



CLIMATE COUNCIL SEASONAL UPDATE: ABNORMAL AUTUMN 2016

Thank you for supporting the Climate Council.

The Climate Council is an independent, crowd-funded organisation providing quality information on climate change to the Australian public.

Published by the Climate Council of Australia Limited

ISBN: 978-0-9945973-5-9 (web)

© Climate Council of Australia Ltd 2016

This work is copyright the Climate Council of Australia Ltd. All material contained in this work is copyright the Climate Council of Australia Ltd except where a third party source is indicated.

Climate Council of Australia Ltd copyright material is licensed under the Creative Commons Attribution 3.0 Australia License. To view a copy of this license visit <http://creativecommons.org.au>

You are free to copy, communicate and adapt the Climate Council of Australia Ltd copyright material so long as you attribute the Climate Council of Australia Ltd and the authors in the following manner:

Climate Council Seasonal Update: Abnormal Autumn 2016 by Will Steffen and Jacqui Fenwick (Climate Council of Australia).

Permission to use third party copyright content in this publication can be sought from the relevant third party copyright owner/s.



Permission to use third party copyright content in this publication can be sought from the relevant third party copyright owner/s.

The authors contain sole responsibility for the contents of this report.

—

Image credit: Cover photo 'Autumn colours in the sun' by Flickr user Mike Russell licensed under CC BY 2.0.

This report is printed on 100% recycled paper.



Professor Will Steffen
Climate Councillor,
Climate Council



Jacqui Fenwick
Researcher, Climate Council

facebook.com/climatecouncil info@climatecouncil.org.au

twitter.com/climatecouncil climatecouncil.org.au

Contents

Key Findings.....	ii
1. Introduction.....	1
2. Australia's Abnormal Autumn.....	2
3. Winter and Spring Outlook.....	9
4. Global Records.....	10
5. Climate Change and the Abnormal Autumn.....	11
References	14
Image Credits	16

Key Findings

1 Climate change continues to drive abnormally warm conditions with autumn 2016 being the warmest on record for Australia.

- › Australia experienced its warmest March, second warmest April and second warmest May on record.
- › Nearly every day in April was above average in Sydney, Darwin, Canberra and Brisbane.
- › The heat has been felt globally with March and April this year the warmest on record, and May likely to follow this trend.

2 Sydney was particularly affected by the abnormal autumn heat.

- › The average maximum temperature for the first half of May was 24.3°C, almost 5°C above the monthly average.
- › On 17 May, only two weeks from the start of winter, inner-Sydney temperatures reached 28.2°C, warmer than the average maximum temperature for January.

3 The abnormally high ocean temperatures wreaked havoc on marine life.

- › Very high ocean temperatures to the northeast of Australia during February and March resulted in a catastrophic coral bleaching event on the Great Barrier Reef, particularly the northern part.
- › A marine heatwave off eastern Tasmania devastated the aquaculture industry throughout early autumn.

4 Climate change, driven by greenhouse gases from the ongoing burning of fossil fuels, is driving these abnormal autumn temperatures.

- › Coal-fired power stations must be phased out and renewable energy scaled up rapidly to meet the challenge of climate change.

1. Introduction

Autumn in Australia is usually a time of cold nights and mild days as the soaring temperatures and balmy nights associated with peak summer wane. But with sweltering temperatures in March, the longest-ever warm spells in April and record-breaking overnight temperatures in May, autumn hardly came at all this year. Autumn 2016 was the warmest on record for Australia (BoM 2016h).

As global temperature records continue to be broken, month by month, year by year, Australia experienced an abnormally warm autumn in 2016.

Climate change, along with the waning El Niño, is driving the rising temperatures. 2015 was the hottest year on record, globally, and the 39th consecutive year with temperatures above the 20th century average (NOAA 2016). Already scientists have indicated that 2016 is likely to exceed that record, with a global annual temperature even hotter than the last (Met Office 2015; King and Hawkins 2016; Schmidt 2016).

Autumn 2016 was the warmest on record for Australia.

Figure 1: Autumn 2016 has been abnormally warm across much of Australia.



2. Australia's Abnormal Autumn

March

Autumn arrived unnoticed as early March temperatures broke records across many regions of Australia. The continent's average March temperature was the warmest ever recorded, at 1.70°C above the long-term average¹ (BoM 2016a).

Early March was particularly warm. Temperature records were broken in parts of northern and central Australia in the first few days of the month (BoM 2016a). Average maximum temperatures from 1 - 9 March were 9.23°C above the long-term March average in Victoria, and 7.35°C above average in New South Wales, reaching an astounding 12°C above average in some in some parts of the state (BoM 2016a). Prolonged March heat spells² affected many parts of Australia until the middle of the month.

Abnormally high ocean temperatures also wreaked havoc in both the north and the south of the country. To the northeast of Australia, abnormally high temperatures during February and March resulted in a catastrophic coral bleaching event on the Great Barrier Reef (GBRMPA 2016; Figure 2; Figure 3). Off the eastern coast of Tasmania, a marine heatwave continued throughout March affecting marine ecosystems and the aquaculture industry. In particular, the oyster industry was devastated by a new disease which is thought to be linked to unusually warm water temperatures (Hobday et al. 2016). Likewise, the abalone and salmon industries were negatively affected by the abnormal autumn warmth (The Guardian 2016a).

Australia's average March temperature was the warmest on record.

¹ Unless otherwise stated, in this report the long-term average temperature is based on 1961-1990 data.

² Heat spells refers to heatwaves which occur outside of the summer months.

Average maximum temperatures from 1-9 March were an astounding 12°C above average in some parts of NSW.

Figure 2: Image of the northern Great Barrier Reef (29 February to 6 March 2016), showing the sea surface temperature anomaly (SSTA) around 1 to 1.5°C above the recent long-term average (2002-2011) for this time of year, with higher temperatures in some areas. Source: adapted from BoM 2016e.

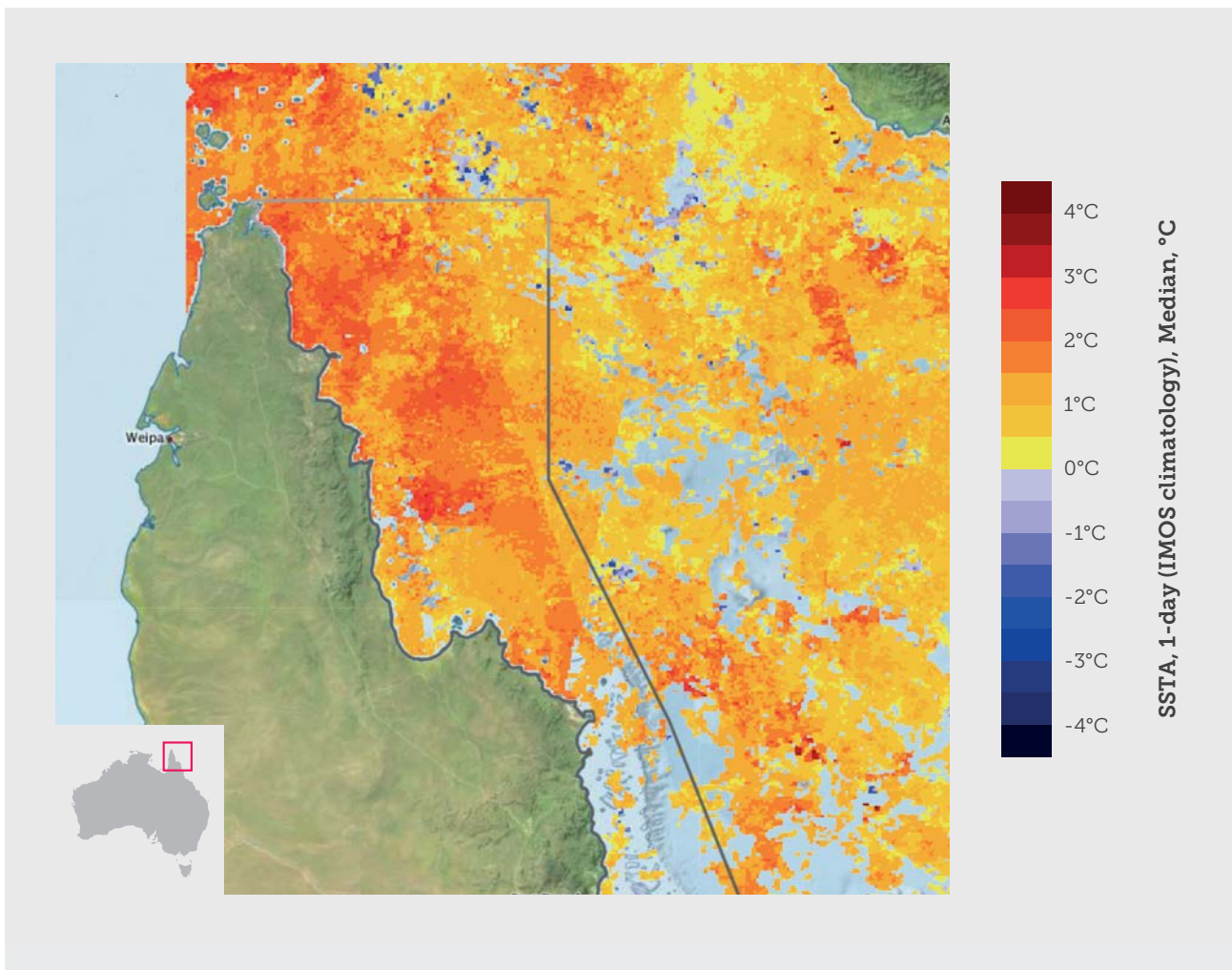




Figure 3: Coral bleaching at Lizard Island, Great Barrier Reef.

April

This April was the second warmest ever recorded for Australia, at 2°C above the national long-term average for the month (BoM 2016d). The average maximum temperature nationwide during April was also the second warmest on record, at 2.38°C above average (BoM 2016d).

Northern Australia in particular felt the warm temperatures. Queenslanders sweltered through the state's warmest-ever April, in which the average temperature, average minimum temperature, and average maximum temperature were all the highest ever recorded (BoM 2016d; Figure 4). Monthly average temperatures were more than 4°C above average in some parts of southwestern Queensland. Records were also broken for highest average maximum temperatures in parts of the Northern Territory and tropical Western Australia.

Queenslanders sweltered through the state's warmest ever April.

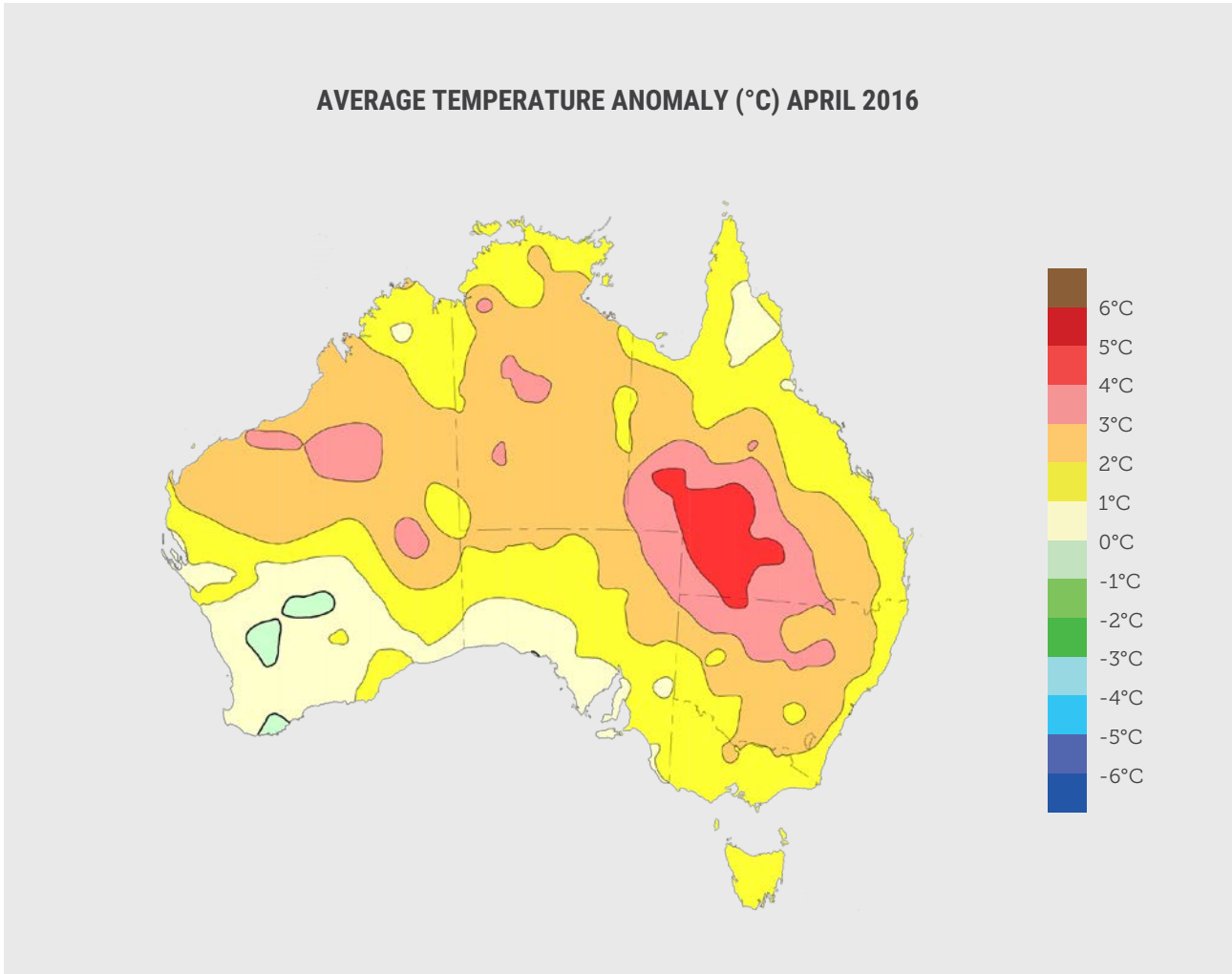


Figure 4: Average temperature anomalies (the difference between the measured monthly average temperatures and the long-term, 1961-1990, average) for Australia through the month of April 2016. Adapted from BoM 2016d.

Table 1 shows the number of days in April with above-average maximum temperatures for Australian capital cities. The greatest number of above-average maximum temperatures was recorded in Darwin, with 29 out of 30 days exceeding the city's average for this time of year.

Warm ocean temperatures to the northwest of Australia during April contributed to coral bleaching off the Western Australian coast as well as at offshore locations such as Christmas Island, Cocos (Keeling) Islands, and Seringapatam Reef (AIMS 2016; BoM 2016c).

Table 1: April statistics for Australian capital cities based on maximum daily temperature data.

City	Number of days with an above-average maximum temperature	New record for the highest monthly average maximum temperature	Max temp (°C)
Sydney	27		34.2
Melbourne	19		30.4
Canberra	26		29.9
Brisbane	26	YES	30.8
Darwin	29	YES	36.0
Adelaide	20		30.1
Perth	9		33.8
Hobart	24	YES	25.8

Data based on recent climate data from the Bureau of Meteorology (BoM 2016b). The temperatures are based on the following stations: 'Observatory Hill' (Sydney), 'Laverton RAAF' (Melbourne), 'Tuggeranong (Isabella Plains) AWS' (Canberra), 'Brisbane QLD', 'Darwin Airport NT' (Darwin), 'Adelaide (Kent Town)', 'Perth Metro WA', 'Hobart (Ellerslie Road) TAS'. Averages are the 1961-1990 monthly average maximum temperatures for April.



Figure 5: Abnormal autumn conditions continued well into May in many parts of Australia, particularly the east coast.

May

May 2016 was the second warmest on record for Australia, 1.88°C above average (BoM 2016g). Average overnight (minimum) temperatures were 2.04°C above average, also the second warmest on record for May (BoM 2016g).

The start of May brought record-breaking overnight (minimum daily) temperatures in Queensland. On the morning of 1 May, cities and towns across the state recorded their hottest May night since records began (ABC 2016; Figure 6). Later in the month, more abnormally high overnight temperatures again broke May records in a number of these

towns, as shown in Figure 6. In Brisbane, maximum daily temperatures didn't fall below the May average of 24.4°C until the 28th (BoM 2016b).

For the first few weeks of May, Sydney wilted in the unseasonal warmth, with temperatures abnormally high for so late in the season. The average maximum temperature for the first half of the month was 24.3°C, almost 5°C above the monthly average (BoM 2016b). The city has not had a start to May this warm since records began in 1858. On 17 May, only two weeks from the start of winter, inner-Sydney temperatures reached 28.2°C, warmer than the average maximum temperature for January (BoM 2016b).

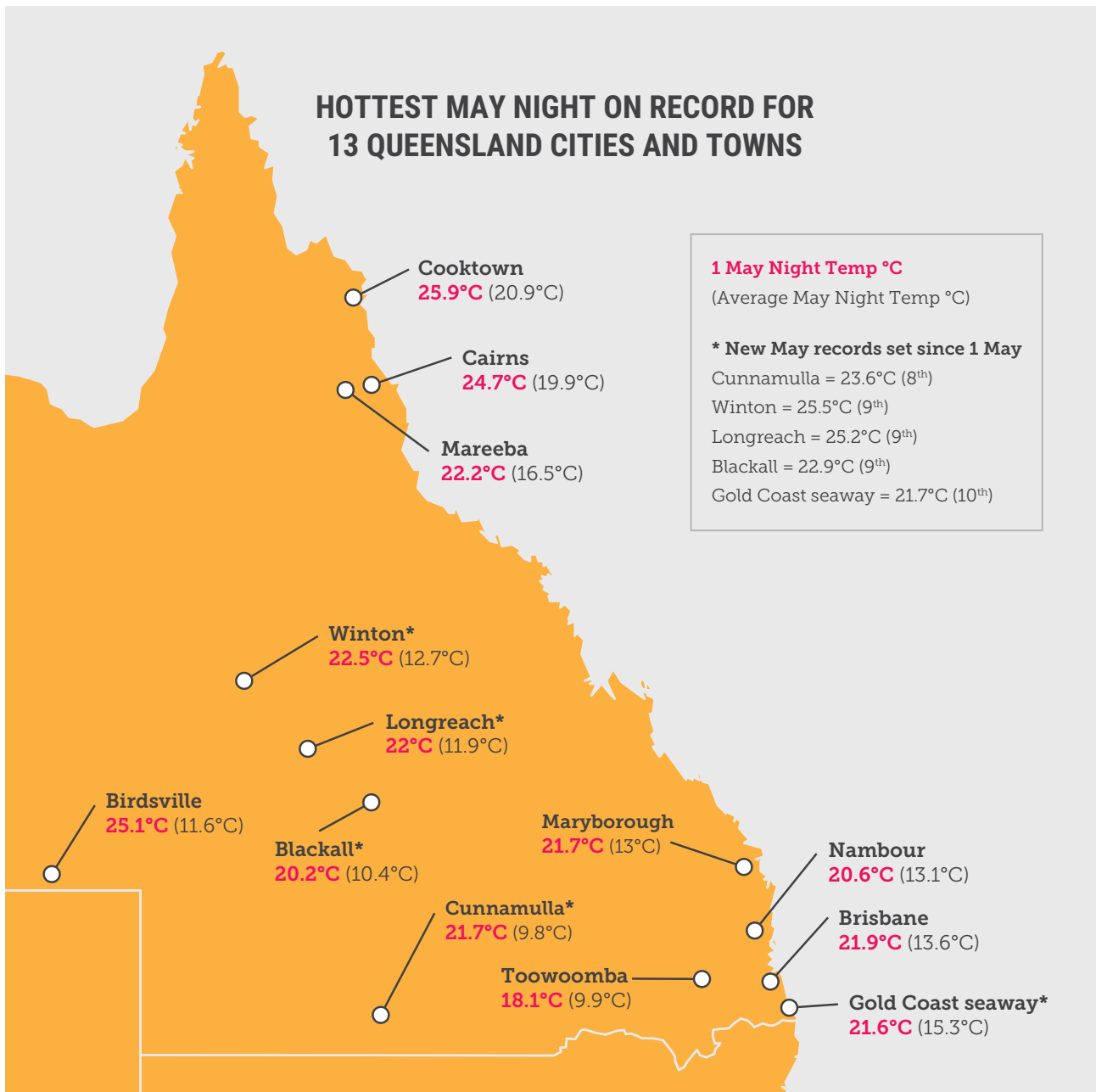


Figure 6: Map of Queensland showing some towns and cities which recorded their hottest May night on record on 1 May. Data sourced from BoM 2016b, figure adapted from ABC 2016.

Sydney was nearly 5°C above the monthly average in the first half of May.

3. Winter and Spring Outlook

The intense El Niño which influenced Australian temperatures during 2015 and early 2016 ended during late autumn (BoM 2016f).

It is likely, however, that with the breakdown of El Niño and warm Pacific Ocean temperatures, above average air temperatures may continue into early winter. Outlooks indicate that warmer-than-average days are expected for northern and parts of far south-eastern Australia throughout winter. Nights are also very likely to be warmer than average across northern and eastern Australia during June to August (BoM 2016c).

4. Global Records

The abnormal autumn temperatures in Australia fit into a broader picture of record-breaking warmth globally.

Global average surface temperatures for March and April were both the warmest ever recorded, with May expected to also break the monthly temperature record (NOAA 2016b). This has made March and April the 11th and 12th consecutive months in which monthly global temperature records have been broken, the longest such streak in 137 years of record keeping (NOAA 2016b). May is likely to have continued this trend, marking the 13th consecutive month.

April was the 12th consecutive month to break its monthly global temperature record.

5. Climate Change and the Abnormal Autumn

The abnormally warm temperatures of autumn 2016 add to the overwhelming evidence for human-driven climate change.

Climate change, driven primarily by the burning of fossil fuels (coal, oil and gas), is causing temperatures to rise and heatwaves to become hotter, longer and more frequent across most of Australia (Perkins and Alexander 2013).

Recent record-breaking hot years would have been virtually impossible in a world without climate change.

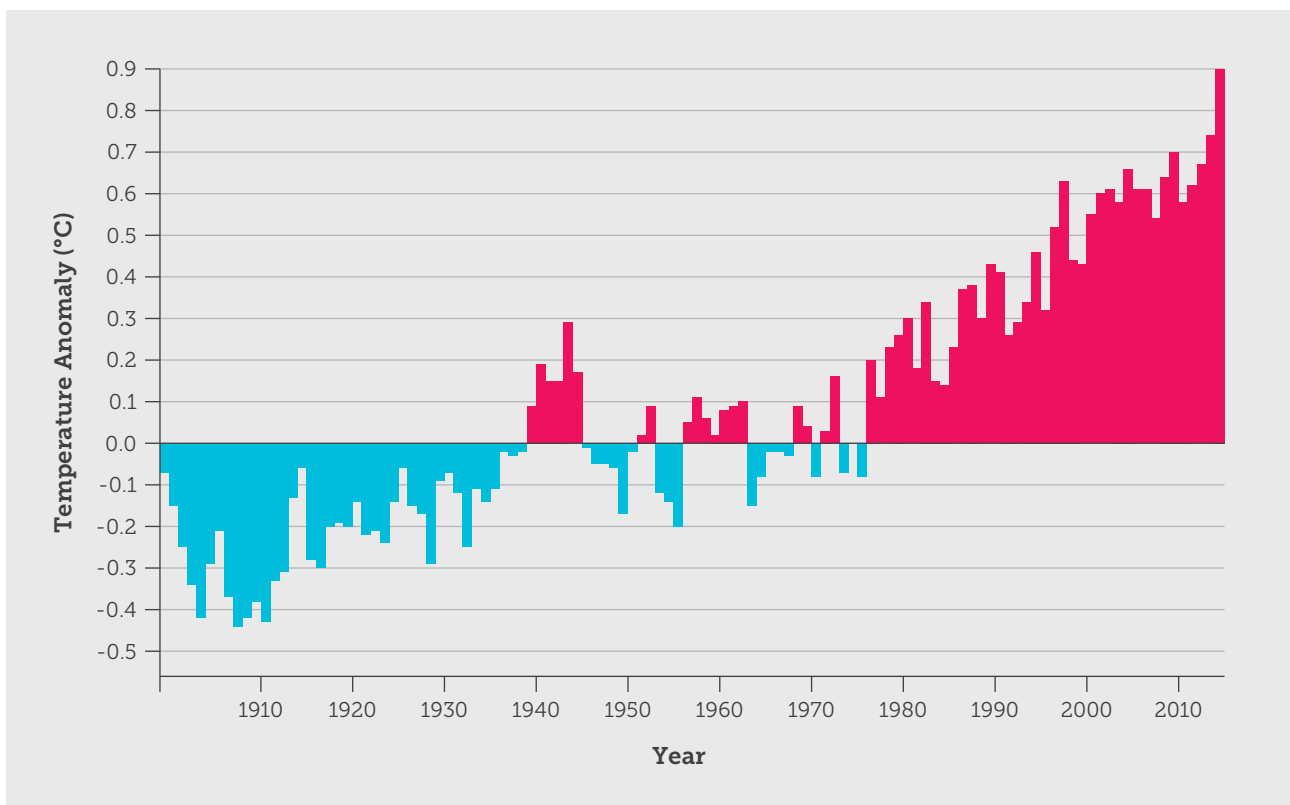


Figure 7: Column graph of the annual global temperature anomalies to 2015, relative to the global annual average temperature for 1901-2000. Adapted from NOAA 2016.



Figure 8: Abnormally warm temperatures, combined with dry conditions, can increase the risk of bushfires.

Recent research has found that climate change increased the likelihood of March 2016 breaking the temperature record in Australia by at least seven times (The Guardian 2016b). The record-breaking hot years the world has experienced in the last few decades would have been virtually impossible in a world without climate change (King et al. 2016; King and Black 2016). Researchers have found that it's virtually certain (a 99.98% chance) that the current run of record-high temperatures — with 13 of the 15 warmest years having occurred since 2000 — were influenced by human activity (Mann et al. 2016).

New analysis has revealed that human-caused climate change made the extreme ocean temperatures that led to bleaching along the Great Barrier Reef this year at least 175 times more likely (CoECS 2016). Moreover, climate change is very likely to make the extreme March ocean temperatures that caused this year's event occur every

two years during March by the mid-2030s. Extreme coral bleaching will become the new normal unless serious reductions in greenhouse gas emissions are achieved (CoECS 2016).

Prolonged warm conditions, like those which have occurred this autumn, combined with particularly dry conditions in some regions of Australia, have increased the risk of bushfires (The Climate Institute 2016). Climate change is making high bushfire risk conditions more likely and is increasing the frequency of long bushfire seasons in many areas of Australia (IPCC 2014; Jolly et al. 2015).

Abnormal and unseasonal temperatures, driven by climate change, can also have a major impact on the growing season of crops and other plants. Where plant growth is not water-limited, warming may continue to extend the length of the growing season of Australian crops, especially in southern Australia (Reisinger et al. 2014).

The path to tackling climate change is clear: no new coal-fired power stations can be built, existing coal mines and coal-fired power stations must be phased out and renewable energy must be scaled up rapidly. The number of climate records that continue to tumble is further evidence that our climate is changing rapidly and with serious impacts. The window of time that we have to limit the global temperature rise is closing.

With every year of delay, the job gets tougher and the likelihood of avoiding many of the worst impacts of climate change becomes more remote. To meet the commitments that we made just a few months ago in Paris, we must urgently get on with the job and join the global transition to a clean energy world.

The window of time that we have to limit the global temperature rise is closing.

Figure 9: Solar PV panels in Sydney, generating renewable energy.



References

- ABC (Australian Broadcasting Corporation). 2016. Hottest May night on record for 20 Queensland cities and towns. Accessed at <http://www.abc.net.au/news/2016-05-01/hottest-may-night-on-record-20-queensland-towns-cities/7373922>.
- AIMS (Australian Institute of Marine Science). 2016. Western Australian reefs feel the heat from global bleaching event. Accessed at <http://aims.gov.au/-/western-australian-reefs-feel-the-heat-from-global-bleaching-event>.
- BoM (Bureau of Meteorology). 2016a. Special Climate Statement 55 – prolonged March heatwave affects many parts of Australia. 4 April 2016. Accessed at: <http://www.bom.gov.au/climate/current/statements/scs55.pdf>.
- BoM. 2016b. Climate Data Online. Accessed at: <http://www.bom.gov.au/climate/data/index.shtml?bookmark=201>.
- BoM. 2016c. Climate Outlooks – monthly and seasonal. Accessed at: <http://www.bom.gov.au/climate/outlooks/#/overview/video>.
- BoM. 2016d. Australia in April 2016. Accessed at <http://www.bom.gov.au/climate/current/month/aus/summary.shtml?cid=006fb03>.
- BoM. 2016e. Marine Water Quality Dashboard. Accessed at <http://www.bom.gov.au/marinewaterquality/>.
- BoM. 2016f. ENSO Wrap-up. Accessed at <http://www.bom.gov.au/climate/enso/>.
- BoM. 2016g. Australia in May. Accessed at <http://www.bom.gov.au/climate/current/month/aus/archive/201605.summary.shtml>.
- BoM. 2016h. Australia in autumn 2016. Accessed at <http://www.bom.gov.au/climate/current/season/aus/summary.shtml>.
- Climate Council. 2016. The Hottest Year on Record (Again). Steffen W and Fenwick J. Accessed at <https://www.climatecouncil.org.au/hottestyear2015>.
- Climate Council. 2016b. Australia's coral reefs under threat from climate change. Hughes L, Steffen W and Rice M. Accessed at <https://www.climatecouncil.org.au/reefreport>.
- CoECSS (ARC Centre of Excellence for Climate System Science). 2016. Extreme coral bleaching may be new normal by 2034. Accessed at <https://www.climatescience.org.au/content/978-extreme-coral-bleaching-may-be-new-normal-2034>.
- GBRMPA (Great barrier Reef Marine Park Authority). 2016. E-Newsletter. Accessed at <http://www.gbrmpa.gov.au/media-room/reef-in-brief-e-newsletter>.
- Hobday A, Oliver E, McDonald J and Grose M. 2016. Was Tasmania's summer of fires and floods a glimpse of its climate future? The Conversation. 19 April. Accessed at <https://theconversation.com/was-tasmanias-summer-of-fires-and-floods-a-glimpse-of-its-climate-future-58055>.
- Intergovernmental Panel on Climate Change (IPCC). 2014. Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects: Australasia. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Barros V, Field C, Dokken D, Mastrandrea M, Mach K, Bilir T, Chatterjee M, Ebi K, Estrada Y, Genova R, Girma B, Kissel E, Levy A, MacCracken S, Mastrandrea P, White L (eds.). Cambridge University Press. Cambridge and New York. 1371-1438.
- Jolly M, Cochrane M, Freeborn P, Holden Z, Brown T, Williamson G and Bowman D (2015) Climate-induced variations in global wildfire danger from 1979 to 2013, *Nature Communications* 6: 7537.
- King A, Black M, Min S, Fischer E, Mitchell D, Harrington L, and Perkins-Kirkpatrick S. 2016. Emergence of heat extremes attributable to anthropogenic influences. *Geophysical Research Letters*. 42.
- King A and Black M. 2016. We traced the human fingerprint on record-breaking temperatures back to the 1930s. The Conversation. 8 March. Accessed at: <https://theconversation.com/we-traced-the-humanfingerprint-on-record-breaking-temperatures-back-to-the-1930s-55438>.
- King A and Hawkins E. 2016. 2016 is likely to be the world's hottest year: here's why. The Conversation. 18 May. Accessed at <https://theconversation.com/2016-is-likely-to-be-the-worlds-hottest-year-heres-why-59378>.
- Mann M, Rahmstorf S, Steinman B, Tingley M and Miller S. 2016. The likelihood of recent record warmth. *Scientific Reports*. 6.
- Met Office. 2015. Met Office forecasts 2016 to be hottest year on record. Accessed at <http://www.metoffice.gov.uk/news/releases/archive/2015/global-temperature>.
- NOAA (National Oceanic and Atmospheric Administration). 2016. State of the Climate: Global Analysis for Annual 2015. National Centers for Environmental Information. Accessed at <http://www.ncdc.noaa.gov/sotc/global/201513>.
- Perkins S and Alexander L. 2013. On the measurement of heat waves. *Journal of Climate*. 26:4500-4517
- Reisinger, A., R.L. Kitching, F. Chiew, et al. 2014. Australasia. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Barros, V.R., C.B. Field, D.J. Dokken, M.D. et al. (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1371-1438.
- Schmidt G. 2016. Twitter. @ClimateOfGavin. April 15.
- The Climate Institute. 2016. Factsheet: True or False? Facts and myths about bushfires and climate change. Accessed at http://www.climateinstitute.org.au/verve/_resources/2016_Bushfire_Factsheet_-_FINAL.pdf.

The Guardian. 2016a. Tasmania marine heatwave hits seafood industry and puts some species at risk. Accessed at <http://www.theguardian.com/australia-news/2016/apr/22/tasmania-marine-heatwave-salmon-global-warming-climate-change>.

The Guardian. 2016b. Unseasonably warm weather a clear sign of climate change, say scientists. Accessed at <https://www.theguardian.com/science/2016/apr/29/unseasonably-warm-weather-a-clear-sign-of-climate-change-say-scientists>.

Image Credits

Cover photo: 'Autumn colours in the sun' by Flickr user Mike Russell licensed under CC BY 2.0.

Page 1: Figure 1 'Sunset Beach' by Flickr user Aristocrats-hat licensed under CC BY-NC 2.0.

Page 3: Figure 2 from Climate Council 2016b, adapted from Bureau of Meteorology (BoM 2016e).

Page 4: Figure 3 'Coral Bleaching At Lizard Island' by XL Caitlin Seaview Survey.

Page 5: Figure 4 courtesy of the Bureau of Meteorology (BoM 2016d).

Page 7: Figure 5 'Autumn Leaves II' by Flickr user Ben Low licensed under CC BY-NC-ND 2.0.

Page 11: Figure 7 from Climate Council 2016, based on data from NOAA 2016.

Page 12: Figure 8 'Burnt to a crisp' by Flickr user Mick Stanic licensed under CC BY-NC-2.0.

Page 13: Figure 9 'Solar' by Flickr user Jason Wong licensed under CC BY-NC-ND 2.0.


Thank you for supporting the Climate Council.

The Climate Council is an independent, crowd-funded organisation providing quality information on climate change to the Australian public.

CLIMATE COUNCIL

 facebook.com/climatecouncil

 twitter.com/climatecouncil

 info@climatecouncil.org.au

 climatecouncil.org.au

The Climate Council is a not-for-profit organisation and does not receive any money from the Federal Government. We rely upon donations from the public. We really appreciate your contributions.

DONATE

climatecouncil.org.au/donate