

# **2016:** GLOBAL HEAT RECORD BROKEN AGAIN

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Published by the Climate Council of Australia Limited

978-1-925573-12-1 (print) ISBN<sup>.</sup> 978-1-925573-13-8 (web)

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# Key Findings

- 2016 was the hottest year on record globally for the third year in a row. Climate change was the dominant factor in driving the record-breaking heat worldwide.
- The global average temperature for 2016 was 0.94°C above the 20<sup>th</sup> century average, overtaking the previous record set in 2015 by 0.04°C.
- The record global warmth of 2016 is part of a longterm trend. All of the world's 10 warmest years have occurred since 1998. 2016 is the 40<sup>th</sup> consecutive year with above-average global temperatures.
- No one aged under 40 has lived in a year with global average temperatures at or below the global 20<sup>th</sup> century average.

### Climate change is worsening heat-related extreme weather conditions in Australia.

- Autumn 2016 was Australia's warmest on record and Perth had more 40°C days in the 2015/2016 summer than ever before.
- > Eight of the ten hottest years on record in Australia have occurred within the past two decades.
- > Averaged across Australia, temperatures for 10 of the 12 months of 2016 were above-average.
- Ocean temperatures around Australia were record breaking in 2016, 0.73 °C above average (1961-1990).



## J Increasing extreme heat is damaging to human health, our economy and the environment.

- > 2016's extremely warm temperatures drove dramatic and unprecedented climate impacts, including the worst coral bleaching event in the Great Barrier Reef's history, an unparalleled largescale mangrove dieback in northern Australia and a major algae bloom in the Murray River.
- > Climate change made the bleaching of the Great Barrier Reef 175 times more likely.
- Increased temperatures driven by climate change are increasing the risk of heatwaves, bushfires and drought in Australia.

## Record temperatures across many regions of the world are strongly influenced by climate change.

- Eight months in 2016 broke global heat records, with March 2016 setting the highest departure from average for any month since records began in 1880.
- An unprecedented sixteen months in a row of monthly temperatures broke global records between May 2015 and August 2016.
- > The emission of greenhouse gases is driving record global heat. Countries including Australia must drastically reduce their emissions from coal, oil and gas to slow and then halt the escalating impacts of extreme heat.
- We are rapidly closing the window of opportunity to limit warming to 2°C above pre-industrial levels

   this is the "guardrail" temperature referred to in the Paris Agreement to stabilise the climate and limit the catastrophic impacts of climate change.

## Introduction

In 2016 heat records were broken across the world, culminating in 2016 becoming the hottest year on record.

### Extraordinary heat was experienced right around the world.

An intense January heatwave in South Africa broke high temperature records at 62 locations, with temperatures rising above 40°C in many areas. New Zealand had its hottest May, while North America experienced its warmest June on record. Europe had record heat in September across a number of countries including France, Norway, Portugal and the UK. In England, the first ever heatwave alert for September was released as temperatures around the country exceeded 30°C. Asia experienced its warmest January-October on record. Heatwaves were particularly severe in India, which observed its hottest day on record when the temperature soared to 51°C in Phalodi. This follows on from the previous years' intense heatwave which claimed more than 3,700 lives in India and Pakistan

These record temperatures drove an unprecedented worldwide coral bleaching event, which led to the worst bleaching in the Great Barrier Reef's history.

At home, Australia sweltered through its warmest autumn on record. Highest temperatures on record were experienced throughout much of eastern and northern Australia including Queensland, New South Wales, Victoria and the Northern Territory. From late February through March 2016, the sea surface temperatures over the northern, most pristine part of the Great Barrier Reef were around 1 to 1.5°C above the recent long-term average (2002-2011). Warm waters caused devastating bleaching and the death of 67% of coral in the northern section. Western Australian and other reefs throughout the world were also badly affected by this mass global bleaching event, the worst in recorded history, driven by climate change and a recent El Niño event.

Human activities, such as the burning of coal, oil and gas for electricity, are driving up greenhouse gas emissions and fuelling the long term warming trend. The atmospheric concentration of CO<sub>2</sub> is now above 400 parts per million, having increased 44% since the Industrial Revolution. The additional greenhouse gases that have accumulated in the atmosphere since the beginning of the Industrial Revolution, and especially since the 1970s, are trapping more heat within the Earth's atmosphere. This heat builds up throughout the lower atmosphere, at the Earth's surface and within the oceans. Off-the-chart heat records are becoming more and more common each year we delay reducing emissions.

Arctic temperatures continue to increase at twice the rate of the global temperature rise. Record monthly highs were set for January, February, October and November 2016. In November 2016, air temperatures soared up to 20°C above the mid-winter average near the North Pole. Arctic sea ice extent was at record low levels and for a brief period, the total extent decreased by an unprecedented 50,000 square kilometres (about twice the size of the Greater Sydney region). It wasn't just the North Pole that has experienced extreme conditions. The Antarctic sea ice extent was also at a record low in November 2016.

### Extreme heat led to mass bleaching of the Great Barrier Reef.

In November, the world's first universal climate agreement entered into force, committing countries (125 at time of publication) to do everything possible to limit global warming to well below 2.0°C above the pre-industrial level, and to make every effort to limit it to 1.5°C.

With the global average temperature in 2016 sitting about 1.1°C above the pre-industrial baseline, there is no time to lose if we are to meet this goal and prevent many more heat extremes and other escalating risks of climate change. Sixteen of the seventeen hottest years on record have occurred this century. The 2016 global heat records are yet another reminder of the urgency of the challenge.

# 16 of the 17 hottest years on record have occurred this century.

1.

## Global Temperatures Off the Charts

In 2016, the world experienced its hottest year on record – again. The global average temperature was the highest since global records began in 1880 (NOAA 2017a). The temperature was 0.94°C\* above the 20<sup>th</sup> century average, making it 0.04°C hotter than 2015 – the previous record holder (NOAA 2017a).

### 2016 was the 40<sup>th</sup> consecutive year with an above-average global temperature.

The 20<sup>th</sup> century average is affected by strong warming from 1970 through the end of the century (Figure 1). When 2016's record hot year is compared to pre-industrial temperatures rather than the 20<sup>th</sup> century, the extent to which our climate has warmed is even more alarming. In fact, 2016's temperature is estimated to be nearly 1.1°C above the pre-industrial baseline (UK Met Office 2017). The Paris Agreement commits countries to doing everything possible to limiting global temperature rise to less than 1.5°C above pre-industrial temperatures. 2016 was the 40<sup>th</sup> consecutive year with an above-average global temperature (NOAA 2017a). You would now need to be at least 40 years old - born in 1976 or earlier - to have lived in a year with temperatures at or below the global 20<sup>th</sup> century average. The world has experienced an unprecedented three consecutive hottest years (2014, 2015 and 2016) on record, while the last record cold year globally was over one hundred years ago in 1908 (NOAA 2017a).

An increase in atmospheric greenhouse gases, resulting mainly from the burning of fossil fuels (coal, oil and gas), is driving climate change, including increasing temperatures in Australia and globally. Unless we take rapid and effective action, the world is set for even hotter conditions ahead as the amount of greenhouse gases in the atmosphere continues to increase (IPCC 2014; Le Quéré et al. 2016).

\* Temperature data in this report are based on the National Oceanic and Atmospheric Administration (NOAA) data, from the US. For more information regarding the data, please refer to the official NOAA website: www.noaa.gov

### 2016 was the world's hottest year on record.



**Figure 1**: Column graph of the annual global temperature anomalies to 2016, relative to the global annual average temperature for the 20<sup>th</sup> century (1901-2000). Data from the US National Oceanic and Atmospheric Administration (NOAA).



Figure 2: Coal fired power stations (e.g., Loy Yang in Victoria) emit significant amounts of carbon dioxide to the atmosphere, which is the most important greenhouse gas driving climate change and increasing global temperatures.

### **BOX 1: HOW DO WE KNOW?**



Figure 3: A drifter buoy collects measurements at and below the ocean surface.

The global average temperature anomaly (the difference between the measured temperature and the 20<sup>th</sup> century average) is calculated monthly, based on observations of land and ocean surface temperatures around the world, and on satellite data. Land-surface temperatures are measured at a network of land-based weather monitoring stations and indicate the temperature in the shade at around 1-1.5 m above the ground. Ocean-surface temperatures (sea surface temperatures) are collected from buoy and ship observations. Rather than using the

raw temperatures (such as -30°C in Antarctica and +45°C in Timbuktu) it is useful to have the temperature anomalies, which tell us how the raw temperature compares to the 20<sup>th</sup> century average temperature in that area (such as +0.3°C above or below the long-term average for that location). To calculate the global average, the ocean- and landsurface temperature anomalies are averaged using area-weighted calculations. The final value tells us how different the temperature of the Earth's surface was, compared to the 20<sup>th</sup> century average, as shown in Figure 1.

### BOX 1 CONTINUED: HOW DO WE KNOW?



Figure 4: A world map showing the locations of fixed temperature monitoring stations which contribute to the global surface temperature anomaly records, adapted from NOAA (2015a).

The monthly analysis is available for all years after 1880 because there are sufficient observations from this time onwards (NOAA 2015b). Nowadays, fixed temperature monitoring stations, measuring temperatures year-round, are located all around the world - as shown in Figure 4.

The 20<sup>th</sup> century global average temperature is used as the long-term average reference because it represents the temperature over quite a long period and therefore allows trends to be differentiated from shorter periods of variability. It is also an easy reference period to understand. However, it is not the same as the pre-industrial temperature. Unlike the pre-industrial period, which is before the climate experienced major human influence, the 20<sup>th</sup> century average includes climate change-driven temperature rise, particularly from 1970 onwards. Global policy targets, such as the aim to limit temperature rise to no more than 2°C agreed at Paris, are referenced against a pre-industrial baseline and not a 20<sup>th</sup> century average. In addition, the world's ecosystems, such as coral reefs, are adapted to only small variations around the pre-industrial baseline, so they "feel" the full temperature rise from a pre-industrial baseline.

2.

# Climate Change is Driving Record-Breaking Heat

Climate change is driving an increase in temperatures across the globe, relative to the long-term average. The hottest year on record in 2016, succeeding the previous hottest in 2015, is just the latest record in a long-term trend of increasing surface temperatures worldwide (Figure 1).

There is considerable variability in temperature from year-to-year, and one of the most important modes of variability is the El Niño-Southern Oscillation (ENSO). The El Niño phase provides an extra boost to the global average temperature, as shown in Figure 5. El Niño years stand out as being somewhat warmer than the years around them, and, conversely, La Niña years are somewhat cooler. However, the magnitude of the ENSO effect is only 0.1-0.2°C (Trenberth et al. 2002; Foster and Rahmstorf 2011; Santoso and McGregor 2014; UK Met Office 2017), so it is clear that climate change was easily the most important factor in driving not only the exceptionally warm years of 2015 and 2016 but also the long-term trend of rising temperature from the mid-20<sup>th</sup> century onwards.



**Figure 5**: Column graph of global (land and ocean) surface temperature anomalies 1950 - November 2016 (1961–1990 baseline). Major tropical volcanic eruptions (green bars) are associated with cooler global temperatures. El Niño and La Niña years (red and blue bars, respectively) show their effect in slightly increasing (El Niño) and decreasing (La Niña) the global average temperature. Climate change is the dominant driver of these records, which get a boost now and then by an El Niño year. Data from the World Meteorological Organization.

There is indeed a clear, strong warming trend since the middle of the 20<sup>th</sup> century, and especially since the 1970s. The 1990s were warmer than the 1980s and the 2000s were warmer than the 1990s. All three decades were hotter than any preceding decade since 1850 (IPCC 2013). In Australia, average surface temperature has increased by 1°C since 1910, with higher increases in night-time minimum temperatures than in daytime maximum temperature (CSIRO and BoM 2016). This underlying, upward trend in temperature driven by climate change is now by far the dominant driver of the temperature records that are being broken at an alarming rate, dwarfing the influence of El Niño events.

Climate change dwarfs El Niño in driving recent record temperatures.

Climate change has also increased the likelihood of extreme heat events in Australia. A number of recent studies investigating the effect of climate change on the occurrence of major heat events have found events to be much more likely with climate change than without (Knutson et al. 2014; Lewis and Karoly 2014; Black et al. 2015; King et al. 2015). For example, 2013 was Australia's hottest year on record and research has shown that, without climate change, such a hot year would only occur about once every 12,300 years, if at all (Lewis and Karoly 2014). Studies on the summer 2012/2013 heatwaves found that climate change tripled the odds that heatwaves would occur as frequently as they did and doubled the odds that they would be as intense as they were (Knutson et al. 2014; Lewis and Karoly 2014). The record October heat in 2015 that triggered bushfires and crop losses in Australia is attributed to climate change (Black and Karoly 2016). In the future, temperatures are projected to continue increasing, with more extremely hot days (CSIRO and BoM 2016).

# Extreme heat is more likely due to climate change.

3.

## The Heat is on: The Australian Story

Australia experienced its 4<sup>th</sup> warmest year on record and temperatures for 10 of the 12 months of 2016 were above the 1961-1990 average (BoM 2017). Ocean temperatures around Australia were record breaking at 0.73 °C above average. The records listed below are referenced against the 1961-1990 average.



- The Australian summer of 2015-16 was the sixth warmest on record, with temperatures 0.82°C above average (BoM 2016a).
- In January, Hobart's mean minimum temperature was the warmest on record, 2.5°C above average (BoM 2016b).
- The maximum temperature for the 2<sup>nd</sup> of March 2016, averaged across Australia, was 38.14°C - the hottest national daily temperature ever recorded in March (BoM 2016c).
- Perth had more 40°C days in the 2015/2016 summer than ever before (BoM 2016d; Figure 6).



Autumn

- > Autumn was Australia's warmest on record  $\rightarrow$  The Australian winter was significantly with the mean temperature 1.86°C above average (BoM 2016e).
- > Highest temperatures on record were experienced throughout much of eastern and northern Australia including Queensland, New South Wales, Victoria and the Northern Territory (BoM 2016e).
- > Queensland, New South Wales, Victoria and the Northern Territory had mean temperature anomalies for autumn of 2.35°C, 2.21°C, 1.88°C and 2.21°C respectively, above average (BoM 2016e).
- > Sydney had its warmest autumn on record, with an unprecedented 46 days of at least 25°C (BoM 2016f).
- > Queensland had its warmest April on record, with the statewide mean temperature 2.7°C above average (BoM 2016g).
- > The Northern Territory had the highest ever recorded May mean minimum temperature at 3.10°C above average (BoM 2016h).



- warmer than average over most of the country, with minimum temperatures the 4<sup>th</sup> warmest on record (BoM 2016i).
- > Highest maximum temperatures on record were experienced in the Top End and small areas of northern Western Australia (BoM 2016i).
- > June was the sixth warmest on record (1910-2016) for Australia with a temperature 1.30°C higher than average (BoM 2016j).



- > The north and coastal eastern Australia experienced a warmer than average spring (BoM 2016k).
- > Record high spring mean temperatures occurred in the Townsville area (BoM 2016k).



Figure 6: February and March 2016 brought prolonged heat conditions for much of southern and eastern Australia.

### 4.

## The Heat is on: The Global Picture

Climate change is a global problem. The trend towards warmer temperatures is being experienced across many regions of the world, with record-breaking heat occurring throughout all seasons of the year and records tumbling at locations on all continents. August 2016 marked an unprecedented sixteen months in a row that global monthly heat records were broken, stretching back to May 2015 (NOAA 2016a).



Figure 7: Global monthly heat records broken 16 months in a row (May 2015 - August 2016).

Note: Monthly global temperature anomalies shown here are relative to the 1901-2000 (20th century) average.

# The trend towards warmer temperatures is being experienced across land and sea.

Globally averaged temperatures are a good indicator of the state of the climate system as a whole, and paint a large-scale, long-term picture of change. Broken down to landsea, month-to-month and region-by-region scales, this new data present a more detailed pattern of record-breaking heat and of changing climate conditions across regions and ocean basins, particularly a frightening increase in extreme heat events.

#### Land-Sea

The record-breaking heat of 2016 consisted of both land-surface and ocean(sea)-surface temperatures.

The 2016 globally-averaged land surface temperature was the highest ever recorded (1880–2016) at 1.43°C above the 20<sup>th</sup> century average. This surpassed the previous record of 2015 by 0.11°C (NOAA 2017a).

In 2016, the globally-averaged sea surface temperature was 0.75°C above the 20<sup>th</sup> century average, exceeding the 2015 record by 0.01°C (NOAA 2017a). Representing more than two-thirds of the Earth's surface, the increasing heat content of the upper ocean has a very important influence on the global climate. Large portions of the the Pacific Ocean and parts of the Atlantic Ocean, Indian Ocean and the Gulf of Mexico and the Caribbean were exceptionally hot (NOAA 2017a).

#### Month-to-Month

Every season was hotter than average in 2016. The hottest year on record did not just result from a single, extremely hot, part of the year. It was the result of 12 months of very warm temperatures, eight of them recordbreaking (NOAA 2017a).

At 1.22°C above the long-term average, March 2016 recorded the highest departure from the average for any month since records began in January 1880 (NOAA 2017a).



Figure 8: Warming temperatures have wide-reaching impacts, including on human health.

### BOX 2: RECORD BREAKING HEAT IN 2016

- The 2016 globally-averaged land surface temperature was the highest ever recorded at 1.43°C above the 20<sup>th</sup> century average.
- In 2016, the globally-averaged sea surface temperature was 0.75°C above the 20<sup>th</sup> century average, exceeding the 2015 record by 0.01°C.
- > Every season was hotter than average in 2016.
- March 2016 recorded the highest departure from the average for any month since records began in January 1880.
- August 2016 marked an unprecedented sixteen months in a row that global monthly heat records were broken.

**Table 1**: Monthly global temperature anomalies for 2016, relative to the 1901-2000 (20<sup>th</sup> century) average, and how they compare to previous years (NOAA 2017a). Grey shading indicates the months January to August in which new monthly temperature records were set.

Month	Global land-ocean average temperature anomaly	How does it compare?
January	+1.04°C	NEW RECORD: The hottest January on record, surpassing the previous record set in 2007 by +0.16°C (NOAA 2016b).
February	+1.21°C	NEW RECORD: The hottest February on record, surpassing the previous record set in 2015 by +0.33°C (NOAA 2016c).
March	+1.22°C	NEW RECORD: The hottest March on record, surpassing the previous record set in 2015 by +0.32°C (NOAA 2016d).
April	+1.10°C	NEW RECORD: The hottest April on record, surpassing the previous record set in 2010 by +0.28°C (NOAA 2016e).
May	+0.87°C	NEW RECORD: The hottest May on record, surpassing the previous record set in 2015 by +0.02°C (NOAA 2016f).
June	+0.90°C	NEW RECORD: The hottest June on record, surpassing the previous record set in 2015 by +0.02°C (NOAA 2016g).
July	+0.87°C	NEW RECORD: The hottest July on record, surpassing the previous record set in 2015 by +0.06°C (NOAA 2016h).
August	+0.92°C	NEW RECORD: The hottest August on record, surpassing the previous record set in 2015 by +0.05°C (NOAA 2016a).
September	+0.89°C	The second hottest on record (NOAA 2016i).
October	+0.73°C	Tied with 2003 as third hottest October on record (NOAA 2016j).
November	+0.73°C	Fifth hottest on record (NOAA 2016k).
December	+0.79°C	The third hottest on record (NOAA 2017b).

## **2016:** WAS THE HOTTEST YEAR **J**



5.

# Impacts of Climate Change and Rising Temperatures

Many heat records were broken throughout 2016, with serious consequences for Australia. This section explores these impacts. For more details about the influence of climate change on extreme weather events and the escalating impacts and risks, please refer to other Climate Council reports (https://www.climatecouncil.org.au/category/ reports).

# 5.1 Heat-related Extreme Weather5.1.1 Heatwayes

Extreme heat is a serious health threat for many Australians, often called the silent killer. Major heatwaves have caused more deaths since 1890 than bushfires, cyclones, earthquakes, floods and severe storms combined (DIT 2013; Coates et al. 2014). Longer, hotter and more intense heatwaves in Australia are being driven by climate change. For example, since 1960, the number of record hot days has doubled (Perkins and Alexander 2013; Cowan et al. 2014). Extreme heat increases the risk of heat-related illness and can also exacerbate pre-existing conditions – children, the elderly and outdoor workers are most at risk (AAS 2015; Climate Council 2015a; Watts et al. 2015). Australia's mortality data indicate that over the past four decades there has been a steady increase in the number of deaths in summer compared to those in winter, suggesting that climate change may already be affecting mortality rates (Bennett et al. 2013).

### Climate change is driving longer, hotter and more intense heatwaves.



Figure 10: Heatwaves are a serious health threat for many Australians, causing more deaths than other extreme weather events.



Figure 11: Climate change is increasing the likelihood of dangerous bushfire weather, particularly in the southwest and southeast of Australia.

### 5.1.2 Bushfires

Climate change is increasing the likelihood of dangerous bushfire weather, particularly in the southwest and southeast of Australia. As temperatures continue to rise, climate change is extending the length of the fire season, which now extends well beyond summer, into October and March, in many regions (Clarke et al. 2013). Analysis of global climate data has shown that the frequency of long fire weather seasons has increased in eastern Australia (VIC, NSW, ACT and QLD) where around 77% of the population live (ABS 2015; Jolly et al. 2015). Record-breaking spring temperatures in 2015, strongly influenced by climate change, contributed to an early start to the 2015/16 bushfire season in Australia. Some of the most damaging fires occurred on Christmas Day 2015, where bushfires near the Great Ocean Road caused damage to more than 116 homes and \$86 million worth of insured losses. Hot, dry conditions in the southeast of the continent over summer may make this summer a particularly bad fire season.

Climate change is already worsening bushfire conditions in Australia, including the summer of 2015/16.

## 5.2 Coral Bleaching

The longest global coral bleaching event on record occurred in 2016, caused by record-breaking ocean temperatures driven by climate change and El Niño. Over one third of the world's reefs were affected by bleaching, with nearly all reefs experiencing some thermal stress (NOAA 2016n). From late February through March, waters over the Great Barrier Reef were around 1-1.5°C above the recent long term average (2002-2011) for the same time of year (BoM 2016m).

Climate change made the bleaching of the Great Barrier Reef 175 times more likely. The increased sea surface temperature resulted in the worst mass bleaching event on record for the Great Barrier Reef, with 93% of individual reefs experiencing some degree of bleaching (Coral CoE 2016), and 67% of coral are now dead in the northern section of the GBR (GBRPMA 2016; Hughes et al. 2016). The mass bleaching event on the Great Barrier Reef was at least 175 times more likely because of the extreme ocean temperatures driven by climate change (CoECSS 2016). On present climate change trends, the Great Barrier Reef will be bleached every two years by the mid-2030s unless deep and rapid reductions in greenhouse gas emissions are achieved (CoECSS 2016). This is a serious threat to the tourism industry in the Great Barrier Reef World Heritage Area, which adds \$7 billion to the Australian economy (Jacobs 2016) and supports 69,000 jobs (Deloitte Access Economics 2013).



Figure 12: Surveying the coral bleaching in March 2016 at Lizard Island, Great Barrier Reef. The northern, most pristine part of the GBR lost almost two-thirds of its coral (GBRPMA 2016; Hughes et al. 2016).

### 5.3 Storms

Increasing global temperatures can exacerbate storms. The rapidly warming climate means that storms are now occurring in an energetically super-charged atmosphere - a recipe for more destructive storms. Global average surface temperature has already risen by over 1°C above the preindustrial level (UK Met Office 2017), and this means that the atmosphere is storing more heat than before. The oceans are also warming, especially at the surface, and this is driving higher evaporation rates that, in turn, increase the amount of water vapour in the atmosphere. The 1°C temperature rise that has already occurred and increasing evaporation have led to an increase of about 7% in the amount of water vapour in the atmosphere (Hartmann et al. 2013). Additionally, increasing temperatures as a result of climate change are exacerbating the impact of coastal flooding as sea levels rise globally – 20 cm since the late 19<sup>th</sup> century - as glaciers and ice-sheets melt and the oceans warm.

Seven storms since 2000 have each resulted in insured losses of more than \$500 million. with five of them resulting in more than \$1 billion in insured losses including the Melbourne and Perth hailstorms in 2010, the Brisbane floods and Cyclone Yasi in 2011, and the Brisbane hailstorms in 2014 (Understand Insurance 2016). In the future, extreme rainfall events in Australia are projected to increase in intensity, while tropical cyclones are projected to become less frequent, although there are likely to be a higher proportion of high intensity storms (CSIRO and BoM 2015). Extra-tropical cyclones occur as deep low pressure systems from the Southern Ocean and along the east coast (known more commonly as 'east coast lows'), affecting adjacent coastlines. These systems and their associated cold fronts are projected to shift south in the winter, consistent with the observed expansion of the tropics (CSIRO and BoM 2015).

The rapidly warming climate means that storms are now occurring in an energetically super-charged atmosphere.



Figure 13: Lightning strike during Perth storms in December 2011.

### **BOX 3: A WARMING WORLD IS DRIVING UNPRECEDENTED CLIMATE IMPACTS**

Off-the-chart temperatures are driving dramatic and unprecedented climate impacts. Here are a few examples experienced in Australia in 2016:

- Record warm sea surface temperatures and widespread bleaching caused devastation on the iconic Great Barrier Reef and Western Australian reefs.
- > Prolonged hot temperatures have contributed to a major algae bloom in the Murray River.
- Hot and dry conditions over the previous summer contributed to devastating fires in Tasmania in January.

- > Unparalleled large-scale mangrove dieback occurred along the northern Australian coastline.
- A one -in-50 year storm that hit South Australia in September caused the loss of power to 900,000 homes in the state.
- Perth had more 40°C days in the 2015/2016 summer than ever before. Such extreme heat events result in an increased use of health services, placing pressure on services, facilities and staff across the health sector.

6.

# Slowing the March of Temperature Records Requires Urgent Action on Climate Change

Record high temperatures and extreme heat events are occurring around the world and here in Australia at an alarming rate. The only way to slow and then stop the march of record heat conditions is to reduce the global emissions of greenhouse gases deeply and rapidly. To meet the Paris target of keeping the rise in global temperature to well below 2°C, emissions must be trending sharply downward within the next couple of years and the global economy must be completely decarbonized by 2050, and preferably earlier.

There are some encouraging signs. For the third straight year, global greenhouse gas emissions have flatlined at around 10 billion tonnes of carbon per year (Le Quéré et al. 2016). China is leading the way in stopping the increase in emissions by a rapid reduction in coal usage, and the United States and European Union have also contributed significantly to emission reductions (Next10 2015). Australia, on the other hand, has become prominent globally as the world's leading laggard on climate change. Unlike nearly every other wealthy country around the world, our emissions from fossil fuel usage are on the rise (Australian Government 2016).

In 2016, the ACT, the Northern Territory and Victoria set or increased their renewable energy targets, and more than 1.58 million Australian households now have solar installed on their rooftops. Yet, at the federal level, Australia is far from doing its fair share to meet the global emissions reduction challenge agreed in Paris. Australia's target of a 26-28% reduction in emissions by 2030 compared to 2005 is very weak in comparison to other OECD countries, and we are likely to miss even this weak target. In fact, a recent United Nations report estimated that Australia's 2020 emissions will be 11.5% higher than 2005 levels (UNFCCC 2016). Australia is ranked by Climate Transparency (2016) as the worst of all G20 nations on climate change action and is the only country to receive a rating of 'very poor' in a majority of categories. The challenge is urgent. Every year of delay is significant, reducing the chances of meeting the Paris target and making the task of protecting Australians from worsening extreme weather events more difficult. Australia is falling further behind in the level of action required to meet the climate change challenge and ensure the long-term survival of the Great Barrier Reef. We signed the Paris Agreement. Now is the time to deliver on our commitment.



**Figure 14**: The Australian government has ratified the Paris Agreement, yet Australia is falling further behind in the level of action required to meet the climate change challenge as its emissions increased by 0.8% the past year (Australian Government 2016).

## **Appendix:** Record Heat Across the World

The record-breaking global temperatures did not come from extreme heat in only one country, or one continent. 2016 brought hot temperatures across the globe.

#### Africa

- Africa had its second warmest January on record (NOAA 2016b).
- > Botswana broke a 72-year record for its highest maximum temperature, after recording a maximum of 44°C in Maun in January (Botswana Daily News 2016).
- > An intense January heatwave in South Africa broke records as 62 locations experienced record high temperatures, reaching up to 46°C in Tosca (South African Weather Service 2016).

#### Asia

- > In May, Phalodi in India reached 51°C, which is India's hottest day on record (The Guardian 2016). Much of India, especially the north, experienced the worst heatwave in a decade and the capital city, New Delhi, experienced five consecutive days with temperatures over 43°C (ClimateWatch 2016).
- > An exceptional heatwave on the Indochinese Peninsula in April resulted in 50 cities setting new maximum temperature records in Thailand. The national record, dating back to 1960 was broken, with 44.6°C recorded in Mae Hong Son (Météo France 2016a).
- Northern Siberia experienced record warmth in January, when temperatures were at least 5°C above the 1981–2010 monthly average (NOAA 2016b).
- > Hong Kong had its equal (with 2014) hottest July on record (NOAA 2016h).

> Asia had its warmest January–October on record (NOAA 2016j).

#### Arctic

- Record monthly highs were observed for January, February, October and November 2016 (NOAA 2016m).
- In 2016, several weather stations in the Arctic recorded temperatures 8°C or more above the 1961-1990 average (Meteorologisk institutt 2016a).
- On 17 November 2016, air temperatures soared up to 20°C above the mid-winter average near the North Pole (SMH 2016).

#### Europe

- > Europe had its hottest September on record since records began in 1910 (NOAA 2016i).
- September's mean temperature for Norway was a record high for the 117 years of measurements, at 3.6°C above average (1961-1990) (Meteorologisk institutt 2016b).
- Germany observed its equal warmest September in its 136 year period of records (Deutscher Wetterdienst 2016).
- > France and Austria observed their third and fifth warmest September since records began in 1900 and 1767, respectively (Météo France 2016b; ZAMG 2016).
- The warmest September day since 1911 was recorded in Gravesend, Kent with the temperature reaching 34.4°C (BBC 2016).
- Pottschach in Austria experienced an equal hottest February day with the temperature reaching 23.2°C (NOAA 2016c).

#### North America

- In the United States, Alaska had its warmest February in 92 years of records, at 6.9°C higher than the 20<sup>th</sup> century average (NOAA 2016b).
- Toronto experienced its highest ever temperature (16°C) for February (NOAA 2016c).
- > North America had its warmest June on record (NOAA 2016g).

#### Oceania

- > New Zealand experienced its hottest May since records began in 1909 with temperatures 2.1°C above the 1981-2010 average, influenced by record warm sea surface temperatures (NIWA 2016).
- Autumn was Australia's warmest on record (BoM 2016e).

#### South America

- > South America experienced its warmest February since records began in 1910 (NOAA 2016c).
- > Several regions of Bolivia, including traditionally cool mountain regions, registered record temperatures. The capital La Paz recorded a temperature of 26.5°C in January, the city's highest temperature since 2003 (Aljazeera 2016).

#### Middle East

In July, Mitrabah, Kuwait likely set the new record temperature for the eastern hemisphere and Asia, reaching 54°C. In the same heatwave, Basra in Iraq recorded a temperature of 53.9°C (WMO 2016).

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## What to do in a heatwave

### IN AN EMERGENCY, CALL TRIPLE ZERO (106 FOR PEOPLE WITH A HEARING OR SPEECH IMPAIRMENT)

- > Take care of yourself everyone is at risk
- > Stay cool

- > Stay hydrated
- > Stay informed Listen to local ABC Radio Station
- > Keep in touch with family, friends and neighbours



### STAY COOL

- > Minimise exertion
- > Keep out of the sun. Minimise heat exposure for yourself and others
- > Limit trips outside and reschedule work meetings and tasks wherever possible
- > Spend time in cooled, well air-conditioned places. If you do not have air-conditioning at home spend time in places that do, such as public libraries, cinemas etc
- > Keep your building cool. Close blinds during the day, and open to cool in the evening
- > Wear cool, comfortable clothes
- > Spray misted water onto body and clothes
- > Spend time lying on and under a wet sheet. Indoor fans can be helpful
- > Avoid using a fan where the indoor temperature is higher than 37°C
- > Remind the elderly of these cooling strategies, and assist them to achieve optimal cooling
- > Check with your local council to hear their heatwave response plan.



### STAY HYDRATED

- > Drink plenty of fluids, chilled if possible
- > Drink enough to urinate at least three times a day, and urine should be very pale in colour. If yellow, or darker, keep drinking. Avoid tea, coffee and alcohol.



### FOOD

- > Ensure that food is refrigerated properly
- > Dispose of spoilt food.



### TRANSPORT/INFRASTRUCTURE

- > Stay informed and up-to-date about planned blackouts
- > Have a backup plan in case electricity or transport (road/rail) infrastructure fails.



### WILDLIFE

- > Leave out shallow containers of water for birds, possums and other animals. Place small stones in the bottom of the container and ensure that the water is left in a shady, protected environment (out of view from birds of prey and high enough to be safe from cats)
- > If you find injured or heat-stressed wildlife, bring them into cooler environments and lightly mist them with water
- > If you are concerned about an animal, call a wildlife rescue centre near you.



### PETS

- If dogs or cats appear heat stressed, panting or restless, bathe them in cool water. Call your vet if you are concerned
- > Bring your pets indoors when it's very hot, or ensure they have outdoor shelter
- > Leave out two bowls of cool drinking water (in case one is knocked over)
- > Never leave your pets alone in the car.

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