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# A quasi-objective assessment of hot and cold spells in Australia across the period 1957-2010

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# Introduction and purpose

Australia's climate is highly variable on a range of time scales. Extreme hot and cold spells are a natural part of this variability.

The aim of this study was to objectively construct a list of broad-scale hot and cold spells to be used for illustrative purposes, educational materials and case studies.



Analysis of broad-scale hot and cold spells may also be of use to the health, energy, agriculture and emergency management sectors.

Our analysis focuses on broad-scale events of moderate duration and intensity on a national scale.

## Introduction and purpose (cont.)



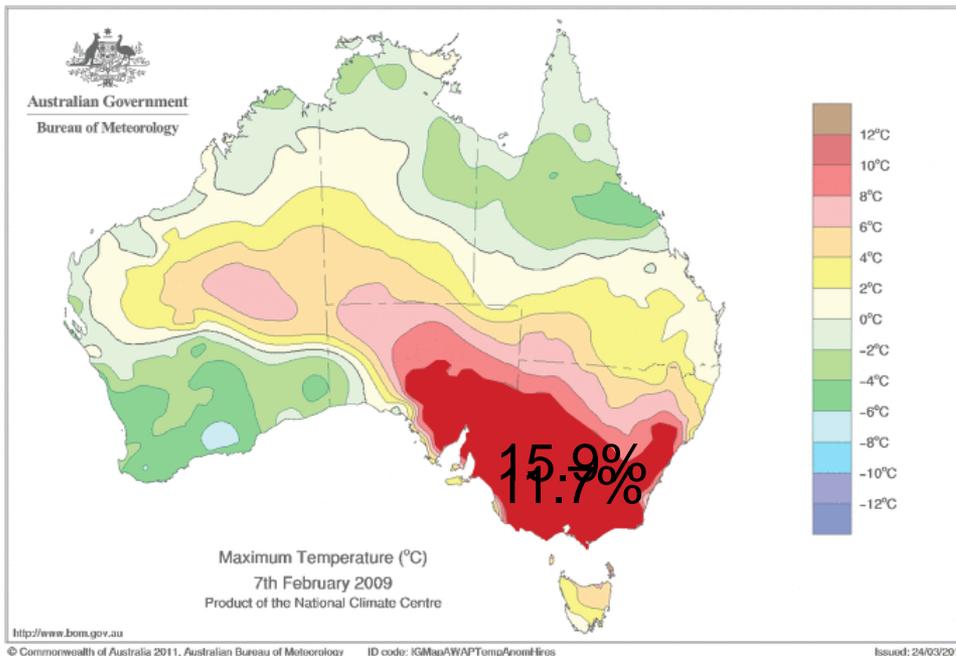
The assessment contains both subjective and objective elements.

We construct indices of the percentage area of the country with extreme high or low temperatures on each day, based on anomaly thresholds of  $\pm 8$  °C and  $\pm 10$  °C.

We then construct a weighted average and aggregate the daily index over a period of seven days.

# Data and methods

Data: Australian Water Availability Project 0.25° resolution daily maximum and minimum temperature analyses from 1957 to present.



Take each of the following as a daily timeseries:

- Percentage area (national) with a temperature anomaly greater than +8°C and
- Percentage area (national) with a temperature anomaly greater than +10°C (high Tmax and high Tmin)
- Percentage area (national) with a temperature anomaly less than -8°C and -10°C (low Tmax and low Tmin) (*not shown*)

Maximum Temperature Anomaly

7<sup>th</sup> February 2009 – “Black Saturday”

## Data and methods (cont.)

Then calculate four weighted daily timeseries as follows:

High Tmax (warm days) =  $(2 \times (\text{percentage area with Tmax anomaly greater than } +10^{\circ}\text{C}) + (\text{percentage area with Tmax anomaly greater than } +8^{\circ}\text{C})) / 3$

Using the example from the previous slide:

$$I_{\text{high Tmax}} = (2 * 11.7 + 15.9) / 3 = 13.1 \%$$

Likewise for high Tmin (warm nights), low Tmax (cool days) and low Tmin (cool nights)



## Data and methods (cont.)



These indices are then aggregated in the form of seven day totals.

This allows us to balance spatial extent (percentage area) with temporal extent (duration).

Use of temperature anomaly thresholds conveys a particular level of intensity across a broad range of climatic zones and avoids restricting our consideration to the hottest/coldest times of the year.

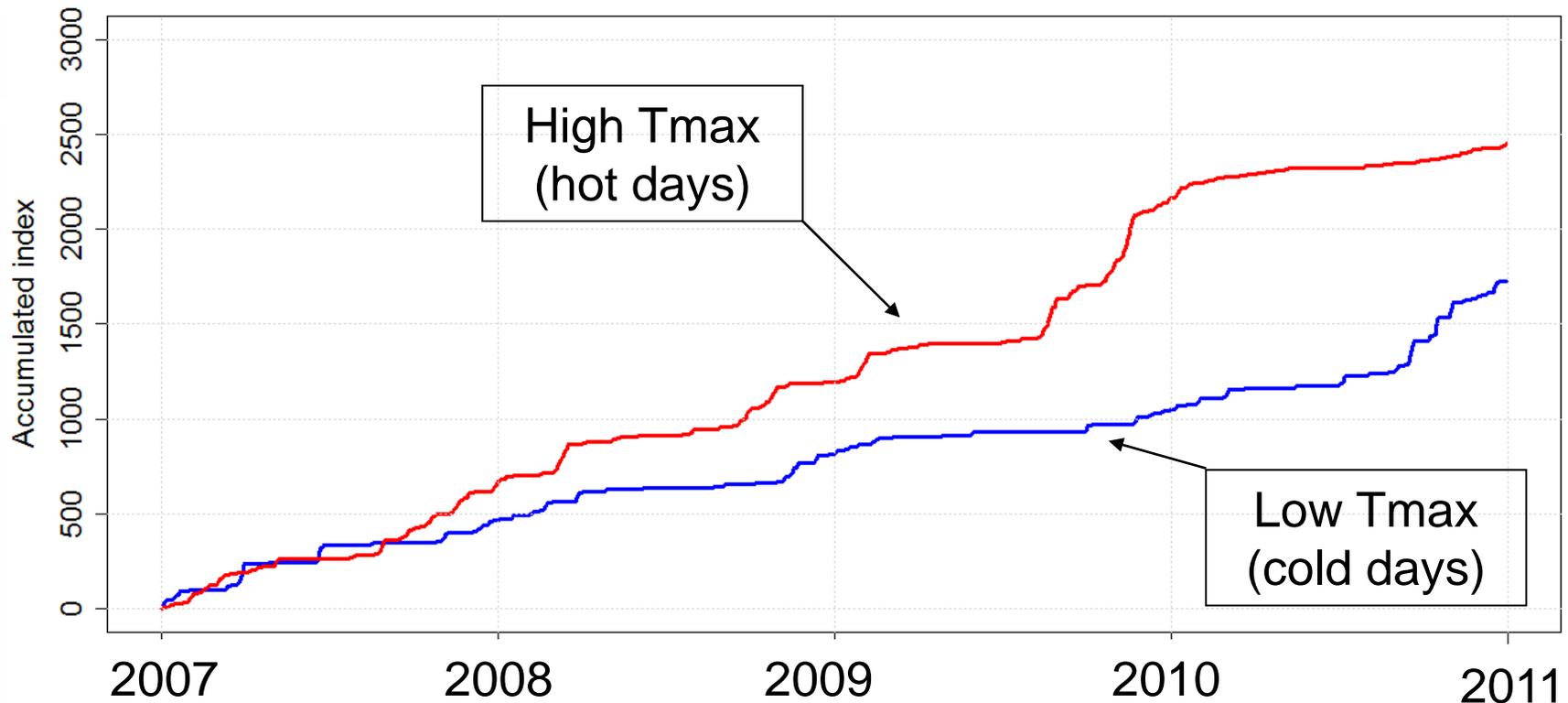
This method does not distinguish between single events and pairs of synchronous events happening in different parts of country. It also does not distinguish between static (i.e., in one location) and dynamic (i.e., sweeping across the country) events.



# Results/discussion

Graphed as an accumulation of the daily indices: Maximum temperature (hot days and cold days) 2007 to 2010

Accumulated national percentage areas index (Tmax anomalies)



# Maximum temperature

## High Tmax – Spells with hot days

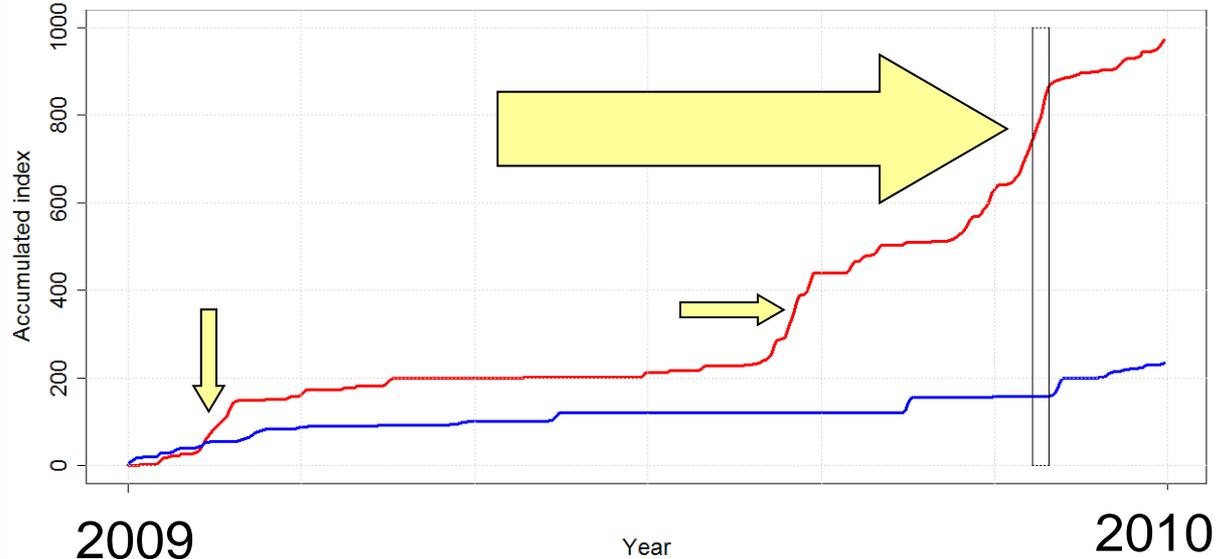
Rank	Period	Index value (seven day total)	Days with daily total $\geq 10\%$
1	14/11/2009 - 20/11/2009	141.67	7
2	19/08/1995 - 25/08/1995	130.23	6
3	24/11/2006 - 30/11/2006	126.07	7

## Low Tmax – Spells with cold days

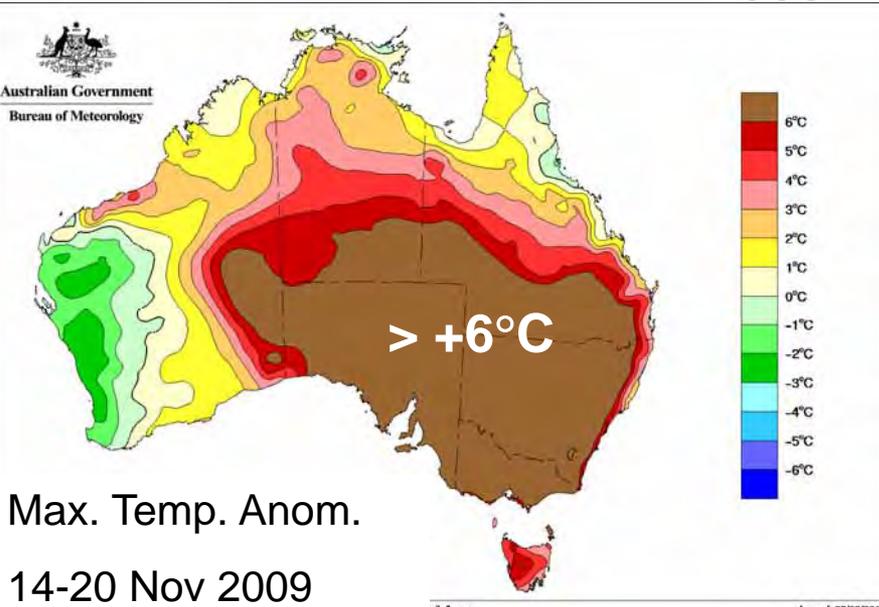
Rank	Period	Index value (seven day total)	Days with daily total $\geq 10\%$
1	01/10/1966 - 07/10/1966	185.00	6
2	14/11/1981 - 20/11/1981	161.37	5
3	22/04/1983 - 28/04/1983	138.23	5

# Top event: High Tmax (hot days)

Accumulated national index (Tmax anomalies)



Heatwave:  
14-20 November 2009

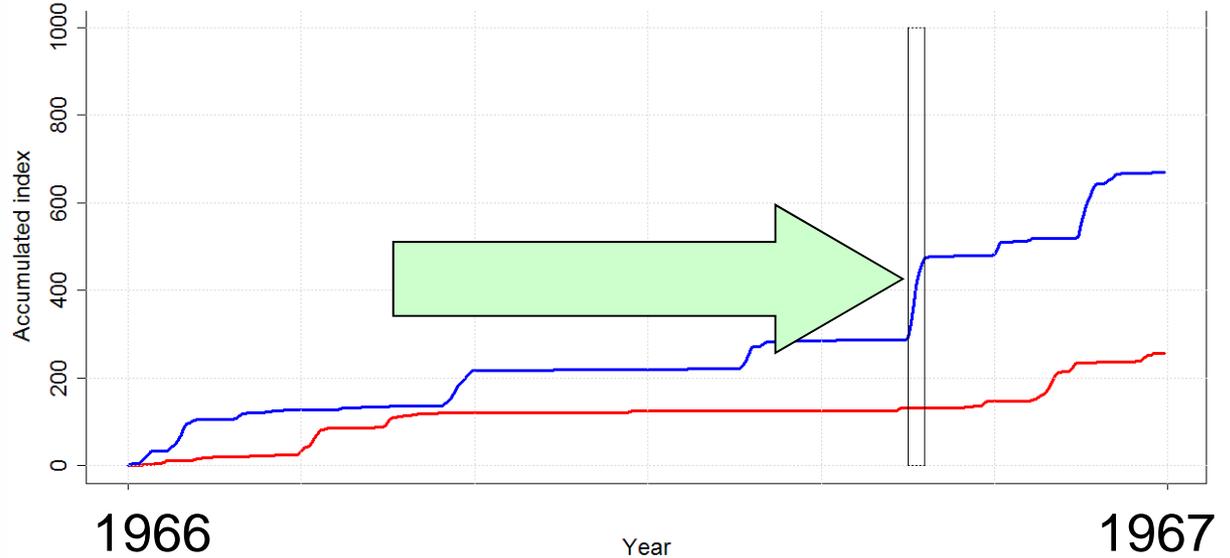


The area shown in brown received maximum temperatures more than 6 °C above average

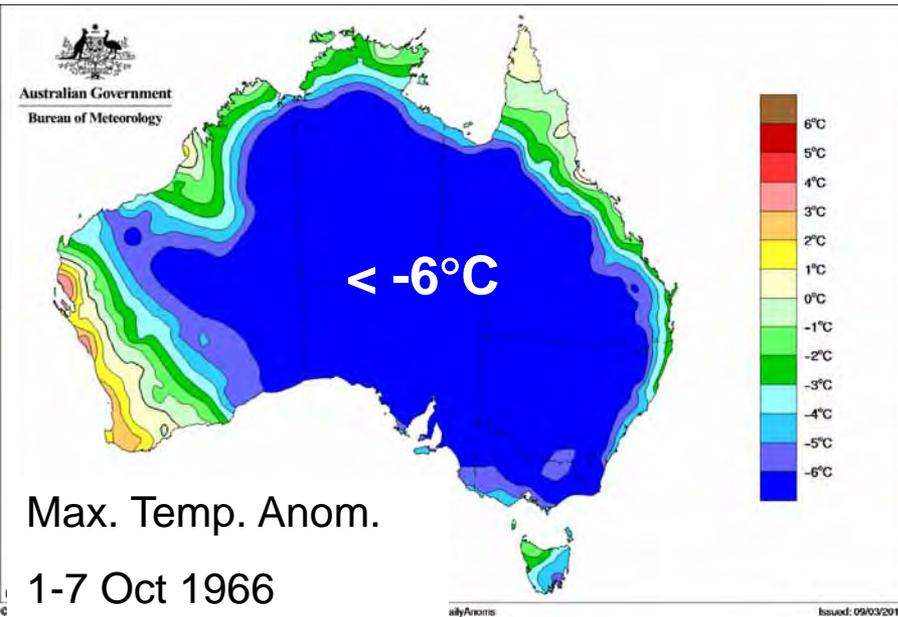
Max. Temp. Anom.  
14-20 Nov 2009

# Top event: Low Tmax (cold days)

Accumulated national index (Tmax anomalies)



Daytime cold snap:  
1-7 October 1966



The area shown in dark blue received maximum temperatures more than 6 °C below average

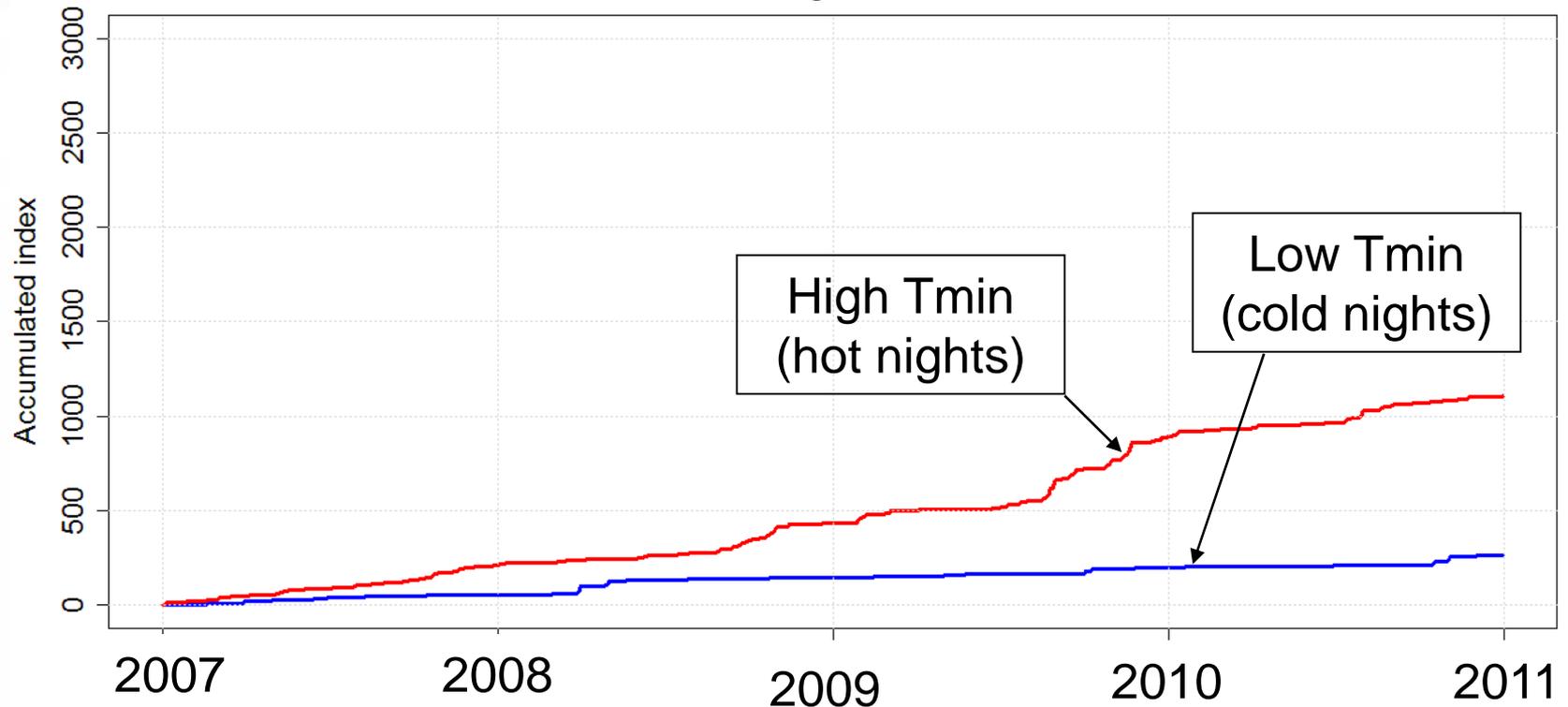
Max. Temp. Anom.

1-7 Oct 1966

# Minimum temperature

Graphed as an accumulation of the daily indices: Minimum temperature (hot nights and cold nights) 2007 to 2010

Accumulated national percentage areas index (Tmin anomalies)





## High Tmin – Spells with hot nights

Rank	Period	Index value (seven day total)	Days with daily total $\geq$ 10%
1	20/08/1995 - 26/08/1995	83.93	5
2	20/09/2003 - 26/09/2003	74.17	4
3	24/08/2009 - 30/08/2009	71.80	3

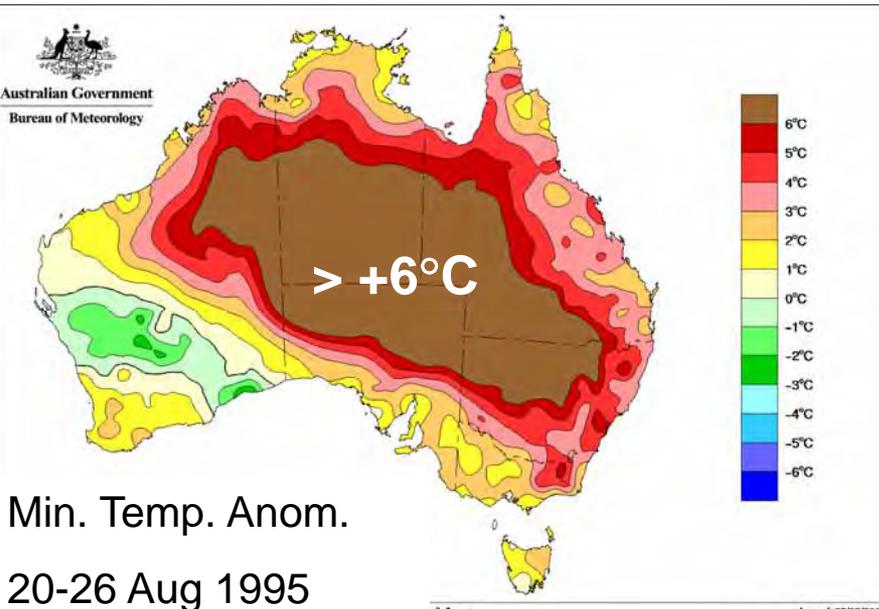
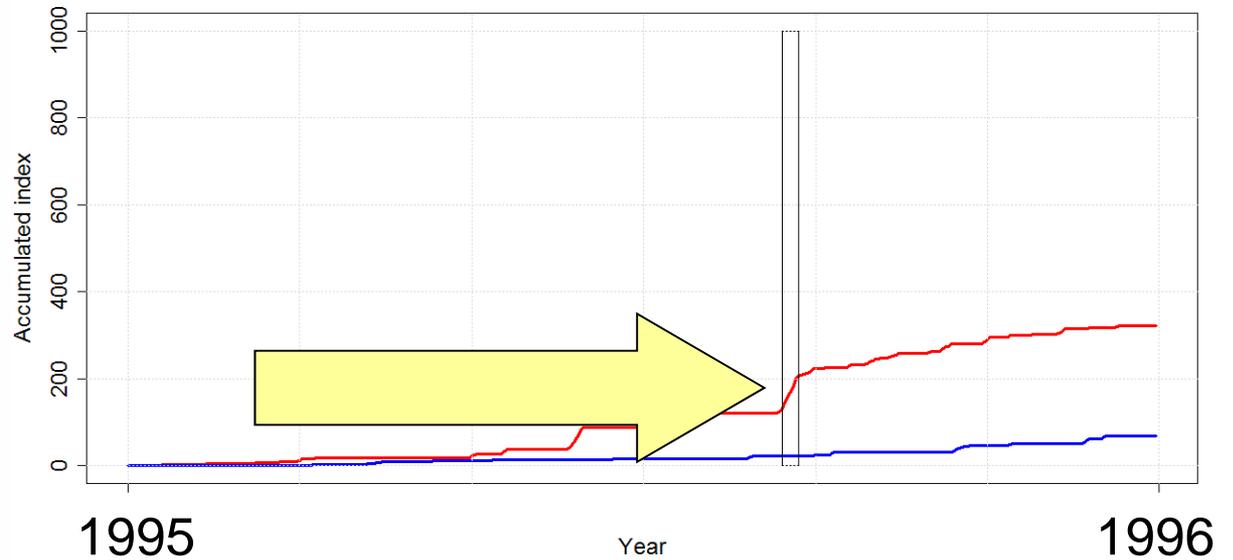
## Low Tmin – Spells with cold nights

Rank	Period	Index value (seven day total)	Days with daily total $\geq$ 10%
1	03/10/1966 - 09/10/1966	88.87	5
2	24/04/1999 - 30/04/1999	64.43	3
3	20/05/1957 - 26/05/1957	53.73	2

# Top event: High Tmin (hot nights)

Spell of warm nights:  
20-26 August 1995

Accumulated national index (Tmin anomalies)

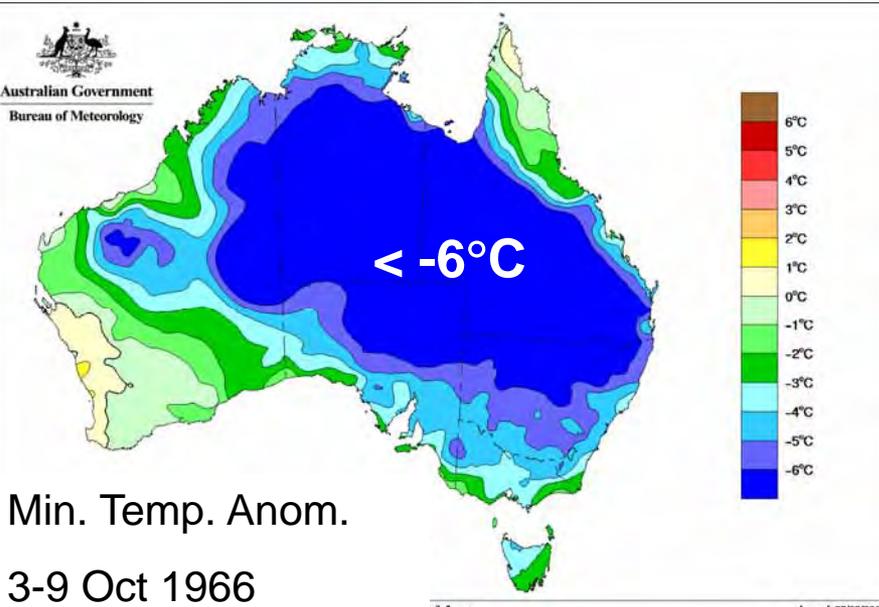
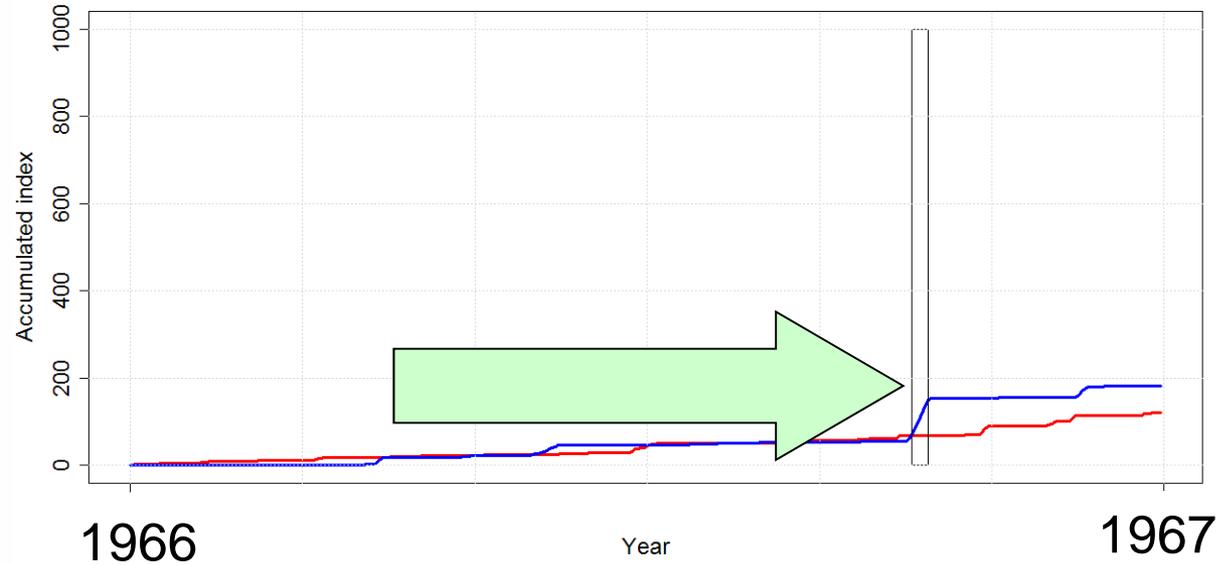


The area shown in brown  
received minimum temperatures  
more than 6 °C above average

# Top event: Low Tmin (cold nights)

Spell of cold nights:  
3-9 October 1966

Accumulated national index (Tmin anomalies)

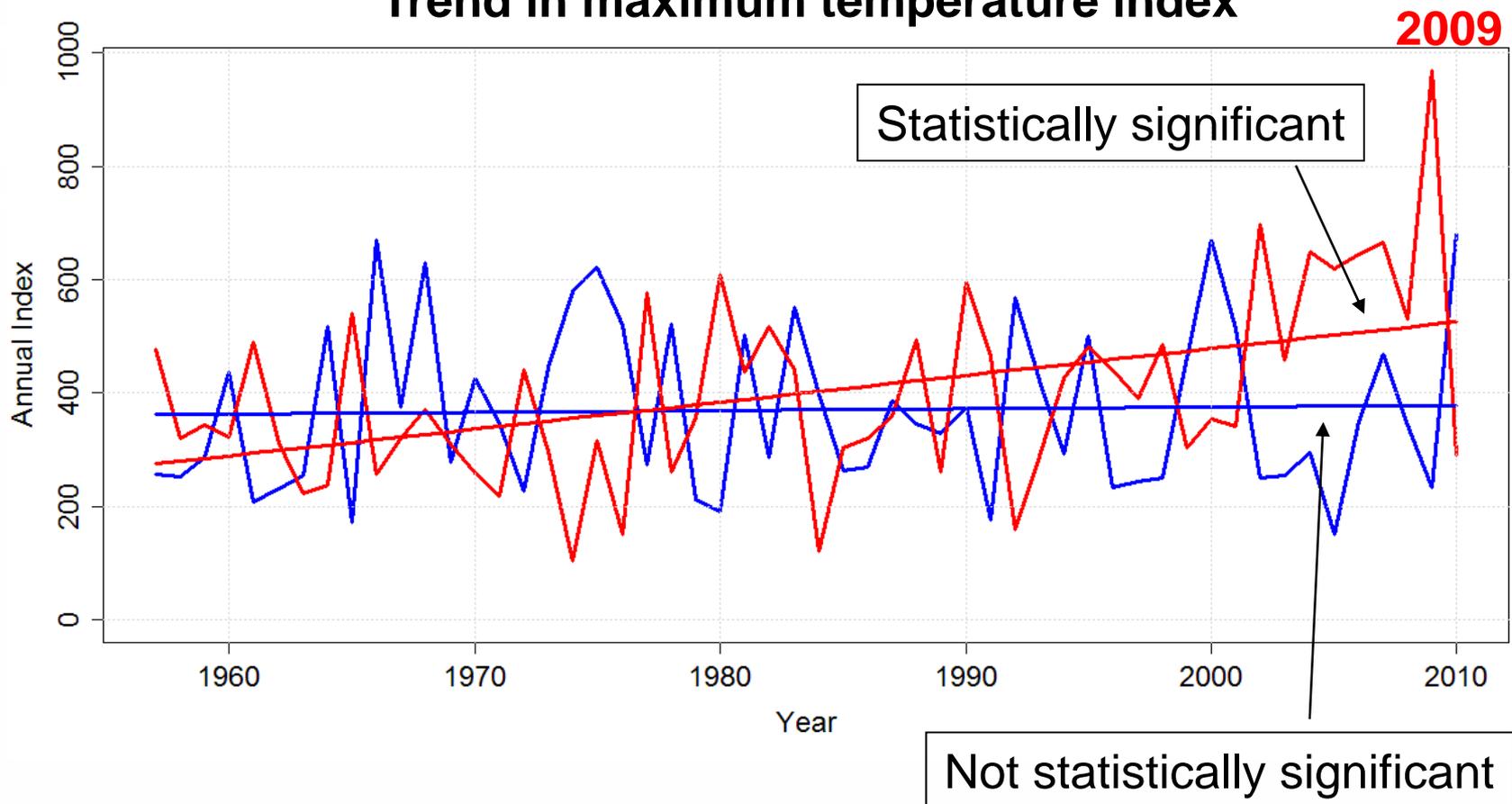


The area shown in dark blue  
received minimum temperatures  
more than 6 °C below average

# Trends?

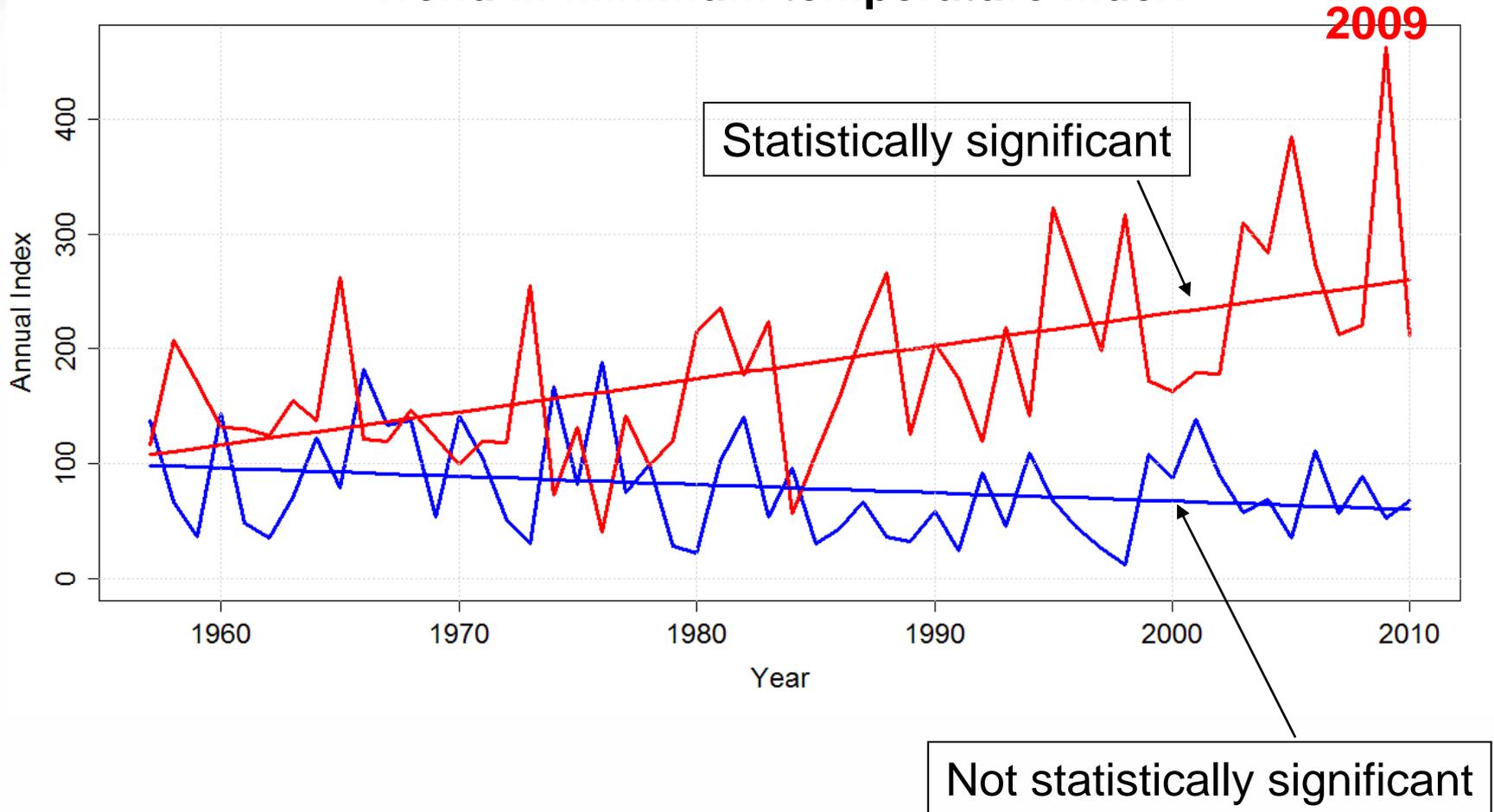
Daily index is summed for each year to form an annual index, then graphed

## Trend in maximum temperature index



# Trends?

## Trend in minimum temperature index





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# Questions?