On the Frequency of Record Events

David Jones and Robert Fawcett

National Climate Centre, Australian Bureau of Meteorology, Melbourne, Victoria
E-mail: d.jones@bom.gov.au

1. Introduction

The acquisition and retention of climate data often leads to the generation of climate statistics attempting to say something meaningful about the statistical distributions of the data. While measures of central tendency (means, medians, *etc*.) and dispersion (variance, inter-quartile range, *etc*.) are of great importance, the extremes of the distributions (highest and lowest on record) typically have a public fascination of their own.

The nation-wide heat-wave in February of this year led to the breaking of many temperature records for individual stations, as well as state wide records for SA, NSW, Victoria and Queensland. It is to be expected that continued global warming will change the frequency of extreme weather and climate events in the future, but mapping how these change will be reflected in the frequency of 'record' events remains largely elusive.

The calculation of records (extremes of the distribution) inevitably leads to the breaking of those records. With large numbers of time series being updated on a regular (daily, monthly, seasonal, annual) basis, new records will continually arrive. The question immediately arises as to what is the expected base rate for obtaining such new records, and what statistical assumptions underpin those rates? How do those expected base rates depend on spatial and temporal correlations in time series at neighbouring locations?

Australia's maximum and minimum temperatures have generally shown a rising trend over the second half of the twentieth century (Della-Marta *et al*. 2004), which has recently been attributed (at least in part) to greenhouse gas increases (Stott 2003). This would lead to the expectation of increased (decreased) rates of new high (low) temperature records. Are these increased (decreased) rates of new records actually being observed? In this talk we will describe recent innovative analyses undertaken in the National Climate Centre, presenting preliminary results for Australian rainfall and temperature on a range of time scales. The methodology we have developed largely follows and extends that recently described in the literature by Benestad (2003).

2. Techniques

The simplest approach for considering expected rates of obtaining new records involves the assumption or model of identically independently distributed data (IID). This hypothesis has the advantage that some theoretical results can be derived from it, which permits comparisons with results derived from Monte Carlo simulation. Indeed, many results for this model have been obtained, although in almost all cases by workers outside of meteorological and hydrological disciplines (Arnold *et al*. 1998, Vogel *et al*. 2001, Benestad 2003). The IID hypothesis is not particularly realistic in the current context however, as auto-correlation within time series affects the rate at which new records occur, tending to increase (decrease) the rate at which new records are set within time series of a given length for positive (negative) auto-correlations.

When considering aggregate rates of new records being set amongst multiple time series, such as in a cluster of neighbouring stations, spatial correlation between neighbouring observation sites conflicts with the IID hypothesis, even under the assumption of a static climate.