) improves upon the 'traditional' PDSI with respect to these points. Owing to a lack of computational resources,

* Correspondence to: G. van der Schrier, Royal Netherlands Meteorological Institute, PO Box 201, 3730 AE, De Bilt, The Netherlands; e-mail: schrier@knmi.nl