

## BUREAU OF METEOROLOGY

PDR: MB14-000161

To: Minister (cc Parliamentary Secretary) (For Information)

**OCEAN ACIDIFICATION**

Timing: 25 March 2014 – for timely consideration following the request for further briefing.

**Recommendation:**

1. Note the information provided in this brief.

**Noted/Please discuss****Minister:**

Date:

**Comments:****Key Points:**

1. As stated in the State of the Climate 2014 report, released by the Bureau of Meteorology and CSIRO on 4 March 2014, ocean acidification is caused by the ocean absorbing higher levels of carbon dioxide (CO<sub>2</sub>) from the atmosphere. It is therefore another consequence of the accumulation of anthropogenic CO<sub>2</sub> in the Earth's climate system.
2. Ocean acidity is measured in units of 'pH'. A lowering pH means increasing acidity. The pH of surface waters in the open ocean has decreased by about 0.1 since 1750, equivalent to a 26 per cent increase in the activity of hydrogen ions (a measure of ocean acidity).
3. Ocean acidification has the potential to cause large-scale changes in the structure of ecosystems and may pose a more immediate threat to ocean ecosystems than global warming. It is irreversible within our lifetimes, in that it will take tens of thousands of years to recover.
4. Ocean acidification is expected to have dramatic effects through three main avenues: disrupting the formation and maintenance of calcium carbonate skeletons in corals, molluscs etc; affecting the oxygen metabolism of animals; and changing the availability of nutrients. Phytoplankton and marine organisms that are directly impacted sit at the very start of the marine food chains. Disruption here can have profound effects on animals further along the chain such as penguins, sea-birds, seals and whales.
5. Ocean acidification has been called "the other CO<sub>2</sub> problem" because it is caused by carbon dioxide but is independent of the climate change effects of CO<sub>2</sub>. Predictions of the impacts of ocean acidification are based on simple chemistry and do not depend on complex climate models.
6. A Supplementary Budget Estimates Brief was prepared by the Australian Antarctic Division, Department of the Environment, for the February 2014 estimates. A copy of the brief is provided at **Attachment A**.

7. The Department has supported research into ocean acidification for a number of years. The Australian Climate Change Science Programme recognised the significance of this threat in national climate science planning, and has supported research by the CSIRO and the Antarctic Climate and Ecosystems Cooperative Research Centre into the effects of ocean acidification on marine ecosystems in the Southern Ocean and the Great Barrier Reef since 2006. Scientists from the Australian Antarctic Division and the Antarctic Climate and Ecosystems Cooperative Research Centre, based in Hobart, have been undertaking research on the impacts of ocean acidification in the Southern Ocean since 2006.
8. Research into the implications of ocean acidification for the Great Barrier Reef has also been supported through the National Environmental Research Programme and its predecessors and partners, including the Great Barrier Reef Marine Park Authority, for several years.
9. The Antarctic Climate and Ecosystems Cooperative Research Centre released a Report Card on Southern Ocean Acidification in 2012, provided at **Attachment B**.



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11 March 2014

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**ATTACHMENTS**

A: Australian Antarctic Division, Senate Estimates Brief, February 2014

B: Report Card, Southern Ocean Acidification, Antarctic Climate & Ecosystems CRC

- Attachment B not included (published document  
- out of scope).

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**SUPPLEMENTARY BUDGET ESTIMATES BRIEF**

**DIVISION/AGENCY:** AUSTRALIAN ANTARCTIC DIVISION

**TITLE:** OCEAN ACIDIFICATION

**KEY POINTS:**

- Since November 2006 scientists from the Australian Antarctic Division and the Antarctic Climate and Ecosystems Cooperative Research Centre, based in Hobart, have been undertaking research on the impacts of ocean acidification in the Southern Ocean, including:
  - Ship-board experiments using the *Aurora Australis* to determine the effects of changes in acidity on oceanic bacterial and phytoplankton communities to understand how it will impact on the base of the food chain.
  - Use of modern and historic material to demonstrate that acidification is already changing the carbonate skeletons of phytoplankton (coccolithophorids) and planktonic molluscs (pteropods or sea-butterflies).
  - Large-scale aquarium mesocosm experiments at Davis Station to determine how acidification will impact on coastal plankton communities.
  - A risk-assessment of the vulnerability of Southern Ocean sea-bed life to acidification using material collected during the Census of Antarctic Marine Life Voyage on the *Aurora Australis* in January 2008.
  - Aquarium experiments on krill and benthic Antarctic invertebrates to determine the effects on growth and development to generate risk maps for the key organisms.
- During Voyage 3 in 2011-12 season, scientists from ACE-CRC, led by [REDACTED] sampled zooplankton as a part of the multi-year project to characterise and monitor the impacts of ocean acidification on shell formation by calcareous zooplankton.
- In 2012 Scientists from AAD, led by [REDACTED] conducted detailed aquarium experiments to determine critical levels of CO<sub>2</sub> that negatively affect the success rate of krill hatching from eggs. These results were combined with projections of CO<sub>2</sub> in waters of the Southern Ocean and identified the consequences for krill populations under four atmospheric CO<sub>2</sub> IPCC scenarios, ranging from no emission mitigation to strong mitigation. This study was published in the scientific journal *Nature Climate Change* in 2013. The results suggested:

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**Background:**

In June 2005, the Royal Society of London released a major review that alerted the world to the dangers of ocean acidification. This acidification is caused by humankind's release of carbon dioxide (CO<sub>2</sub>) to the atmosphere, which subsequently dissolves in the ocean to form carbonic acid. The Southern Ocean was identified as particularly vulnerable to acidification due to the higher solubility of CO<sub>2</sub> in cold water and the ecological importance of species vulnerable to increased acidity. Dramatic changes in ecosystem structure and function are foreseen.

Human activities currently release some 7.1 billion tonnes of CO<sub>2</sub> to the atmosphere per year, mainly by burning fossil fuels. Since the beginning of the industrial revolution, the atmospheric concentration of CO<sub>2</sub> has risen from 280 ppm (parts per million) to about 380 ppm, increasing the greenhouse effects and increasing global temperatures.

Recent calculations have shown that almost half of the additional CO<sub>2</sub> released to the atmosphere over this period has been taken up by the world's oceans. While this has ameliorated the increase in CO<sub>2</sub> in the atmosphere and slowed global warming, it has made the ocean more acidic.

Ocean acidification has been called "the other CO<sub>2</sub> problem" because it is caused by carbon dioxide but is independent of the climate change effects of CO<sub>2</sub>. Predictions of the impacts of ocean acidification are based on simple chemistry and do not depend on complex climate models. Ocean acidification is expected to have dramatic effects through three main avenues: disrupting the formation and maintenance of calcium carbonate skeletons in corals, molluscs etc, affecting the oxygen metabolism of animals, and changing the availability of nutrients.

Ocean acidification is being targeted through research within the Australian Antarctic Division's (AAD) Terrestrial and Nearshore Ecosystems and Southern Ocean Ecosystem Change programmes, and the Antarctic Climate and Ecosystems Cooperative Research Centre's (ACE CRC) Carbon programme. The research is measuring and tracking trends in dissolved carbon dioxide and particulate inorganic carbon in the Southern Ocean. The effects of ocean acidification are being studied on key organisms, including phytoplankton (e.g. coccolithophorids), zooplankton (foraminifera, small molluscs such as pteropods), krill and animals living on the seabed such as cold water corals, echinoderms and bryozoa. This research is coupled with reconstructions of past carbonate chemistry from analysis of marine bottom sediments, and models of future ocean carbon scenarios. The AAD's krill aquarium at Kingston and a mobile field aquarium at Davis are being used to understand the likely effects on Antarctic krill and coastal benthos respectively.

Ocean acidification has the potential to cause large-scale changes in the structure of ecosystems and may pose a more immediate threat to ocean ecosystems than global warming. The Royal Society report makes it clear that ocean acidification is irreversible within our lifetimes, and that it will take tens of thousands of years to recover. The report questions whether ecosystems can adapt, noting that acidification is additional to, and may exacerbate, the effects of climate change. It recommends additional research into ecosystem effects.

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2014 summer has been hindered logistic reasons, and expected to be undertaken during 2014-05 season. .

2. All three of the diatom species that flourished at high CO<sub>2</sub> are being cultured at Kingston. They are being grown at elevated CO<sub>2</sub> levels and their nutritional value measured. Early results indicate that they are higher in carbohydrates but that krill larvae fed on them have half the normal growth rates (student [REDACTED] and [REDACTED]).
3. Krill hatching success ([REDACTED]) – Eggs of Antarctic krill were experimentally exposed to 380 (current atmospheric level), 1000 and 2000 ppm CO<sub>2</sub>. No significant effects were detected at 1000 ppm; however, at 2000 ppm development was disrupted at early stage of their embryonic development, and no larvae hatched successfully. Our model projections demonstrated that Southern Ocean sea water pCO<sub>2</sub> could rise up to 1400 μatm in krill's depth range under the IPCC IS92a scenario by the year 2100 (atmospheric pCO<sub>2</sub> 788 matm) (published 2010). A detailed pCO<sub>2</sub>-response relationship for krill hatching success has recently been established, which indicates negative impacts kicks in just above 1000 μatm, which suggests some of the current main reproductive grounds for krill will be at risk in the future. A recent study on adult krill further suggested increasing ocean acidity may result in increased mortality, reduced activity levels, and interruptions to the moult cycle (unpublished).
4. Development of echinoderms - Combined effects of increased temperature (+1.5°C and 3°C) and acidification (decreased pH -0.3 and -0.5 pH units or increased pCO<sub>2</sub> 850 and 1370ppm) on the fertilization and embryonic development of the planktotrophic sea urchin (*Sterechinus neumayeri*) and juveniles of 3 species of brooding heart urchins (*Abatus* sp.) were investigated. While fertilization and development of *S. neumayeri* to the blastula stage were robust to levels of temperature and pH change predicted over coming decades, deleterious interactive effects were evident between these stressors at levels projected to occur by 2100 and beyond. There was a significant reduction in fertilisation success and in the percentage of normally developing cleavage and blastula stage embryos subjected to the combination of highest temperature and lowest pH treatment. For the *Abatus* species, no differences were observed in spine growth of juveniles relative to controls following 4 weeks exposure to elevated temperatures and CO<sub>2</sub> enriched seawaters, Juveniles reared at elevated temperatures did however exhibit more incidences of epithelial separation in spines. These results highlight the importance of considering the impacts of both temperature and acidification in assessing the life history response of invertebrates in a changing polar ocean ([REDACTED] – unpublished observations arising from field-work at Davis 2009-11).
5. Calcareous zooplankton – changes in the calcification of Southern Ocean zooplankton shells are being investigated to determine whether they are suitable for long term monitoring of the ecosystem effects of ocean acidification. [REDACTED] (ACE-CRC), [REDACTED] and [REDACTED] (AAD), [REDACTED] and [REDACTED] (ANU) and [REDACTED] (Victoria University, NZ) have contributed to this investigation.

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6. A team led by [REDACTED] (ACE-CRC) and including scientists from the Australian Antarctic Division and Monterey Bay Research Aquarium Institute (USA) has been awarded an ARC Linkage Infrastructure, Equipment and Facilities (LIEF) grant of \$150,000 to develop equipment required for a whole-of-community CO<sub>2</sub> enrichment experiment to determine the impact of rising ocean acidity on a natural Southern Ocean seabed community. The AntFOCE project is one of the major logistics determining activities for the Australian Antarctic Science program in 2014/15. This year the team completed characterisation of a potential site for the experiment in O'Brien Bay near the Casey research station.

## BUREAU OF METEOROLOGY

FROM THIS DOCUMENT - s22.

PDR: MS14-000122

To: Minister (cc Parliamentary Secretary) (For Information)

**RELEASE OF STATE OF THE CLIMATE 2014 REPORT BY THE BUREAU OF METEOROLOGY AND CSIRO**

**Timing: 3 March 2014**, for timely noting in advance of the release of the *State of the Climate 2014* report on 4 March 2014.

**Recommendation/s:**

1. Note the latest Bureau of Meteorology and CSIRO biennial State of the Climate report will be released on 4 March 2014.

**Noted / Please discuss**

2. Note a designed proof that is still subject to minor changes will be submitted electronically to you and the Parliamentary Secretary's office on the afternoon of Thursday, 27 February 2014.

**Noted / Please discuss**

3. Note that the report is likely to receive significant media coverage and public attention.

**Noted / Please discuss**

**Minister:**

Date:

**Comments:**

**Key Points:**

1. As discussed with you and the Parliamentary Secretary, the Bureau of Meteorology and CSIRO will release the third biennial *State of the Climate* report on Tuesday, 4 March 2014 to provide the Australian public with an authoritative statement on observed climate change trends. This publication provides context about climate change, whereas other climate products provide a record of the climate or extreme weather events. A copy of the previous State of the Climate 2012 report can be found at: [www.bom.gov.au/climate](http://www.bom.gov.au/climate) - see link on the right hand menu.
2. The 2014 report will be approximately 20 pages in length, subject to layout, and will provide an update on the state of climate change science, particularly variations and trends in Australia's climate observations. The information contained in the report will be of public and media interest.

3. *State of the Climate 2014* will be supported by a range of media activities by the Bureau and by CSIRO and is likely to generate significant media coverage. We will provide your office with a copy of the media release, talking points and a schedule of any confirmed interviews.
4. CSIRO CEO Dr Megan Clark and the Director of Meteorology Dr Rob Vertessy, were the primary spokespeople on the day of the release of the last *State of the Climate* report in 2012. Senior scientists who contributed to the report spoke to their relevant area of expertise. We propose to follow this arrangement for the 2014 report. Public statements by Bureau staff will be consistent with the Bureau's role in recording and analysing observed climate data and in developing projections of future climate scenarios.



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PDR: MS13-000223

To: Minister (cc Parliamentary Secretary) (for information)

**RELEASE OF THE AUSTRALIAN ANNUAL CLIMATE STATEMENT 2013**

**Timing:** 2 January 2014, prior to the public release of the Australian Annual Climate Statement 2013.

**Recommendation/s:**

1. Note the Bureau of Meteorology will release the Australian Annual Climate Statement 2013 on 3 January 2014.

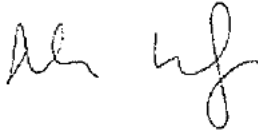
**Noted / Please discuss****Minister:**

Date:

**Comments:****Key Points:**

3. The main feature of Australia's climate in 2013 has been high temperatures. Australia is likely to see its warmest calendar year on record in 2013, with most states (except Western Australian and Tasmania) likely to set records. Nationwide, mean temperatures are expected to show an anomaly of +1.2 °C to +1.3 °C, some 0.2 °C hotter than the previous record of +1.04 °C set in 2005. In other words, the year is likely to be, by a significant margin, the hottest recorded for Australia in the last 114 years (record commenced in 1910).
4. There have been many notable weather and climate events during 2013, including very dry conditions in Queensland, record rainfall in parts of the southeast and eastern Australia, and wildfires and heatwaves affecting particularly southern and eastern areas. These will be briefly described in the statement.

5. The statement typically receives significant media coverage, and will be interpreted in light of observed climate change. Formal attribution studies suggest that global warming is a dominant factor in the nationally average record-high temperatures in 2013. Attributing individual weather events (such as individual heatwaves) to natural and human-made factors is difficult and not well supported by available science.



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To: Parliamentary Secretary (cc Minister), for information

**BUREAU OF METEOROLOGY INPUT TO ABC CATALYST DOCUMENTARY ON EXTREME WEATHER**

**Timing:** 18 November 2013: the Catalyst documentary is scheduled to air on 1 December 2013.

**Recommendation/s:**

1. Note that the Bureau of Meteorology has recently contributed to a science documentary on preparedness for extreme weather for the ABC's Catalyst programme.

**Noted/Please discuss**

2. Note the expected airing of the ABC Catalyst science documentary on 1 December 2013.

**Noted/Please discuss**

3. Note that the Bureau will prepare an online resource detailing the data it has provided to the documentary and the supporting scientific literature, for publication in December 2013.

**Noted/Please discuss**

**Parliamentary Secretary:**

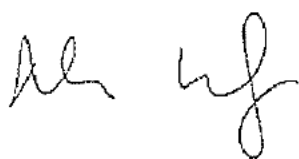
**Date:**

**Comments:**

**Key Points:**

1. In August and early September 2013, at the invitation of the ABC, the Bureau contributed to an ABC Catalyst science documentary focussing on preparedness for extreme weather. Various state emergency services and other science bodies also contributed to the documentary. The programme explores the role of emergency services and the Bureau in preparing for weather related disasters.
2. The programme is scheduled to air on Sunday 1 December 2013.
3. The Bureau will provide a dedicated webpage explaining the data it has contributed to the programme and supporting scientific publications.
4. The documentary will explore two realistic severe weather scenarios, a tropical cyclone in Queensland's Tweed Heads region, a situation that last occurred in February 1954 and a bushfire in Hornsby Heights NSW. The Bureau's input was to provide the underlying weather details and some operational information around our weather warnings and interaction with other agencies.

6. The documentary features a Bureau climate scientist explaining recent observed climate trends, shifts in the distribution of daily weather conditions and changes to weather extremes. This content draws heavily upon the Bureau submission to the Senate Inquiry on recent trends in and preparedness for extreme weather events, which is based on published research and is publicly available at number 65 on the following list of submissions: [http://www.aph.gov.au/Parliamentary\\_Business/Committees/Senate/Environment and Communications/Completed\\_inquiries/2010-13/extremeweather/submissions](http://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Environment_and_Communications/Completed_inquiries/2010-13/extremeweather/submissions).
7. The link between extreme weather, recent observed trends in climate and global warming is an emerging part of the science. In the last decade, the link between temperature-related extremes and climate trends has been increasingly established in Europe, Australia and the United States, in the scientific literature. The latest science is summarised in various recent Intergovernmental Panel on Climate Change (IPCC) scientific synthesis reports, including the Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX), which is available at: <http://ipcc-wg2.gov/SREX/report/>.
8. Bureau inputs to the upcoming programme are consistent with the IPCC SREX publication and also with previous Bureau publications and the input the Bureau provided to the Catalyst special 'Taking Australia's Temperature' in late 2012, which is available at <http://www.abc.net.au/catalyst/stories/3633447.htm>.
9. In providing input to the programme, Bureau scientists made no comment on policy relating to preparedness for extreme weather or other climate related policy. Programme content and detail is subject to some change by the ABC producers of Catalyst.
9. Since the filming of the documentary, the issue of the relationship between extreme weather and climate change has attracted a high level of media interest. The frequency with which climate records have been broken in 2013 has ensured continued high scientific and public interest.



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To: Minister, for information  
Cc: Parliamentary Secretary

## SEPTEMBER 2013 - HEAT RECORDS AND IMPACTS ON AGRICULTURE AND EMERGENCY MANAGEMENT

**Timing:** 16 October 2013, noting that the Update to Special Climate Statement 46 and the September Climate Update were provided to your office in advance of being published on the Bureau website on 1 October 2013.

### Recommendation/s:

1. Note the Update to Special Climate Statement 46 at **Attachment A**, and the September Climate Update at **Attachment B**, both summarising the unusually warm climatic conditions affecting much of Australia, particularly the record September heat and record 12-month heat.

**Noted / Please discuss**

2. Note documented impacts are being reported in the agriculture and emergency management sectors.

**Noted / Please discuss**

**Minister:**

**Date:**

**Comments:**

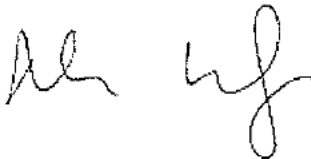
### Key Points:

1. September 2013 will be Australia's hottest September on record, with a mean temperature anomaly of +2.69°C against the 1961-1990 average. This exceeds the previous September record of +1.66°C in 1983.
2. The records set in September have also contributed to a new warmest 12 months on record for Australia. Nationwide, temperatures at the end of September showed a 12 month anomaly of +1.2 to +1.3 °C, some 0.15 °C hotter than any 12 month period prior to 2013 and approximately 0.2 °C higher than 2005, previously the hottest calendar year on record.
3. The intensity, extent and duration of record high temperatures in September 2013 are unprecedented for any spring month since at least 1910, when records began.
4. The Bureau has produced an update to Special Climate Statement 46 (**Attachment A**) on this significant event as part of its routine climate monitoring. The update was published on

the Bureau's website on the afternoon of 1 October 2013 and provided in advance to your office.

5. The Bureau makes such climate updates routinely, as events continue to unfold. Special Climate Statements aim to provide a comprehensive description of climatic events, including significant figures and records around the country.

7. The dry, warm conditions have had an impact on crop production in northeast Australia. The Weekly Australian Climate, Water and Agricultural Update produced by the Department of Agriculture (**Attachment C**) notes predictions of possible lower harvest volumes than 2012.



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#### ATTACHMENTS

- A: Update to Special Climate Statement 46: "Exceptionally warm late winter/early spring with unusually persistent warm conditions over the last 12 months".
- B: September Climate update.
- C: Weekly Australian Climate, Water and Agricultural Update produced by the Department of Agriculture.
- D: Talking points for media enquiries.

Attachments A and C not included (published material - out of scope).

Attachment B

# Australia's warmest 12-month period on record, again

## Australia's warmest September on record

Australia's record for warmest 12-month period has been broken for a second consecutive month. This continues a remarkable sequence of warmer-than-average months for Australia since June 2012.

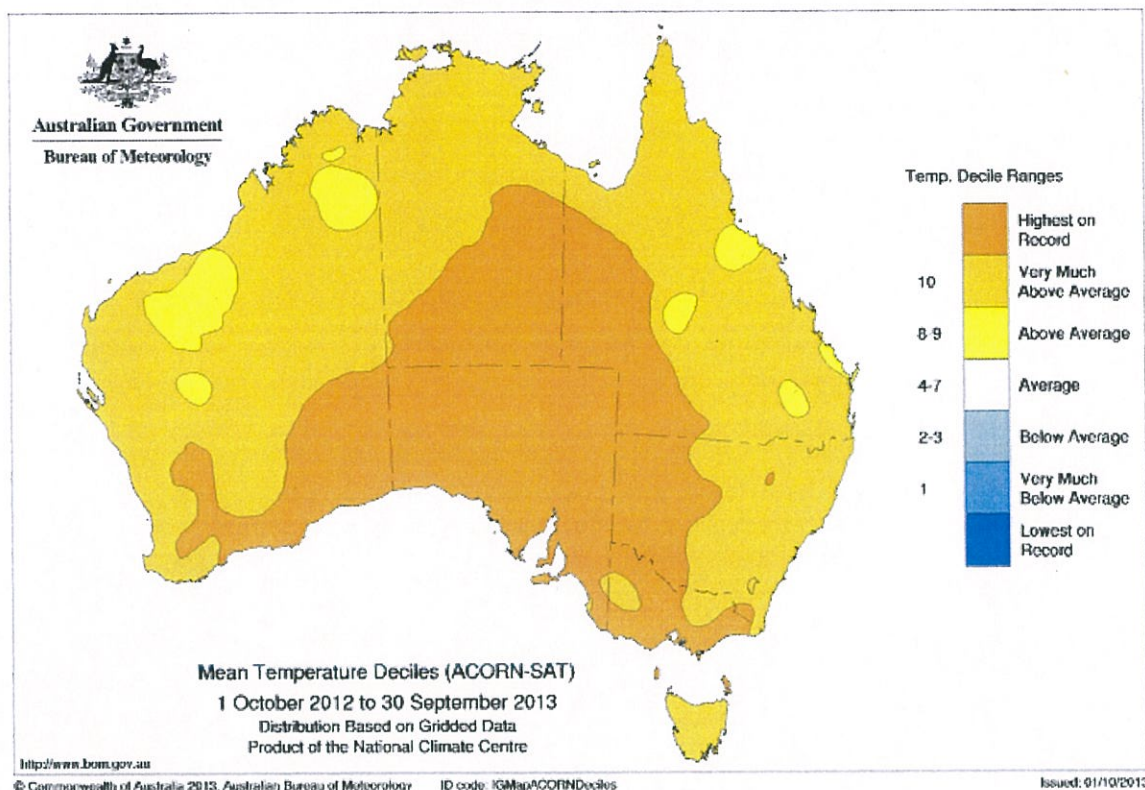
September 2013 was easily Australia's warmest September on record. The national average temperature for September was +2.75 °C above the long-term (1961–1990) average, which also sets a record for Australia's largest positive anomaly for any monthly mean temperature. The previous record of +2.66 °C was set in April 2005.

The mean temperature for Australia, averaged over the 12 months from October 2012 to September 2013, was 1.25 °C above the long-term average. This was also 0.17 °C warmer than any 12-month period prior to 2013.

The previous record, set over September 2012 to August 2013, was +1.11 °C above the long-term average, and the record preceding the current warm spell was +1.08 °C, set between February 2005 and January 2006.

Temperatures for the calendar year to date (January to September) are also the warmest on record, at 1.31 °C above the long-term average, well above the figure set for January to September 2005 (+1.07 °C). 2005 currently holds the record for Australia's warmest calendar year.

The past 18 months have been characterised by widespread heat across Australia. The mean temperature has been above average over the entire continent.



*October 2012 to September 2013 mean temperature deciles for Australia showing 12-month temperatures were the highest on record for 39% of Australia.*

In the past 12-month period, a large number of mean temperature records have fallen across Australia including:

- Australia's warmest month on record (January)
- Australia's warmest September on record
- Australia's largest positive monthly anomaly on record (September)
- Australia's warmest summer on record (December 2012 to February 2013)
- Australia's warmest January to September period on record
- Australia's warmest 12-month period on record (broken twice, for the periods ending August and September)
- Australia's warmest period on record for all periods 1 to 18 months long ending September 2013

Two significant daily maximum temperature records were also set this year:

- Australia's hottest summer day on record (7 January)
- Australia's warmest winter day on record (31 August)

The periods inclusive of September 2013 have also resulted in numerous state and territory mean temperature records including:

- Warmest September on record for South Australia, Victoria, New South Wales, Queensland and the Northern Territory, and also for Melbourne, Sydney and Adelaide

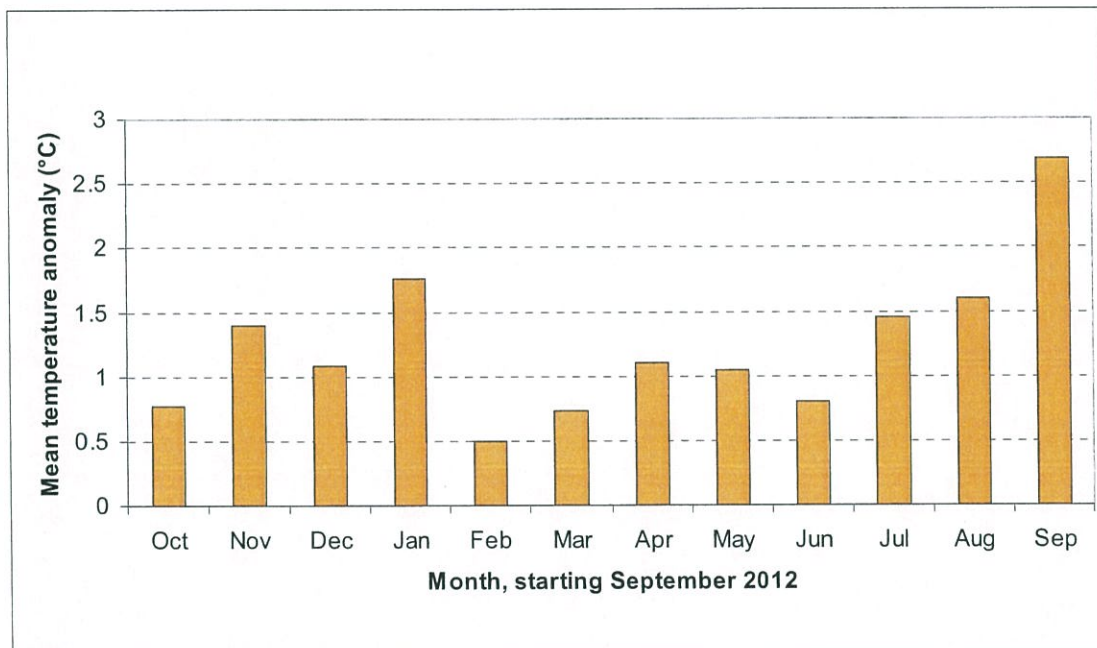


- Largest positive monthly anomaly on record for South Australia and Queensland (September)
- The warmest January to September period on record for South Australia, Victoria, New South Wales and the Northern Territory
- The warmest 12-month period on record for South Australia, the Northern Territory, and southern Australia

In addition to these records, and those set during the heat events of January and autumn, many individual stations have set records for early season heat or September record highs.

Generally above-average temperatures have persisted with few breaks since September 2012. The period has been characterised by long periods of warmer-than-average days and a distinct lack of cold weather. Nights have also been warmer than average, but less so than daytime temperatures.

Every calendar month since September 2012 has recorded temperatures at least 0.5 °C above average, with eight of those thirteen months topping 1.0 °C above average including January, April, May, July, August and September of 2013. Widespread record warmth has also been recorded in the oceans around Australia.



*Monthly mean temperature anomalies for September 2012 to September 2013.*

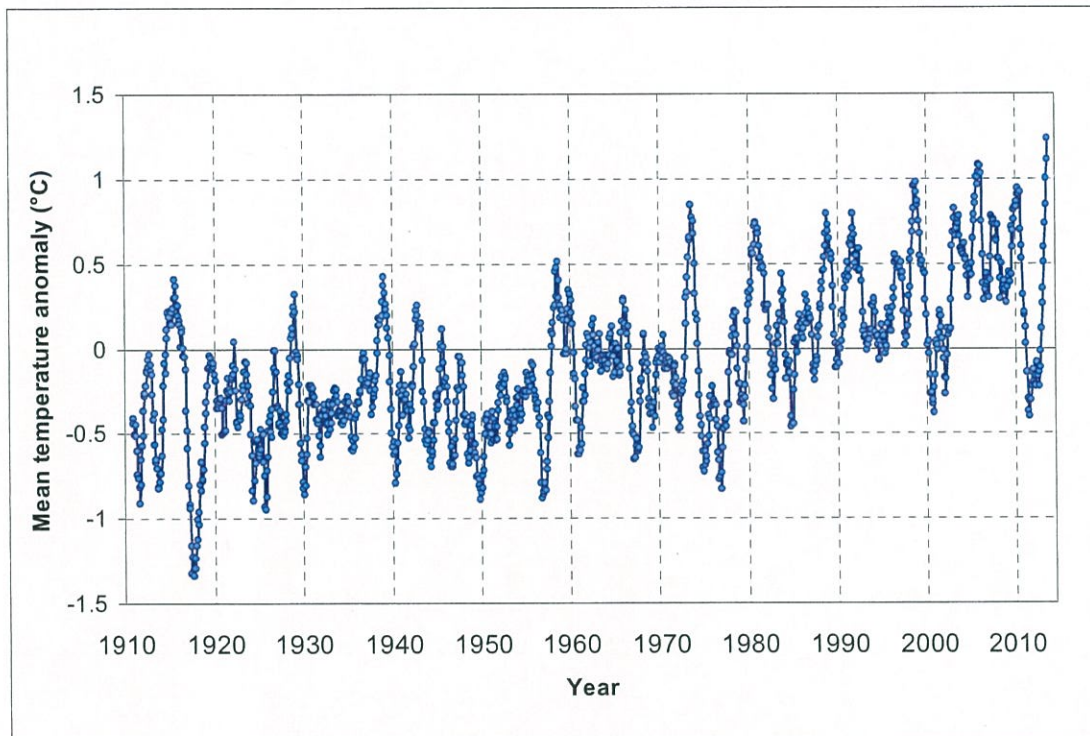
## **The Remainder of 2013**

The year-to-date temperature anomaly is currently so large that mean temperatures during the remaining three months of 2013 only need to be slightly above average for the year to set a new calendar year record. An anomaly of just +0.23 °C for the remainder of the year (i.e., October to December) will result in 2013 equalling the record held by 2005. Zero anomalies for the last three months of the year will result in 2013 finishing as the second-warmest year on record.

## Attachment B

It also remains possible that the 12-month mean temperature record will be equalled or broken again before the end of the year, for the periods ending October, November and/or December.

The Bureau's latest seasonal outlook ([http://www.bom.gov.au/climate/ahead/temps\\_ahead.shtml](http://www.bom.gov.au/climate/ahead/temps_ahead.shtml)) indicates that both maximum and minimum temperatures are most likely to be above average over most of Australia. The outlook for warmer-than-average temperatures over the remainder of the year is consistent with the Bureau's knowledge of background temperature trends, and the well-above-average sea-surface temperatures that currently surround Australia. Australian temperatures are now on average more than 1 °C warmer than during the 1950s.



*Running means for Australian temperature anomalies for 12-month periods ending September 2013. Vertical grid lines mark 12-month periods commencing January 1920, January 1930, etc.*

IRRELEVANT INFORMATION REMOVED  
FROM THIS DOCUMENT - s22.

## Talking points



### Recent warm temperatures

- September 2013 will be Australia's warmest September on record, with an average of 2.75°C above normal (against the 1961-1990 average), beating the previous September record of 1.66°C above normal in 1983.
- The September record is also the largest positive anomaly for any month recorded since 1910. The previous record of +2.66°C was set in April 2005.
- The 12 months ending September 2013 will also be the hottest 12-month period on record for Australia, since 1910.
- The recent heat has been particularly extreme across central and eastern Australia, with September 2013 expected to be the hottest September on record for South Australia, Victoria, New South Wales, Queensland and the Northern Territory.

- Temperatures have been 3°C above average across a wide area, with some areas up to 5°C above average.
- It is not possible to attribute any single weather event to global warming, but these recent extremes are consistent with the general pattern of warming. A number of more recent studies are drawing probabilistic links between extreme seasonal heat records and climate change, including the Australian summer of 2012-2013

Bureau of Meteorology – QB13-000136

Last updated by department: 31 October 2013

**NATURE OF CLIMATE CHANGE RESEARCH AND ADVICE TO  
GOVERNMENT**IRRELEVANT INFORMATION REMOVED  
FROM THIS DOCUMENT - s22.**Background/Issue**

The Bureau of Meteorology is involved in a number of research activities focused on Climate Change. These activities occur in collaboration with the CSIRO through the Centre for Australian Weather and Climate Research (CAWCR). The Bureau provides Climate Change Research advice through its National Climate Centre and CAWCR.

**Suggested Comments**

- The Bureau gathers and produces a wide variety of environmental intelligence salient to managing climate variability and change. The Bureau works closely with CSIRO, universities and other national meteorological services on various climate science matters.
- There is considerable media interest when a climate record is recorded by the Bureau. Australia has recently experienced three consecutive warmest 12-month periods on record in August, September and October 2013. Bureau data is regularly referenced by media in relation to climate change.
- The Bureau's climate record has been rigorously peer-reviewed and found to be among the best in the world.

**Key Facts**World Meteorological Organization (WMO): Statement on the Status of Global Climate

- The WMO annually releases a summary and analysis of the key global climate events of the preceding year. The 2012 report confirmed the continuing upward trend in global temperatures.

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- The next WMO global Climate Statement will be released on 13 November 2013.

#### Bureau of Meteorology – CSIRO: State of the Climate Biennial Report

- In March 2010, the Bureau and CSIRO released State of the Climate 2010, a collaborative report providing a summary of observations of Australia's climate and analysis of the factors that influence it. This was followed by State of the Climate 2012, an updated summary that confirmed the long-term warming trends observed around Australia are consistent with global-scale warming measured over recent decades.
- The Bureau, in collaboration with CSIRO, is planning to release State of the Climate 2014 in March 2014.

#### Bureau of Meteorology – CSIRO Australian Climate Change Science Program

- The Australian Climate Change Science Program is a major research undertaking by the Department of Industry, the Bureau and CSIRO, spanning a range of research activities aligned with the *National Framework on Climate Change Science* published in 2009.
- The Australian Climate Change Science Program has played a significant role in informing the development of climate change policy, international negotiations and domestic adaptation.

## TRENDS IN EXTREME WEATHER

IRRELEVANT INFORMATION REMOVED  
FROM THIS DOCUMENT - s22.

### Background/Issue

Recent extreme weather events have highlighted observed trends in various climate indicators. This issue remains topical in the media due to the high local impact of extreme weather in Australia and the emerging role of climate change.

### Suggested Headline Statement

Extreme weather has historically been a feature of natural variability in Australia's climate. Recent observations indicate that extreme heat is increasing, while extreme cold is decreasing. The occurrence of individual heat-related extremes such as heat waves and record high temperatures that have been experienced in the past year can now be linked to both natural variability and climate change.

### Suggested Comments

- The range of extreme weather events due to natural climate variability is large, making attribution of these to a single cause difficult.
- For Australia, however, there are clear trends in many different indicators related to extreme weather and climate. These trends are influencing the increased frequency with which these events are occurring.
- Recent studies at the Bureau have shown large proportional increases in extreme hot days and warm nights and increasing severity of the southern bushfire season.
- Recent studies in Australia and internationally have shown an increased likelihood of extreme summer temperatures around the world. Recent record breaking heatwaves in Europe, Australia and North America have been attributed in large part to global warming.
- Global and Australian data suggest that the proportion of rainfall from heavy rain events is generally increasing. However, studies have shown that it is difficult to attribute individual extreme rainfall events in Australia to climate change.

- The Bureau made a submission to the Senate Inquiry into recent trends in and preparedness for extreme weather events. The report on the review was released on 7 August 2013. The Government is currently considering the report.

### **Key Facts**

- The occurrence of extreme heat records in Australia is now outpacing cold records. The frequency of record high daytime maximum temperatures is 2.8 times the rate of cold daytime records, while the frequency of record warm night-time temperatures is occurring at 5.2 times the rate of cold night time records
- The frequency, intensity and duration of heatwaves is increasing across large parts of Australia, and globally.
- Fire weather is also increasing since consistent records began in the 1970s. There is a longer fire season and an increase in the occurrence of extreme fire days at the majority of sites studied in fire prone regions of southern Australia.