



Off the charts: Extreme Australian summer heat

Key messages

- The length, extent and severity of the current heatwave are unprecedented in the measurement record.
- Although Australia has always had heatwaves, hot days and bushfires, climate change is increasing the risk of more frequent and longer heatwaves and more extreme hot days, as well as exacerbating bushfire conditions.
- Climate change has contributed to making the current extreme heat conditions and bushfires worse.
- Good community understanding of climate change risks is critical to ensure we take appropriate action to reduce greenhouse gas emissions and to put measures in place to prepare for, and respond to, extreme weather.

Australia is a land of extremes. As global temperature rises, very hot days are becoming more frequent and heatwaves are becoming more prolonged across many parts of Australia.

The heatwave affecting Australia in late December and early January brought extreme heat to most of the Australian continent over a sustained period. Temperatures above 40°C and 45°C were unprecedented in their extent across the continent, breaking new records for Australian averaged maximum temperatures. The heat was also unprecedented in its duration.

The Climate Commission has received questions from citizens and media seeking to understand the link between climate change and the very unusual weather. This document provides a summary of the influence of climate change on Australia's temperature and extreme heat events.

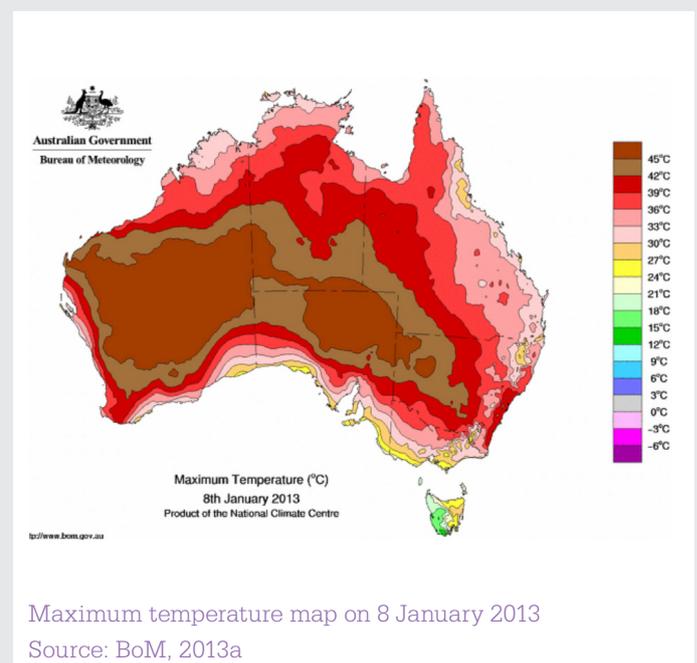
Understanding the link between heat extremes and climate change is important because efforts today to reduce greenhouse gas emissions will influence the severity of these types of events in the future. Having a good understanding of climate change risks can ensure that we take appropriate action to reduce greenhouse gas emissions and to put measures in place to prepare for, and respond to, more extreme weather.

How does climate change influence Australia's temperature?

While hot weather has always been common in Australia, it has become more common and severe over the past few decades. There has been a significant increase in the frequency of hot days (days over 35°C) and hot nights over the last 50 years (CSIRO and BoM, 2012). The frequency of record hot days has been more than three times the frequency of record cold days during the past ten years (Trewin and Smalley, 2012).

For example, over the period from 1970–2011, the number of hot days in NSW has increased, in some areas by up to 7.5 days per decade (BoM, 2012a). In Melbourne the long-term average number of days per year above 35°C was 10 (BoM, 2012b), but during the decade 2000–2009 the average number of such days rose to 13 (BoM, 2010).

Australia's average temperature has already risen by 0.9°C since 1910 (CSIRO and BoM, 2007). This is consistent with the global trend of increasing average temperature. Globally the 10 hottest years on record have all occurred in the last 15 years (NASA, 2012).



Although a temperature increase of 0.9°C may seem modest, small changes in average temperature can have a significant impact on the frequency and nature of extreme weather events. When the average temperature shifts, the temperatures at the bottom and top of the temperature scale shift too. As the average temperature increases, the distribution of the range of temperatures shifts to include a greater likelihood of more extreme hot temperatures and less extreme cool temperatures. For example, the number of record hot days across Australia has doubled since 1960 despite only an average temperature increase of 0.9°C (CSIRO and BoM, 2007). Many more record hot days will occur if global warming progresses unabated during the 21st century.

Greenhouse gases in the atmosphere trap heat so the more greenhouse gases there are in the atmosphere, the more heat is trapped. The increase in temperature observed around the world is directly connected to the increase in greenhouse gases from human activities (IPCC, 2011).

Over the last 40 years much of eastern, southern and southwestern Australia has become drier.

- **Tasmania's** total rainfall has reduced, most noticeably in autumn (Grose et al., 2010; BoM/ACSC, 2011).
- The Big Dry of 1997–2009 in **Victoria** was the driest period on record in the state, surpassing previous droughts that extended from 1936–1945 (the World War II drought) and 1896–1905 (the Federation drought) (SEACI, 2010). In the last two decades Victoria has experienced both a 10–20% reduction in rainfall during the late autumn/winter season and a reduced frequency of very wet years (SEACI, 2010).
- Most of **New South Wales** has experienced a drying trend over the past 40 years (BoM, 2012c).
- There has been a clear decline in rainfall in southern **South Australia** since 1970 (BoM, 2012d).
- Southwestern **Western Australia** has become markedly drier. There has been a 15% reduction in rainfall since the mid-1970s (BoM, 2012e).
- **Western Australia** and **Tasmania** did not experience the increased rainfall seen over parts of southeastern Australia over the last two years (BOM, 2012e).



How does climate change influence bushfires?

Bushfires can be catastrophic in Australia, claiming lives, causing widespread damage, and devastating towns and communities. Southern Australia is an extremely fire-prone region in summer. While many factors influence the potential for bushfires, so called 'fire weather' is highly sensitive to changes in climatic conditions (Clarke et al., 2012). Changes such as hotter temperatures, longer duration of heat events, high winds due to strong temperature gradients and drier soils and fuel can dramatically exacerbate fire conditions. Thus when fire occurs in more extreme weather conditions, there is the potential for the fire to be far more intense and difficult to control.

Many regions have already experienced an increase in extreme fire weather. The main contributors to this increase are prolonged periods of low rainfall and the increased frequency and intensity of extreme heat (Lucas et al., 2007; Clarke et al., 2012).

The Forest Fire Danger Index (FFDI), which is used to gauge bushfire threat, has increased significantly at 16 of 38 weather stations across Australia between 1973 and 2010, with none of the stations recording a significant decrease (Clarke et al., 2012). The increase has been most prominent in southeastern Australia. Fire seasons have also become longer (Clarke et al., 2012).

The opportunity for fuel reduction burning is reducing as fire seasons have become longer (Clarke et al., 2012). This means that vulnerability to fire is increasing.

Why are the current heat and bushfire conditions unusual?

Large parts of Australia have experienced intense heatwaves, extreme hot days and bushfires in late December and early January. The conditions are unusual because of their widespread nature and duration. Over a sequence of six days almost the entire continent except for coastal fringes experienced extreme heat conditions. While typical summer heatwaves exert a more regional influence this heatwave has affected over 70% of Australia. A number of long-standing site records have been broken for both maximum temperatures and sequences of days above temperature thresholds.

These conditions follow a very warm and dry end to 2012. The period of September 2012–January 2013 has been the hottest such four month period on record. Rainfall has been below average across much of Australia, with a notably inactive monsoon onset period across the tropics (BoM, 2013b). It also followed two years of record rainfall across southeastern Australia, which has increased the amount of vegetation and thus the amount of potential fuel for a fire.

As of 9 January 45 temperature records had been broken: 28 daily maximum temperatures and 17 daily minimum temperatures (BoM, 2013b). More temperature records are likely to be broken as the hot conditions continue in early 2013.

Record-breaking temperatures across Australia in 2013

Australia: Record highest daily-average temperature of 32.36°C set on 8 January 2013. Australia also experienced 7 consecutive days with area-average maximum temperatures above 39°C between 2–8 January 2013, breaking the previous record of 4 days in 1973.

New South Wales: On 5 January 2013 Hay reached 47.7°C, breaking its previous temperature record by 1.7°C.

Northern Territory: Curtin Springs broke its maximum temperature record on 4 January 2013, only for it to be broken again on 8 January when it reached 45.7°C.

South Australia: Between 4–6 January 2013 maximum temperature records were broken at four weather stations.

Tasmania: On 4 January 2013 maximum temperature records were broken at eight weather stations across Tasmania. Hobart reached 41.8°C, breaking the previous temperature record by 1°C.

Victoria: On 4 January 2013 Portland broke its temperature record by reaching 42.1°C.

Western Australia: On 3 January 2013 Eucla broke its temperature record reaching 48.2°C. On 8 January 2013 alone, maximum temperature records were broken at five weather stations across Western Australia.

Source: BOM, 2013b

The record average temperature around Australia over a 24 hour period was broken two days in a row. The previous record was 31.86°C set on 21 December 1972. This was broken on 7 January 2013 by an average temperature of 32.23°C and then again on 8 January 2013 when the average temperature was 32.36°C (BoM, 2013b). The average temperature across Australia was 0.5°C hotter than the 1972 record, a substantial increase.

The record for the average maximum temperature for a 24 hour period was set on 7 January.

Hottest average daily maximum temperature for a 24 hour period for Australia

1	07/01/2013	40.33°C
2	21/12/1972	40.17°C
3	08/01/2013	40.11°C

The average maximum temperature from 2–8 January was over 39°C. This is the longest period ever for such high temperatures. It broke the previous record of four days set in 1973. A four day sequence had only occurred once in the historical record. The length, extent and severity of this heatwave are unprecedented in the measurement record.

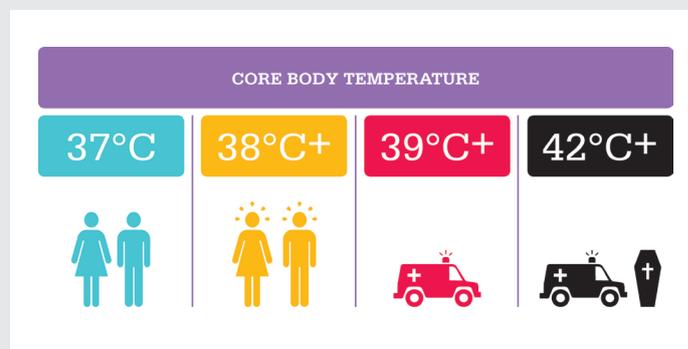
Although Australia has always had heatwaves, hot days and bushfires, climate change has increased the risk of more intense heatwaves and extreme hot days, as well as exacerbated bushfire conditions. Climate change is making extreme hot days, heatwaves and bushfire weather worse.

The increase in extreme weather in Australia illustrates an important way that greenhouse gases are forcing a shift in climate that is very costly. This highlights the need for urgent action to reduce greenhouse gas emissions.

What impact does extreme heat have on Australians?

Hot days and heatwaves have a significant impact on our health and our health systems. Heat is the silent killer and is the leading cause of weather-related deaths in Australia.

Even small changes in our environment can have dramatic effects on the human body. For example, humans can only survive when core body temperature remains in a narrow range, around 37°C (Hanna et al., 2011). If the body produces or absorbs more heat (from physical activity or high air temperatures) than it can remove through sweating, core body temperature will rise.



If core body temperature exceeds 38°C for several hours, the body can suffer heat exhaustion and reduced mental and physical capacity (Parsons, 2003; Berry et al., 2010). People's judgement and behaviour can be impaired on the roads and at home which increases risks of physical accidents. At core

body temperatures above 39°C, more serious heat stroke and unconsciousness may occur (Kjellstrom et al., 2009). Serious heat stroke and even death occurs after a relatively short time if core body temperature goes above 42°C (Parsons, 2003).

Heatwaves in recent years around Australia have resulted in increased hospital admissions for kidney disease, acute renal failure and heart attacks, and in death (Climate Commission, 2011). During the severe heatwaves in southeastern Australia in 2009, Melbourne sweltered through three consecutive days at or above 43°C in late January. There were 980 deaths during this period—374 more than the estimated 606 that would have occurred on average for that time of year, or an estimated increase of 62% (DHS, 2009). Most of the increase was among people aged 75 or older (DHS, 2009).

If we don't improve the way we forecast, prepare for and manage extreme heat events, excess deaths are likely to increase with climate change (PWC, 2011). During the Brisbane heatwave of 7–26 February 2004 the temperature ranged from 26°C to 42°C. Overall deaths increased by 23% (excluding injury and suicide) compared with the death rate during the same period in 2001–2003 when the temperature ranged from 22°C to 34°C (Tong et al., 2010).

These are examples of extreme heatwaves over short timeframes. It is a similar story over the longer term. Over 13 summers from 1993 to 2006, the number of people requiring ambulance transport during heatwaves in Adelaide increased by 4% when compared with non-heatwave periods. A corresponding increase in total hospital admissions of 7% was observed during heatwaves (Nitschke et al., 2007).

Children, the elderly, people with existing health issues and workers with heat exposed jobs are more vulnerable to heat extremes.

The [Climate Commission website](http://www.climatecommission.gov.au) (www.climatecommission.gov.au) provides some information about coping with hot weather.

Authors



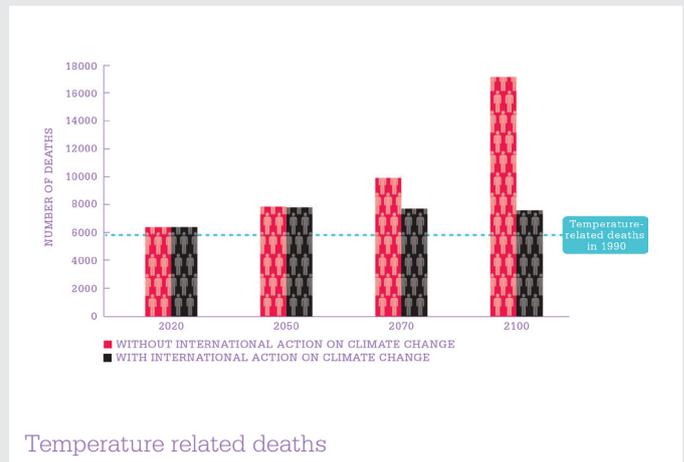
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