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CSIRO

Australian Government Bureau of Meteorology

State of the

Summary

Atmospheric CO₂ concentrations reached 395 parts per million in 2013 CO2 (ppm

Thousands of years ago

Carbon dioxide concentrations over the last 800,000 years

The State of the Climate report



• Joint Bureau and CSIRO publication

• Previous reports, 2010 and 2012

• Seeks to convey complex information to a general audience

• Accompanied by further material online





Carbon dioxide emissions

Sources of increased atmospheric carbon dioxide concentrations



Sinks of carbon dioxide



continue to rise and are mainly from fossil fuel burning.

CO₂ emissions



About 30% has been taken up by land vegetation.

Concentration and isotopic composition of atmospheric carbon dioxide



The decrease in the ratio of the carbon-13 isotope (δ^{13} C) that accompanies increasing CO₂ trends show that the sources are fossil fuel and land-use change.

Source: CSIRO





Changes in the global climate system



Global mean temperature has risen by 0.85°C from 1880 to 2012.

The amount of heat stored in the global oceans has risen, and global mean sea level has increased 225 mm from 1880 to 2012.

With regional variation (almost all glaciers worldwide losing mass but some gaining) but overall net loss.
With regional variation (large loss in the Arctic, small net gain in the Antarctic) but overall net loss.



Australian Government Bureau of Meteorology

Oceans are a major component of climate





Warming of the world's oceans accounts for more than 90% of additional energy accumulated from the enhanced greenhouse effect.





Ocean heat content





Sea level







Warming trends



Australia's climate has warmed, and the frequency of extreme weather has changed, with more extreme heat and less extreme cold.





Annual mean temperature changes







Sea-surface and surface air temperature





Distribution of monthly temperatures





We are setting more temperature records



The frequency of cold records has declined

The frequency of hot records has increased dramatically since 1900



Exceptional heat is becoming more frequent





Summer heatwaves

Black Saturday 2009 heatwave Record-breaking heatwave across southeastern Australia



January 2013 heatwave Over 70% of the continent recording temperatures in excess of 42 ° C







2013, a year of heatwaves







Increased rainfall?



Rainfall averaged across Australia has slightly increased since 1900, with the largest increases in the northwest since 1970.





Intensification of the hydrological cycle

- Rainfall will increase in the tropics (monsoonal regions)
- Rainfall will be more intense (heavy rainfall)
- General decreases in rainfall will occur over the subtropics
- Even in areas where average rainfall decreases, rainfall intensity is projected to increase





Increased rainfall?











Twin La Niñas of 2010 to 2012 and record Australian rainfall



Sea surface temperatures have been consistently close to highest on record around Australia

Australian sea surface temperature deciles for spring and summer

2010-2011

Australian sea surface temperature deciles for spring and summer 2011–2012

Australian spring and summer rainfall deciles 2010–2012





Tropical cyclone Oswald

- Tropical low developed in the Gulf of Carpentaria from 17 January
- Made landfall as a Cat 1 storm on 21 January near Kowanyama (western Cape York Peninsula)
- Torrential rain followed the ex-cyclone south over following days, peaking at Tully with ~1000 mm for the event, 632 mm in 48 hours
- Extensive flooding along coastal rivers, with 6 recorded deaths



Drying across the south



Rainfall has declined since 1970 in the southwest, dominated by reduced winter rainfall. Autumn and early winter rainfall has mostly been below average in the southeast since 1990.





Drying across the south











More fire weather



There has been an increase in extreme fire weather, and a longer fire season, across large parts of Australia since the 1970s.





More fire weather, a longer fire season

Forest fire danger index (FFDI)



Projections for Australia





Annual-average rainfall projections **uncertain in** northern Australia

Frequency and intensity of **extreme daily rainfall** to increase for most regions

Sea-level rise will increase frequency of **extreme** sea-level events

Ocean acidification will continue

Potential long-term decrease in number of tropical cyclones but increase in intensity

Temperatures to rise, with more hot days and fewer cool days

Extreme fire-weather days to increase in southern Australia, with a longer fire season

Annual-average rainfall to decrease in southern Australia, with an **increase in droughts**



Source: Bureau of Meteorology and CSIRC

Some future warming is now certain





Emissions scenarios make little difference to 2050



Australian climate projections for 2100

Annual temperature change



Temperature change in degrees for 2081–2100 with respect to 1986–2005

																ſ°C
-2	-1.5	-1	-0.5	5 (0.	5	1 1	.5	2	3	4	5	7	9	11	

April to September rainfall change



Percentage rainfall change for 2081–2100 with respect to 1986–2005







Projections of Australian annual temperature





Small shifts, but potential change in climate zones





Small shifts, but potential change in climate zones



Climatological rainfall map based on around 2 degrees of warming and more than 20% drier



Wimmera







Thank you ...



