



Climate observations, projections, and communication

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CSIRO OCEANS AND ATMOSPHERE FLAGSHIP
www.csiro.au

EAGA Climate Science Roadshow ,Knox City Council, 16 July 2014

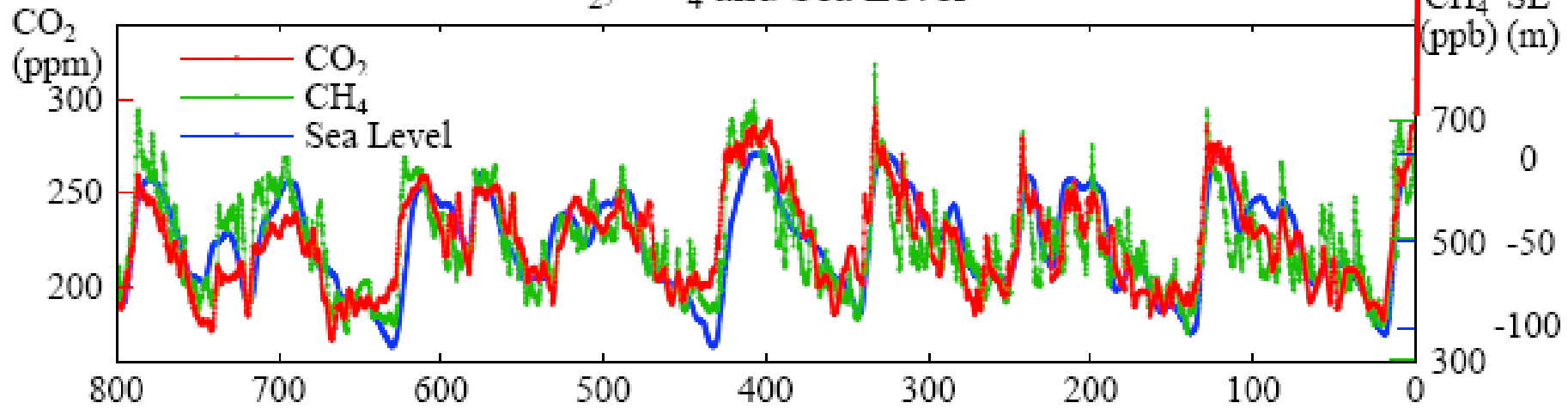


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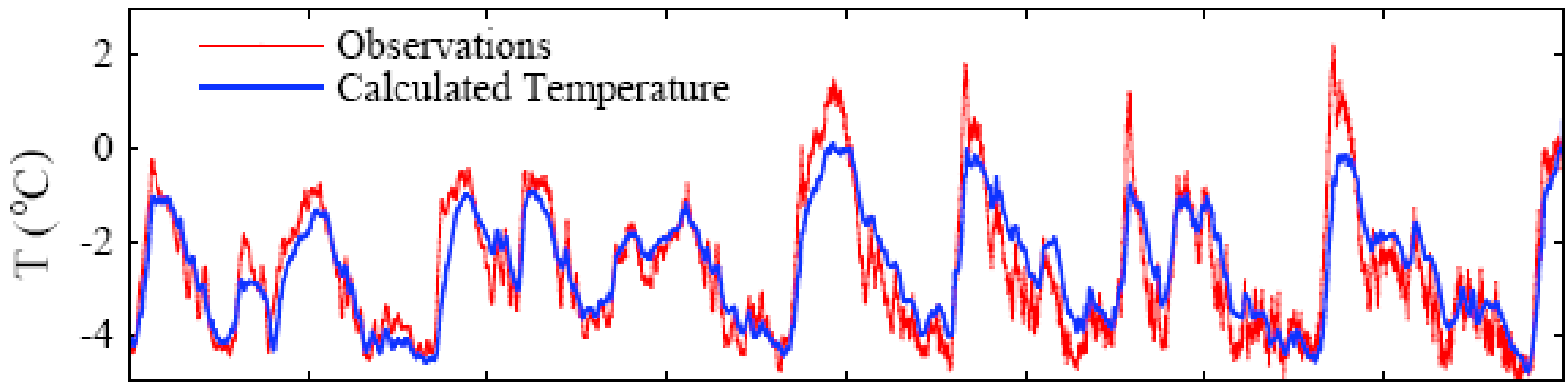
- Introduction
- **Observed change**
- Projected change
- Communication and response

Climate has always changed

CO₂, CH₄ and Sea Level



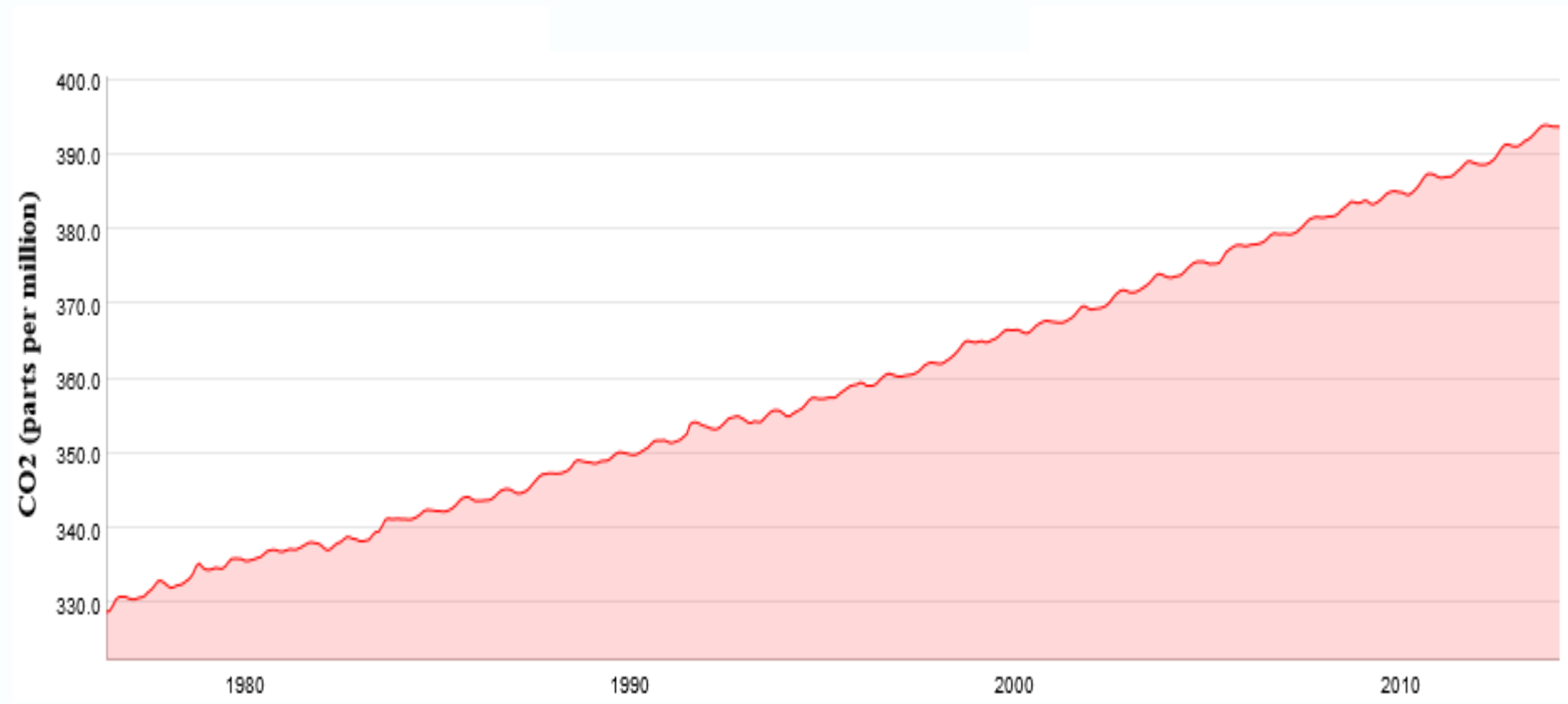
Temperature Change



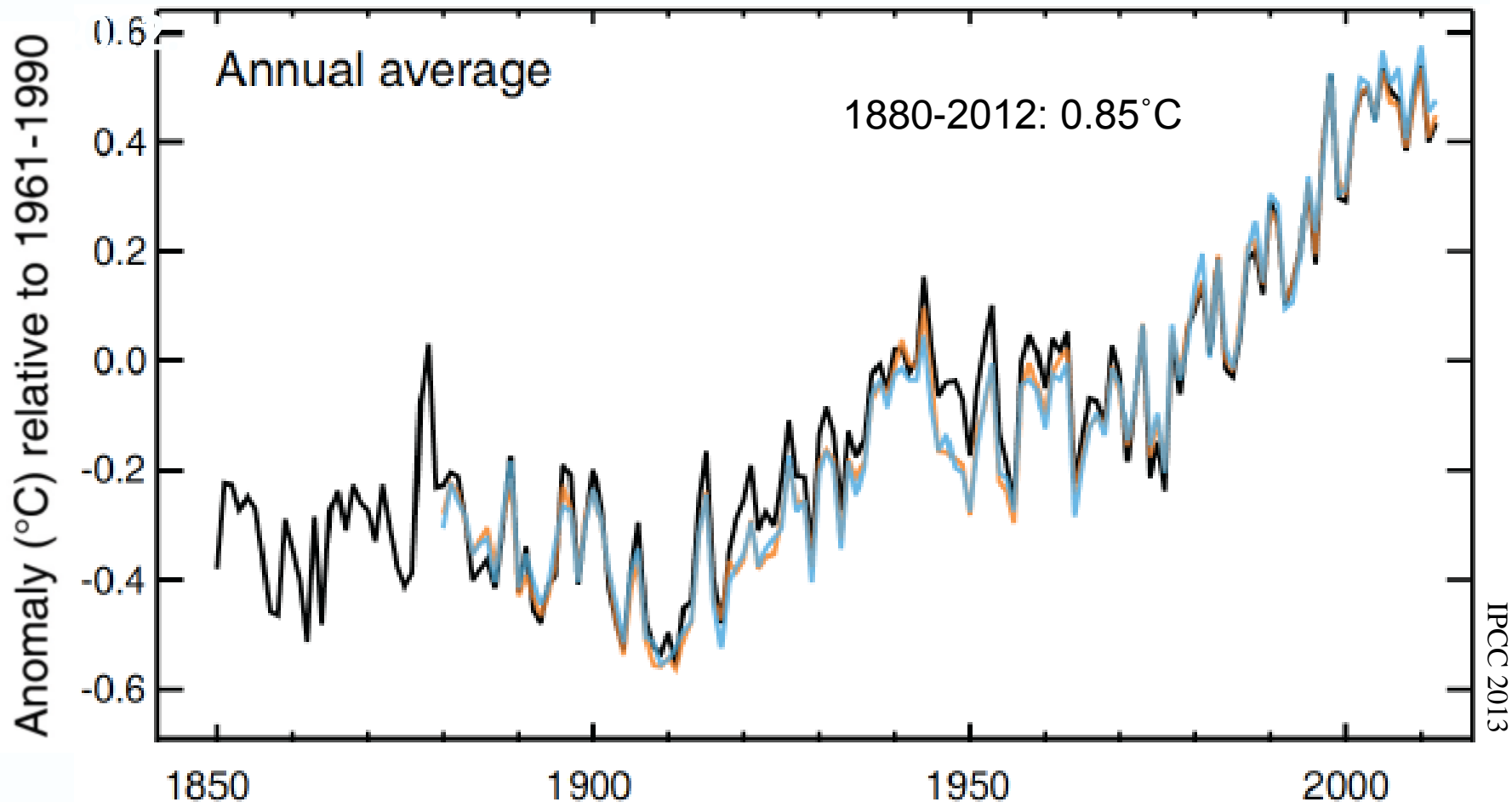
Hansen et al. (2008) Target atmospheric CO₂

Carbon dioxide concentrations (395 ppm) are likely greater than at any time during the past 2 million years. The growth rate is now accelerating.

Atmospheric concentration of carbon dioxide

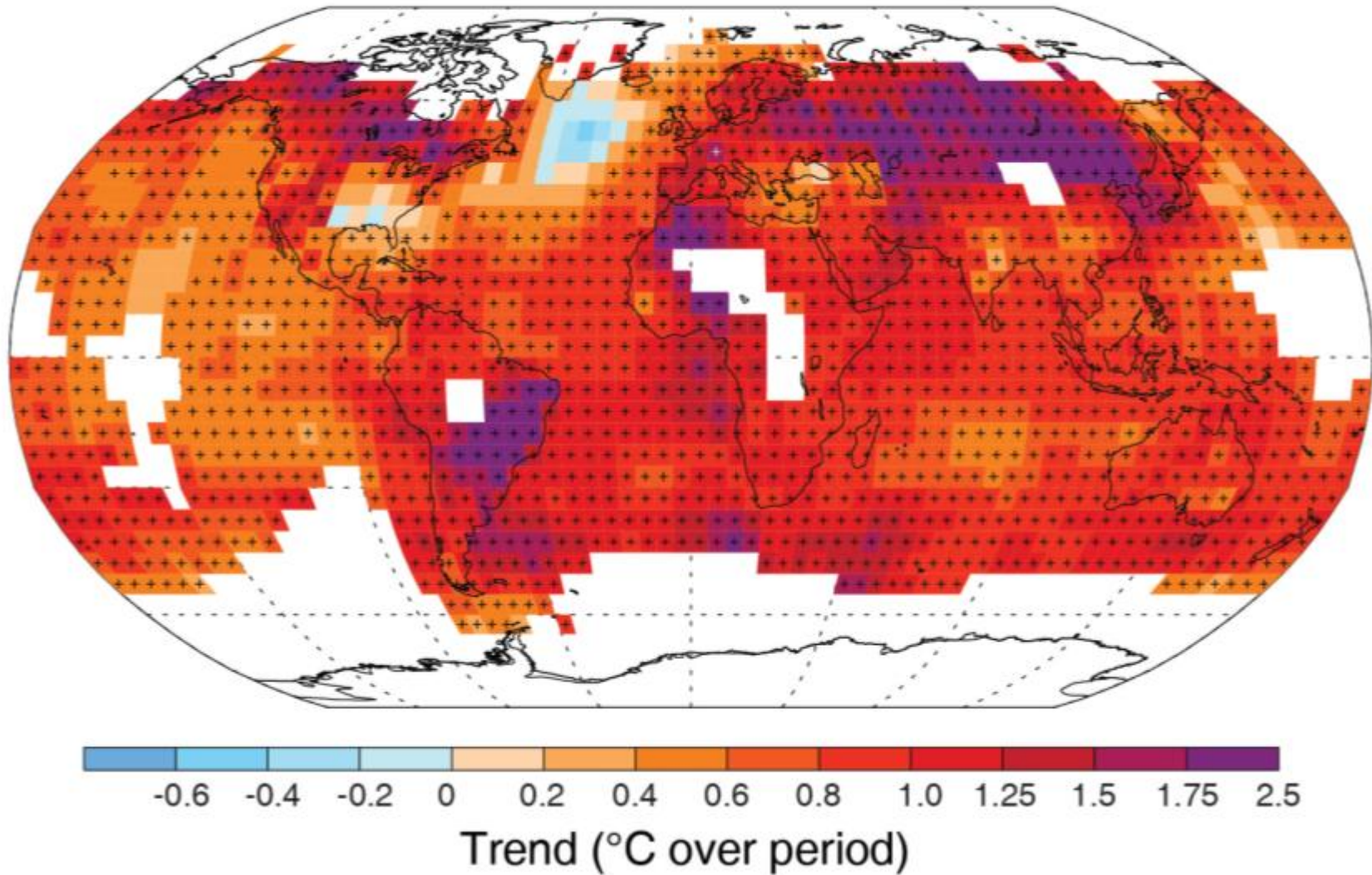


Global average surface temperature



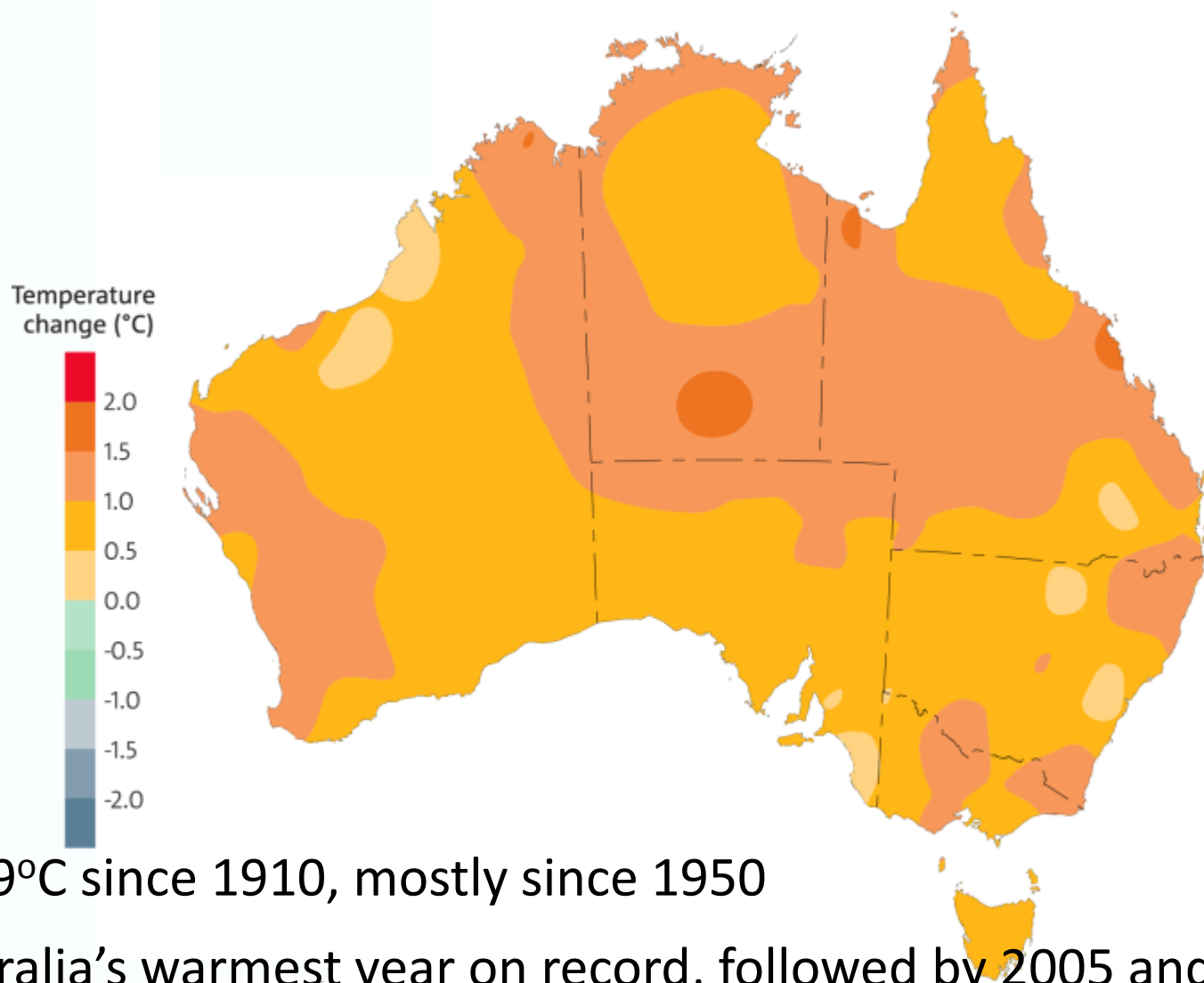
2013 tied with 2003 as 4th warmest year globally (warmest 3 were 2010, 2005, and 1998)
13 of the 14 warmest years ever measured occurred in the 21st century.
37th consecutive year (since 1976) that global temperature is above average
352 months in a row warmer than the average

Almost the entire globe warmed between 1901 and 2012



IPCC 2013

Australia warming

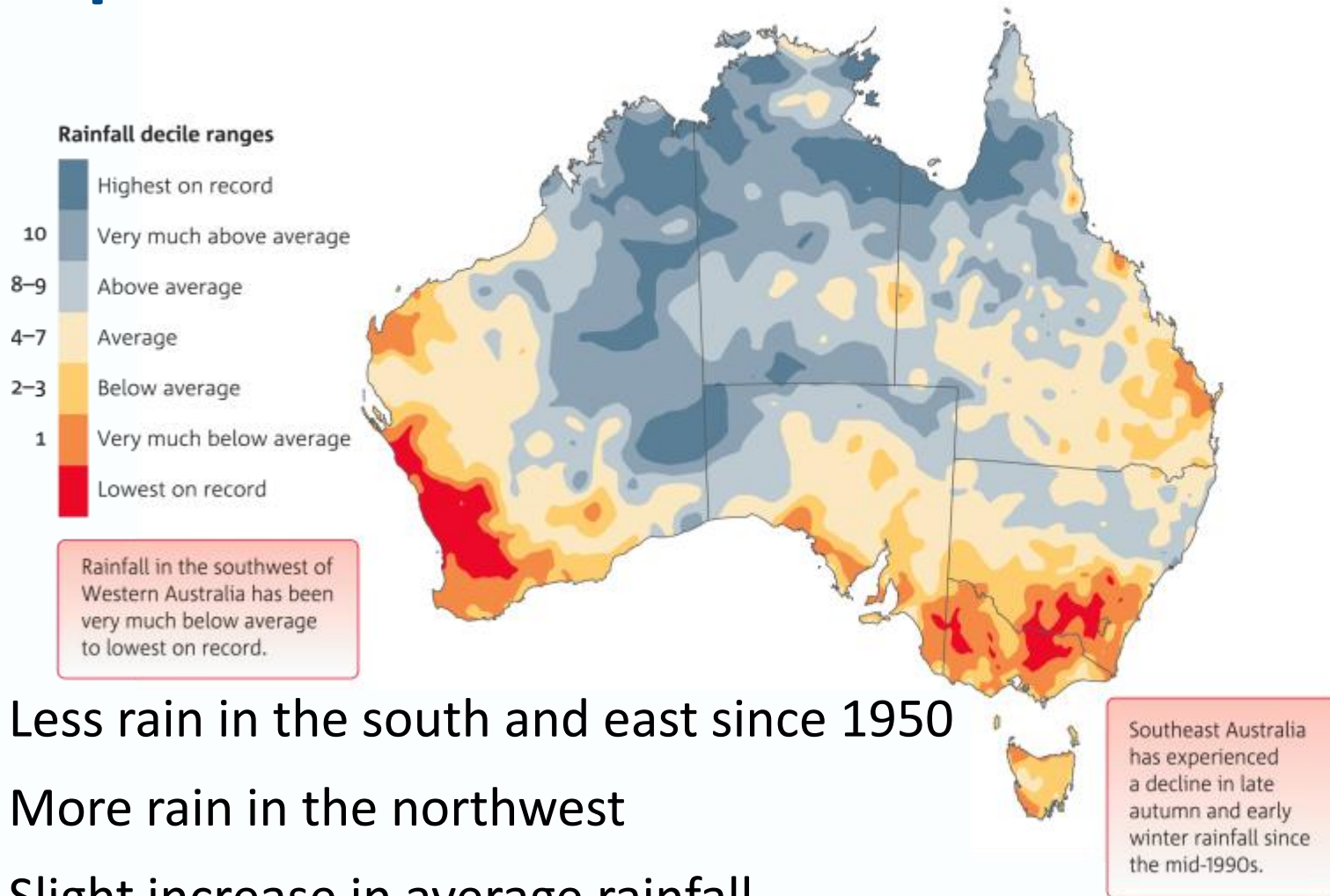


Source: CSIRO/Bom State of the Climate 2014

Warming of 0.9°C since 1910, mostly since 1950

2013 was Australia's warmest year on record, followed by 2005 and 2009

April-Nov rainfall



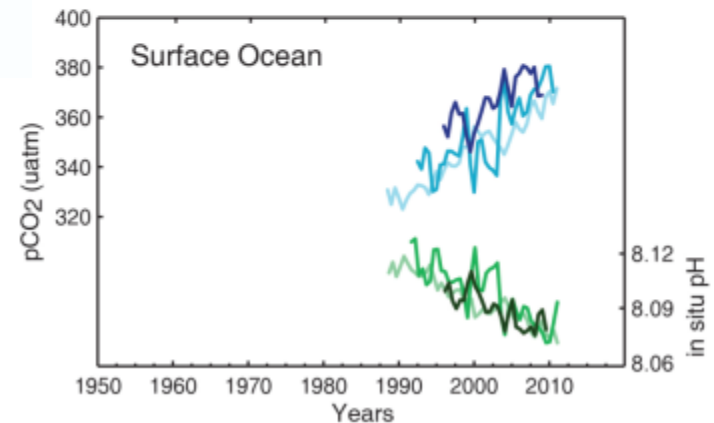
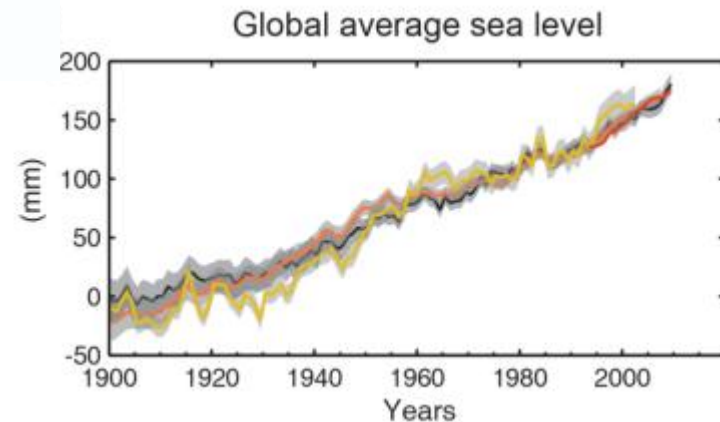
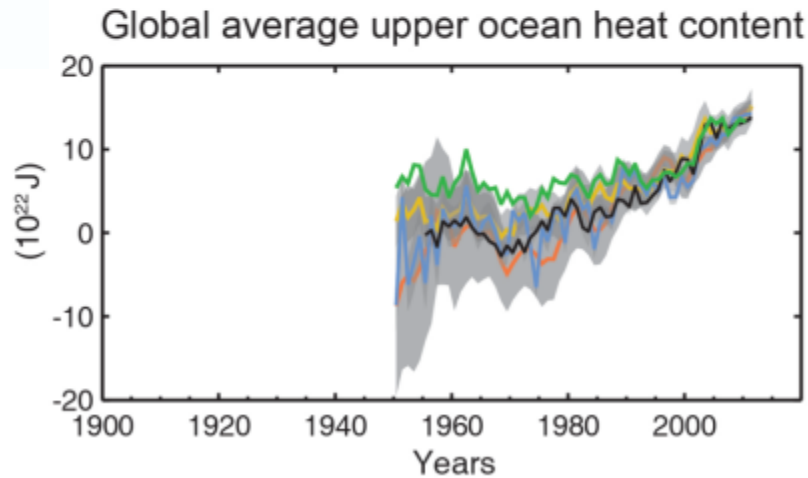
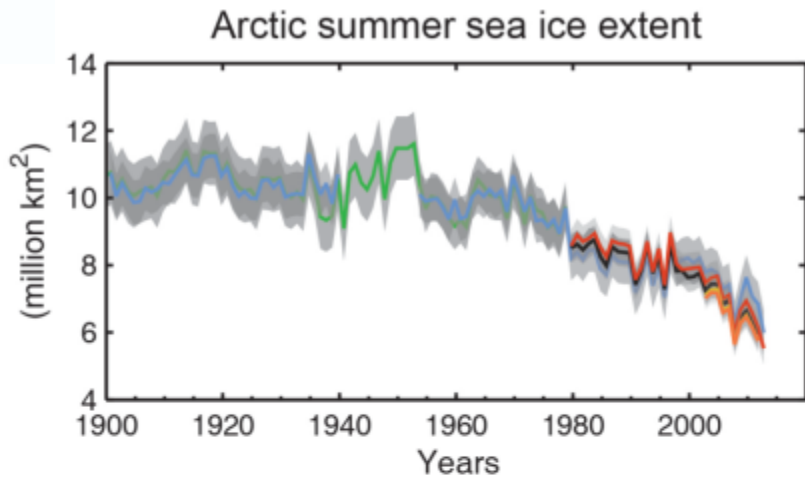
Less rain in the south and east since 1950

More rain in the northwest

Slight increase in average rainfall

Increase in intensity of droughts

Multiple lines of robust and compelling evidence support the conclusion that many aspects of the climate system have changed.



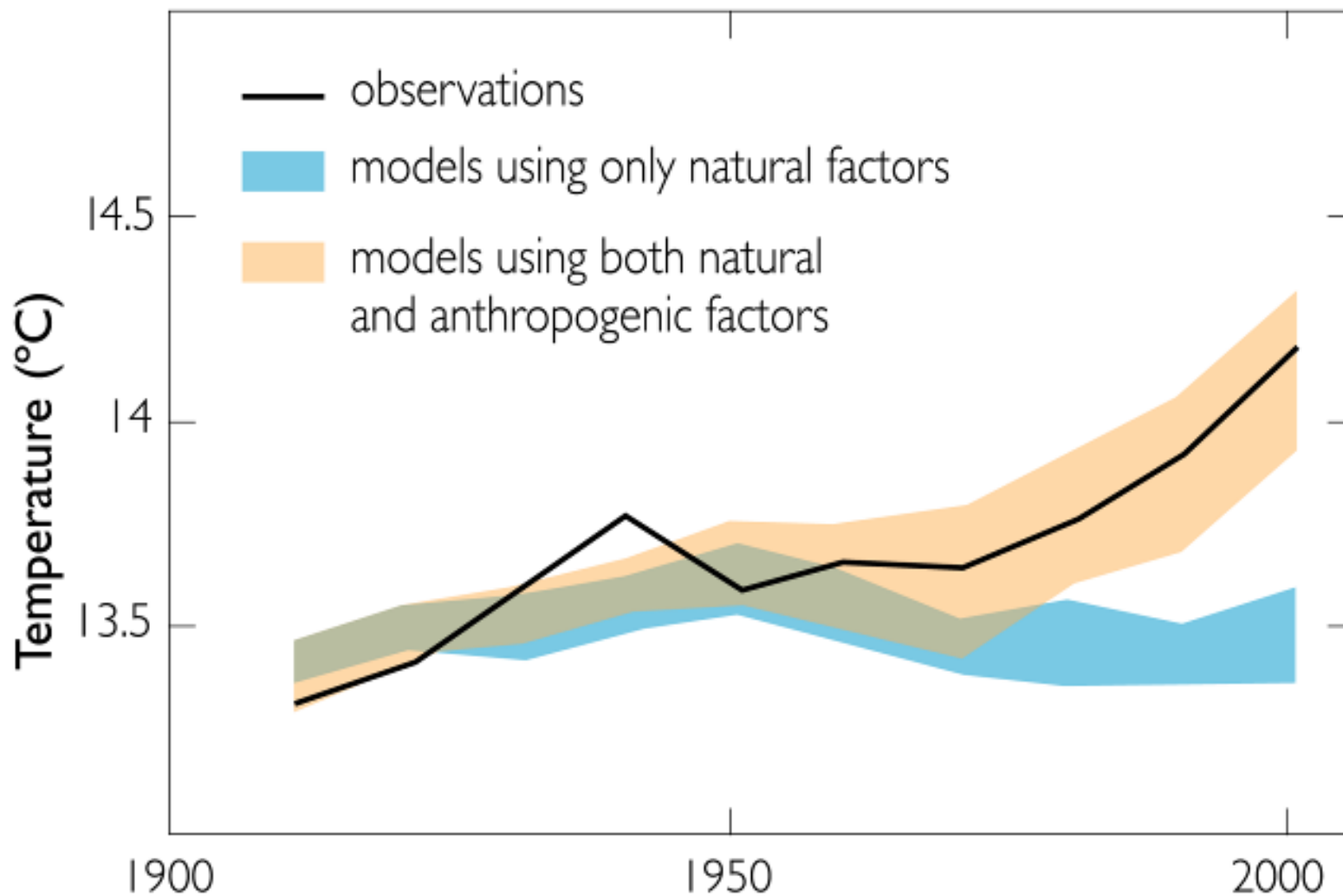
The consensus opinion

2013: “Warming of the climate system is unequivocal, and since the 1950s many of the observed changes are unprecedented over decades to millennia.

Human influence on the climate system is clear.

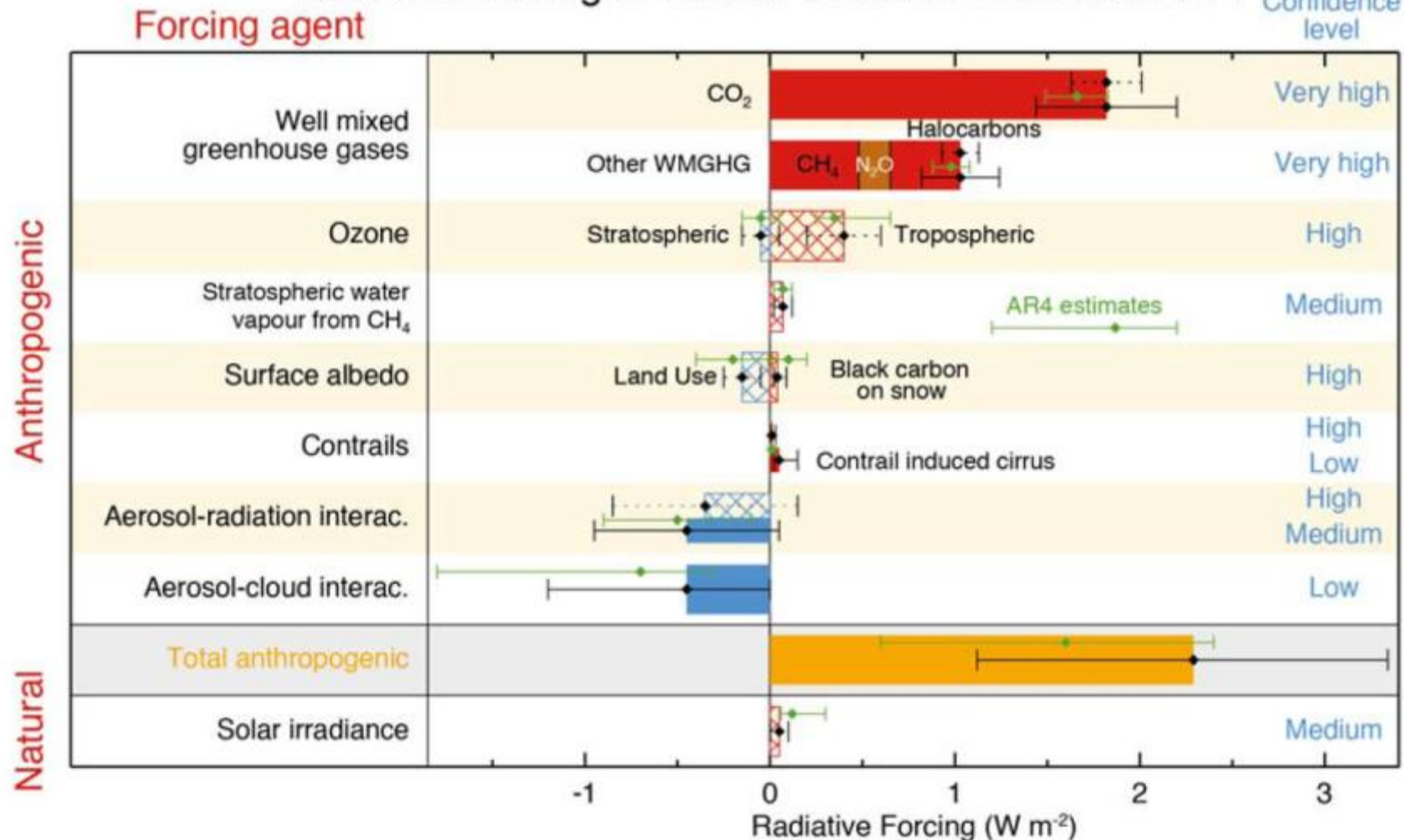
Human influence has been detected in warming of the atmosphere and the ocean, in changes in the global water cycle, in reductions in snow and ice, in global mean sea level rise, and in changes in some climate extremes. This evidence for human influence has grown since AR4.

It is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century.”



Radiative Forcing Components

Radiative forcing of climate between 1750 and 2011

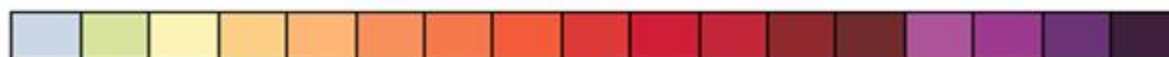
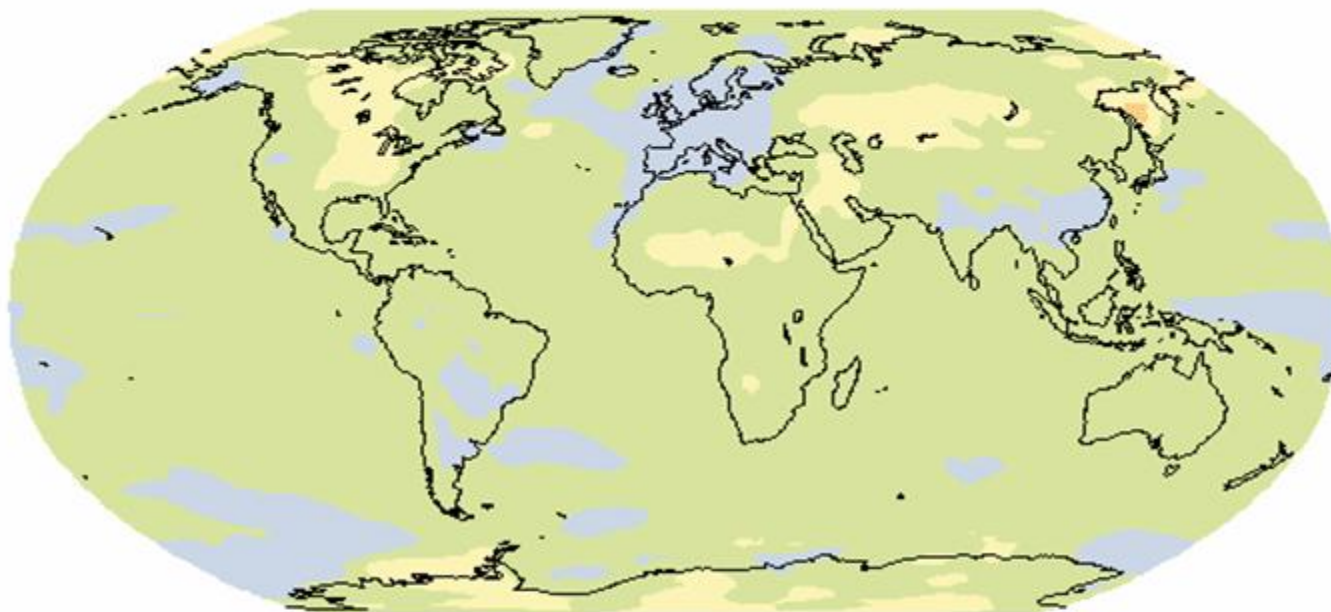


IPCC 2007

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2001



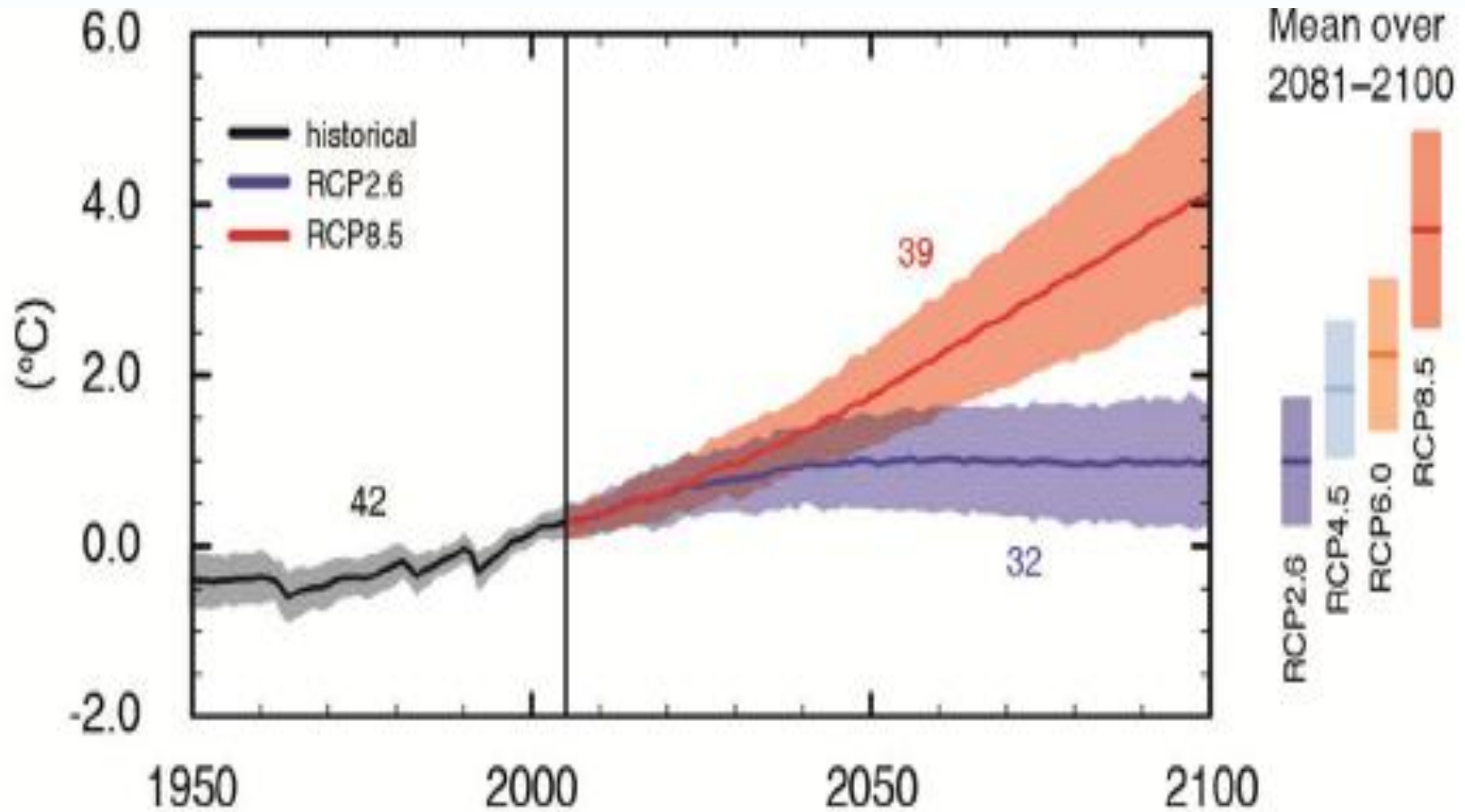
0 1 2 3 4 5 6 7

Temperature Change (°C)

CSIRO Mark 3.5 climate model
700 ppm emission scenario
Change relative to 1980-1999 average



Global average surface temperature change



IPCC 2013

Global warming of 0.3 - 4.8 °C by 2100, depending on emissions
Sea level rise of 0.26 - 0.98 m by 2100

Carbon dioxide and temperature

‘Double the concentration of carbon dioxide in the atmosphere and the average surface temperature will rise by 4.9 to 6.05°C.’

THE
LONDON, EDINBURGH, AND DUBLIN
PHILOSOPHICAL MAGAZINE
AND
JOURNAL OF SCIENCE.

[FIFTH SERIES.]

APRIL 1896.

XXXI. *On the Influence of Carbonic Acid in the Air upon the Temperature of the Ground.* By Prof. SVANTE ARRHENIUS *.

I. *Introduction: Observations of Langley on Atmospheric Absorption.*

A GREAT deal has been written on the influence of the absorption of the atmosphere upon the climate. Tyndall† in particular has pointed out the enormous importance of this question. To him it was chiefly the diurnal and annual variations of the temperature that were lessened by this circumstance. Another side of the question, that has long attracted the attention of physicists, is this: Is the mean



Svante Arrhenius, 1859-1927

Time to feel Earth's pulse

IS man's pollution of the air changing the climate of the Earth? And if so, is it getting hotter or colder? Is our punishment to be frizzled or frozen?

Scientists are not sure, but they are curious and anxious enough to urge the need for more sophisticated observation and analysis of the upper atmosphere.

Oddly enough, some consequences of man's activities could lead to a general warming and others to a world-wide cooling of his environment.

In addition, there is a danger of an increased level of harmful ultra-violet radiation penetrating a pollution-weakened upper atmosphere.

The amount of carbon dioxide in the atmosphere has measurably increased over the past 30 years, possibly as a result of industrial emission. This could trap the radiation of heat from the Earth's surface and perhaps lead to a general warming.

CLAUDE FORELL gives the background to one of the questions confronting an international scientific conference opening in Melbourne today: has man's pollution changed the Earth's climate?

al of a strong Soviet delegation in a Russian oceanographic research vessel, the *Dimitri Mendelaev*.

Several American and Australian scientists, including Dr. John Garratt, of the CSIRO, joined the ship in Adelaide 10 days ago for a combined experiment to improve weather forecasting.

One of the obstacles to more accurate and longer-range forecasting in the southern hemisphere is the lack of a sufficient number of ex-

perimentary satellites which, from a height of 22,300 miles, will be able to scan the entire globe with highly sensitive monitoring equipment and thus survey, more intensely than ever before, the mysterious forces that influence the world's weather.

The distinguished scientists at the conference will not only be talking about the weather; they will be seriously concerned about the future of the Earth's climate.

Dr. C. H. B. Priestley, vice-president of IAMAP and chairman of CSIRO's Environmental Physics Research Laboratories, said there were three ways in which man could be interfering with the climate to his possible detriment and even danger.

One is the potential impact of high-flying, supersonic aircraft. Some scientists fear that their exhaust gases may reduce the ozone in the stratosphere which protects life on Earth from the damaging effects of ultra-violet radiation from the Sun.

Another fear is that their discharge of water vapor at high levels may create more cloud which would reflect more of the Sun's radiation and so possibly lead to a global cooling.

The second problem is that the amount of carbon dioxide in the atmosphere has measurably increased over the past 30 years, possibly as a result of industrial emission.

Here the anxiety is that this could trap the radiation of heat from the Earth's surface and perhaps lead to a general warming.

Thirdly, there has been an increase in fine dust particles suspended in the atmosphere, probably because more and more of the Earth's surface is being brought into cultivation, and, to a lesser extent, because of industrial pollution.

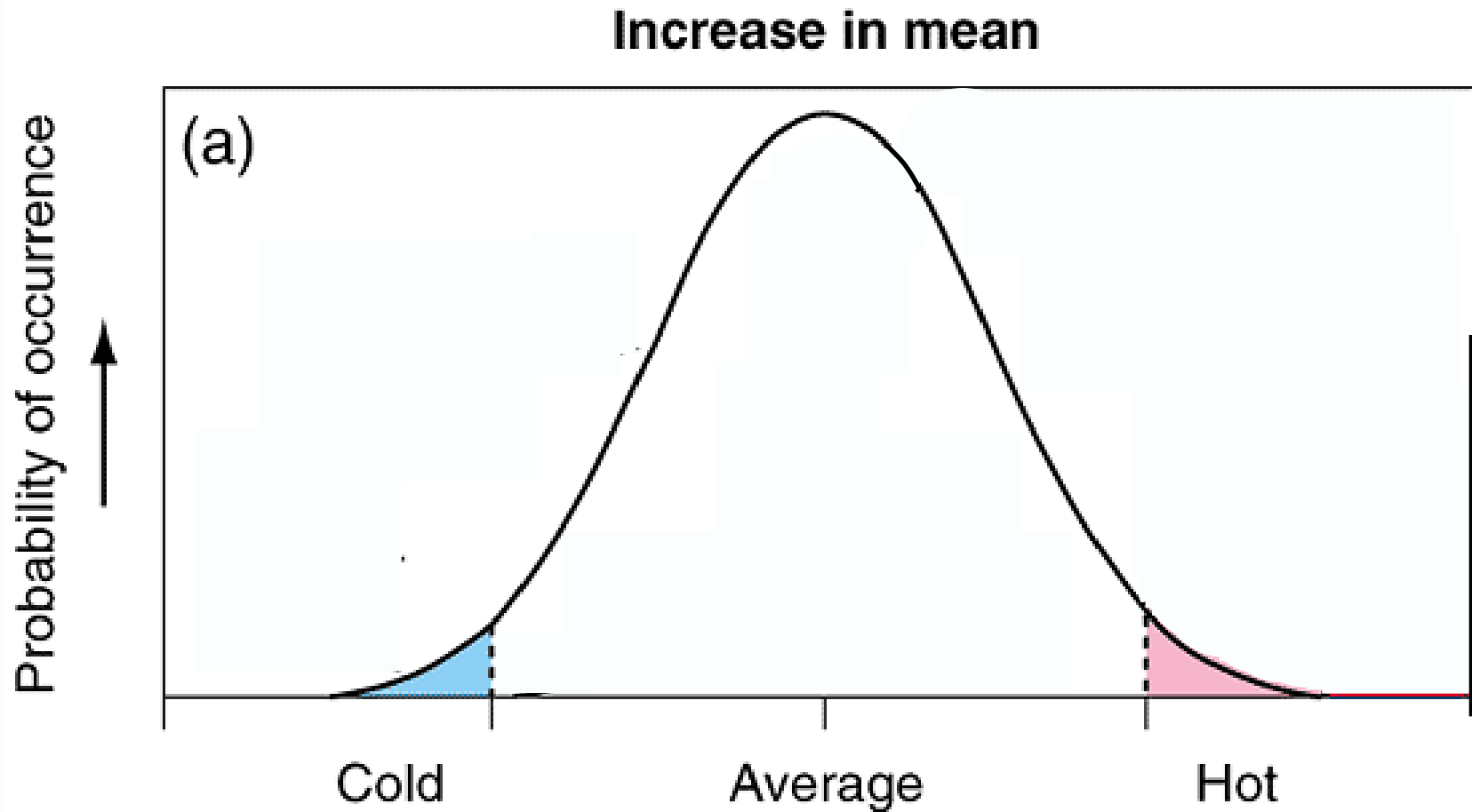
This could have a cooling influence.

How serious are these dangers? Dr. Priestley said: "If we knew all the answers, we wouldn't be meeting to discuss these problems and others affecting the atmosphere and the oceans."

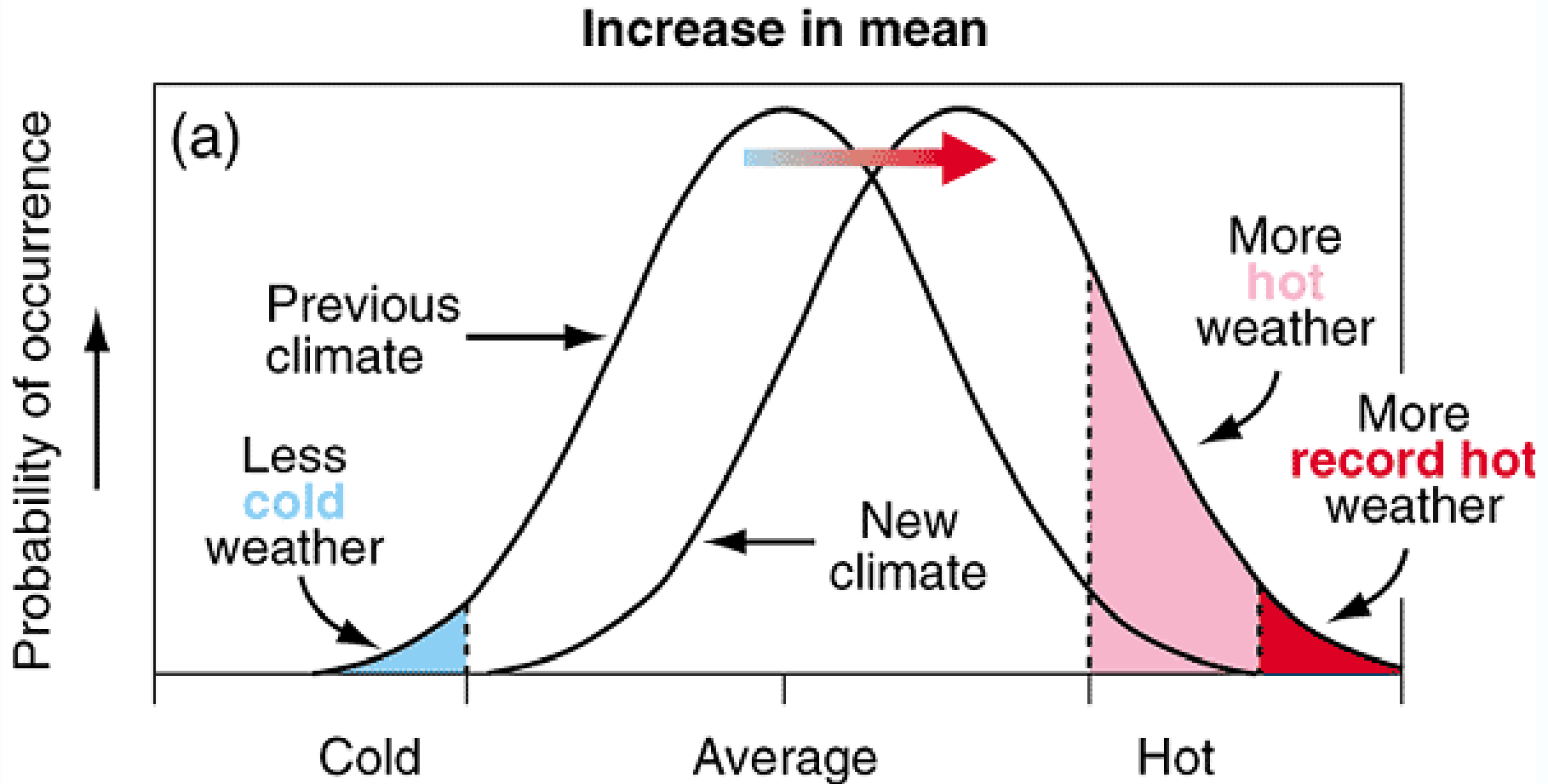
"But we all agree on the need for more research on a global scale. We also realise that man must learn to manage his total environment and live in reasonable balance with it."

Age 14/1/74

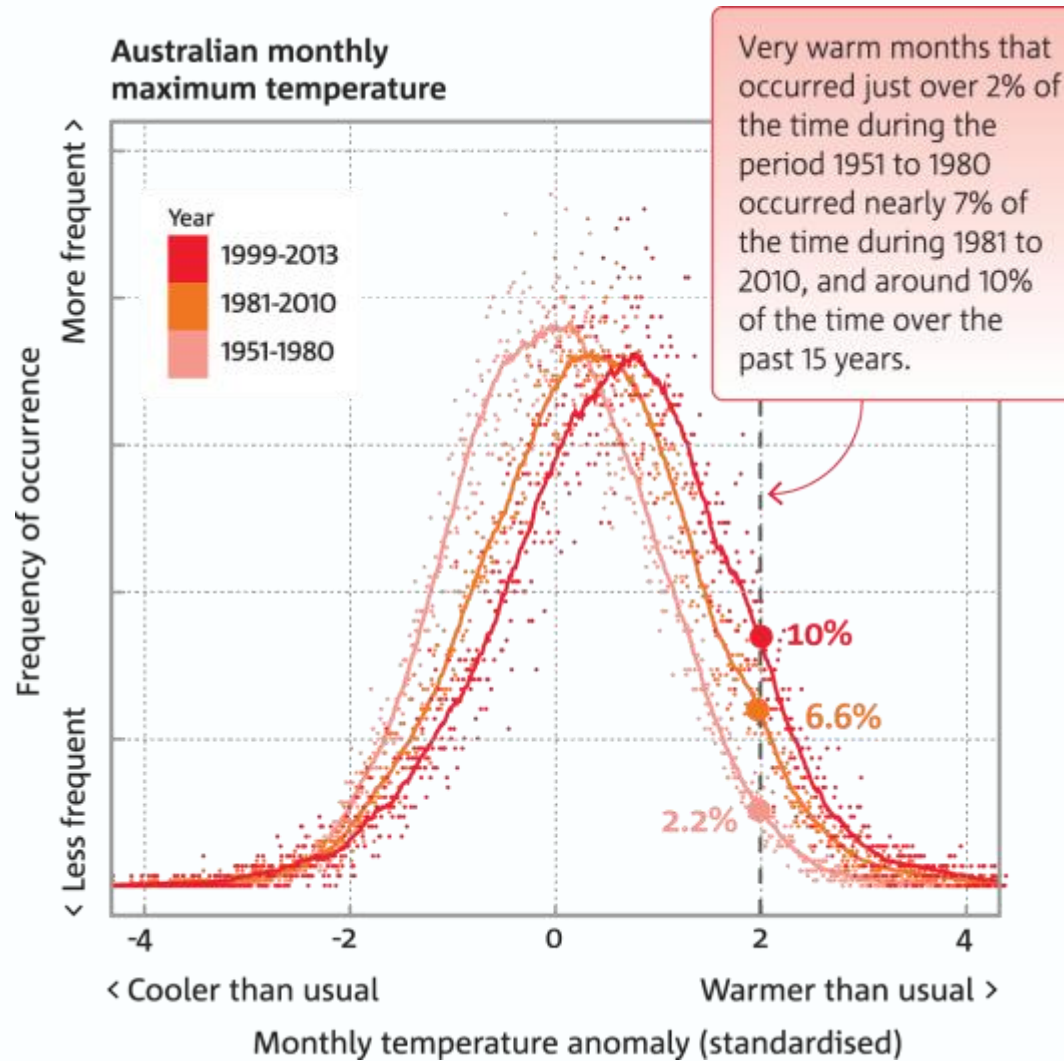
Why small increases in means can lead to large increases in extremes



Why small increases in means can lead to large increases in extremes



More frequent warm months in Australia



Source: CSIRO/Bom State of the Climate 2014

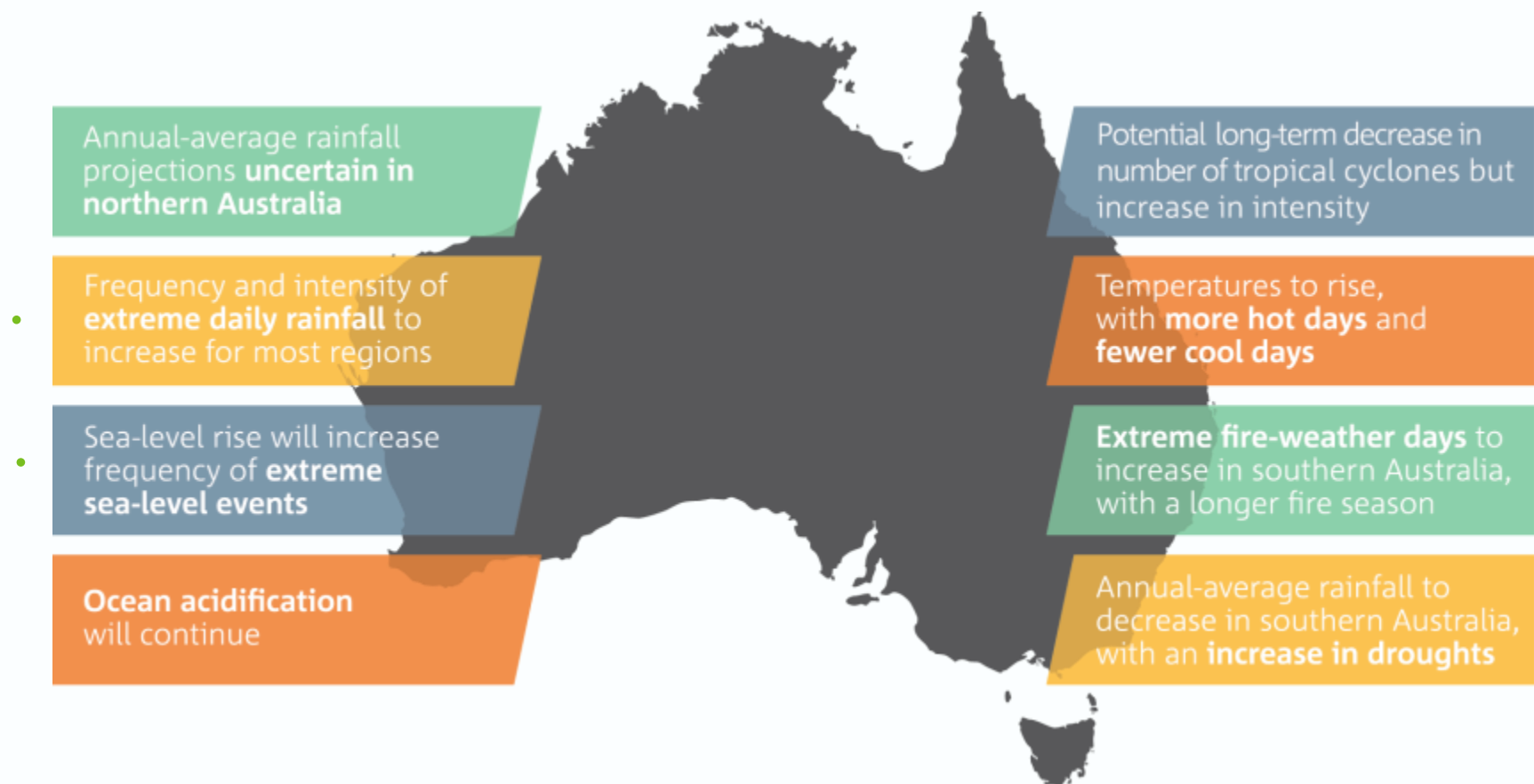
Days of extreme temperature

	Current	2030 A1B low	2030 A1B median	2030 A1B high	2070 B1 low	2070 B1 median	2070 B1 high	2070 A1F1 low	2070 A1F1 median	2070 A1F1 high
Adelaide	17	21	23	26	24	26	31	29	36	47
Alice Springs	90	102	109	118	112	122	138	132	155	182
Brisbane airport	1.0	1.5	2.0	2.5	2.1	3.0	4.6	4.0	7.6	20.6
Broome	54	71	86	107	89	119	173	147	220	281
Cairns	3.8	5	7	9	8	12	22	19	44	96
Canberra	5	7	8	10	8	10	14	12	18	26
Darwin	11	28	44	69	49	89	153	141	227	308
Dubbo	25	31	35	39	35	40	51	44	61	87
Hobart	1.4	1.6	1.7	1.8	1.7	1.8	2.0	2.0	2.4	3.4
Melbourne	9	11	12	13	12	14	17	15	20	26
Mildura	32	36	39	43	39	45	51	48	60	76
Perth airport	28	33	35	39	36	41	46	44	54	67
St George	47	56	63	72	64	74	91	80	103	135
Sydney	3.5	4.1	4.4	5.1	4.5	5.3	6.6	6	8	12
Wilcannia	63	71	77	82	79	85	96	92	106	129

10-50% more hot days (>35 °C) by 2030

A doubling in some capital cities: Melbourne 11-13 days

Projected Australian climate



Source: CSIRO/BoM State of the Climate 2014

2030: 0.6 – 1.5°C warmer than 1980 – 1999

2070: 1.0 – 2.5°C (low emissions), 2.2 – 5.0°C (high), and rainfall 0–20% decrease (low), 30% decrease–5% increase (high)

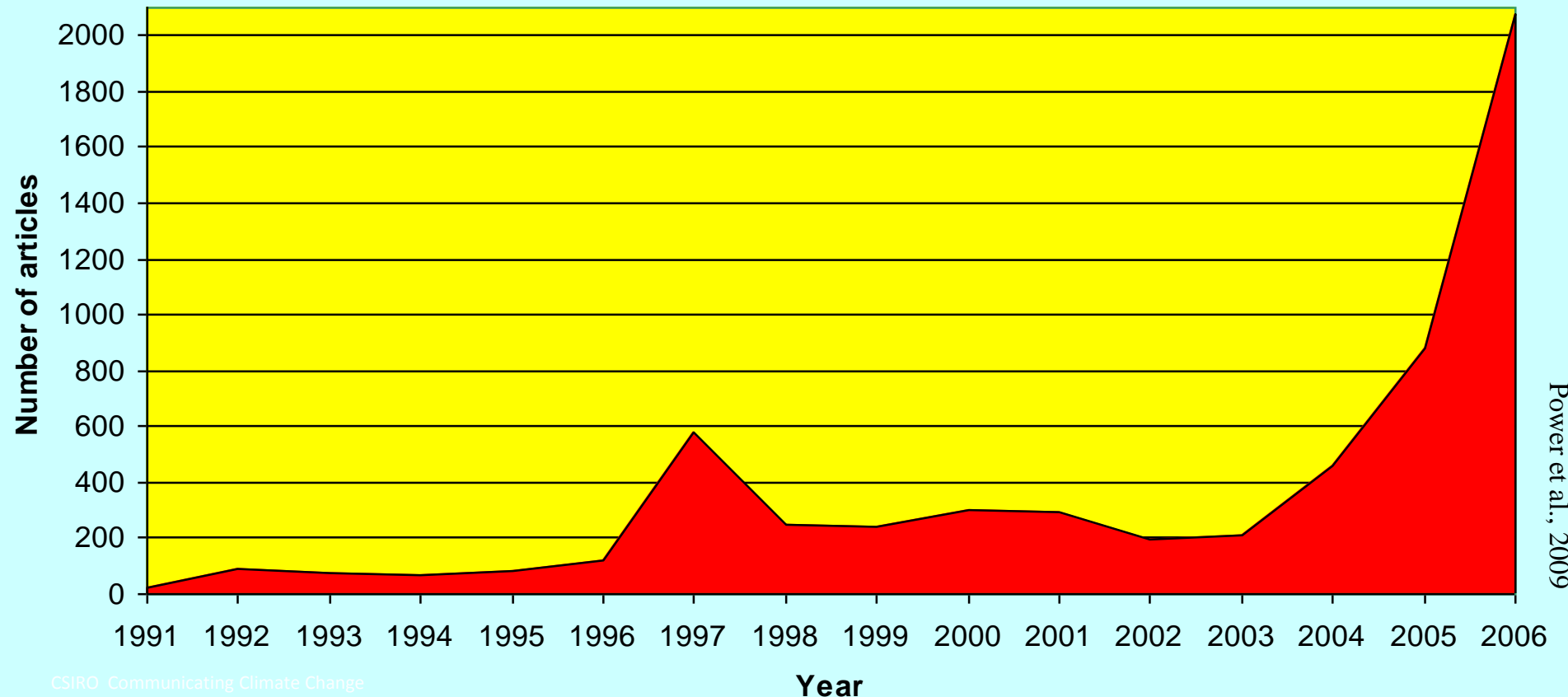
Climate observations, projections, and communication

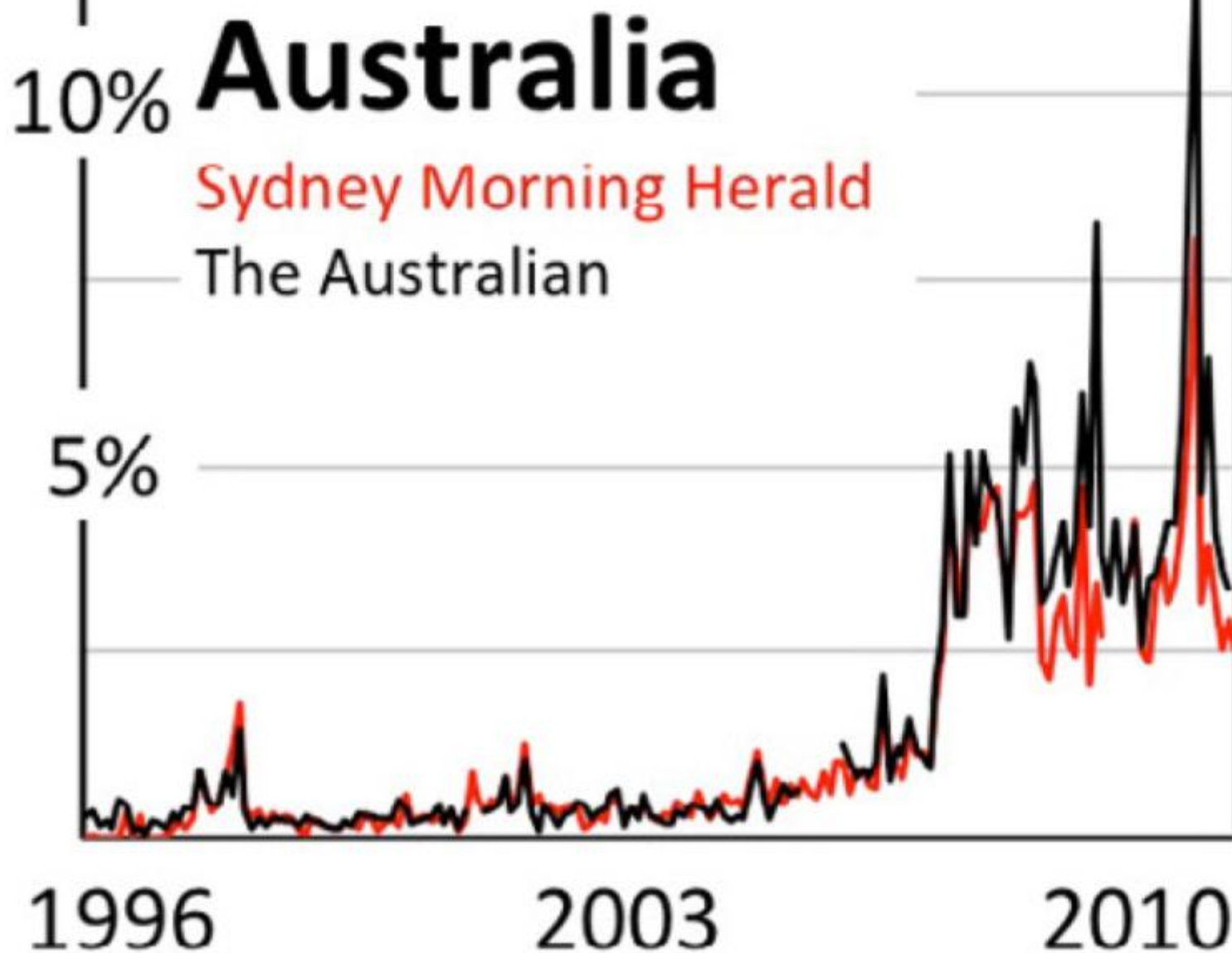
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Climate change in the media

In Australia, there was a ten-fold increase in the number of media reports about climate change from 2003 to 2006, which tripled again in 2007.

**References to climate change in articles from major metropolitan newspapers
(1991-2006)**





Denial to despair

A survey in 2007 of 600 young people aged 10 to 14 in Australia found 44% are nervous about the future impact of climate change, and 27% are so troubled about the state of the world they believe it will end in their lifetime.

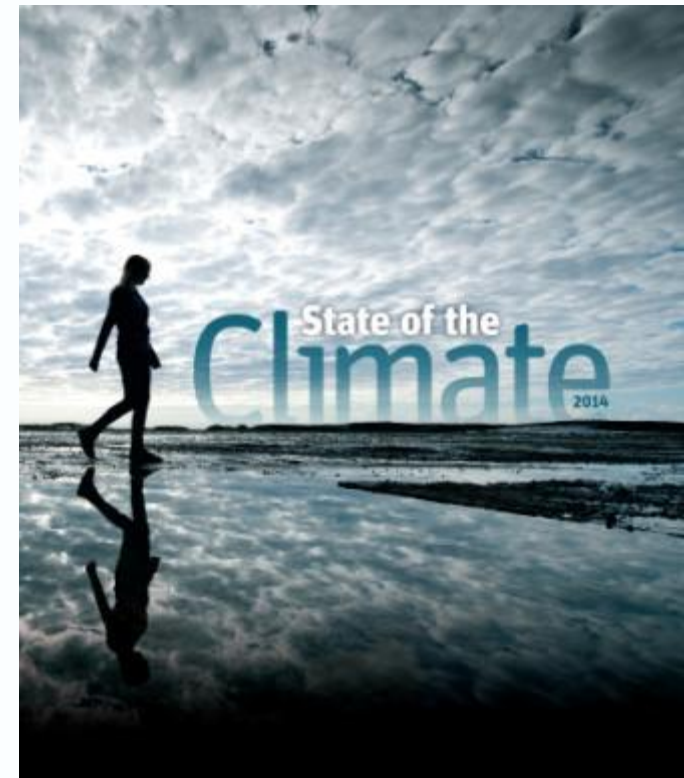
Climate change is reported in an increasingly alarmist and urgent language, with extreme weather events blamed on climate change

The scale of the problem can be overwhelming for many and therefore lead to inaction through a belief that individual actions will be ineffective against such a vast, global problem.

This can be compounded by the common messages of simple (and simplistic) individual actions that are provided.



Moving from information transmission (deficit model) to dialogue and effective campaigns, as advised by social research



Tackling the Problem

Understanding and communication/education

Adaptation ('climate-proofing')

Mitigation (reducing net greenhouse gas emissions)

Tackling the Problem

Adaptation ('climate-proofing')

- Preparing for the impacts of climate change
- Aim is to reduce the negative consequences, take advantage of any possible opportunities
- Autonomous vs planned

For example

- Reducing water demand through restrictions and incentives
- Increasing water supply (e.g. desalination, recycling, tanks)
- Engineering solutions and planning guidelines in coastal areas (e.g. sea walls, buffer zones, planned retreat)
- Snow making
- Changing crop varieties and farming practices
- Migration corridors for biodiversity.

Tackling the Problem

Mitigation (reducing net greenhouse gas emissions)

- Reducing greenhouse gas emissions to address the cause of climate change
- Reducing the risk of larger and dangerous changes to which we cannot adapt

For example

- Technologies to reduce emissions (renewables, biofuels, energy efficiency)
- Enhancing carbon uptake by increasing carbon sinks through carbon dioxide capture etc, and decreasing deforestation
- Policy mechanisms

In conclusion . . .

Climate varies naturally, and the natural greenhouse effect has been enhanced by increased greenhouse gas concentrations.

Global temperatures have risen, and other observations show evidence of climate change globally and in Australia.

While climate has numerous drivers, human influence on the climate system is clear, and has been known for some time.

Projections indicate that changes to the climate are expected to continue into the future, being felt through extremes.

There are many challenges in communicating climate change, which can be addressed through framing messages to include solutions to avoid despair; using dialogue as well as information dissemination; and other communication advised by social science.

Adaptation is required to reduce impacts, mitigation is required to avoid dangerous changes.

Questions?

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