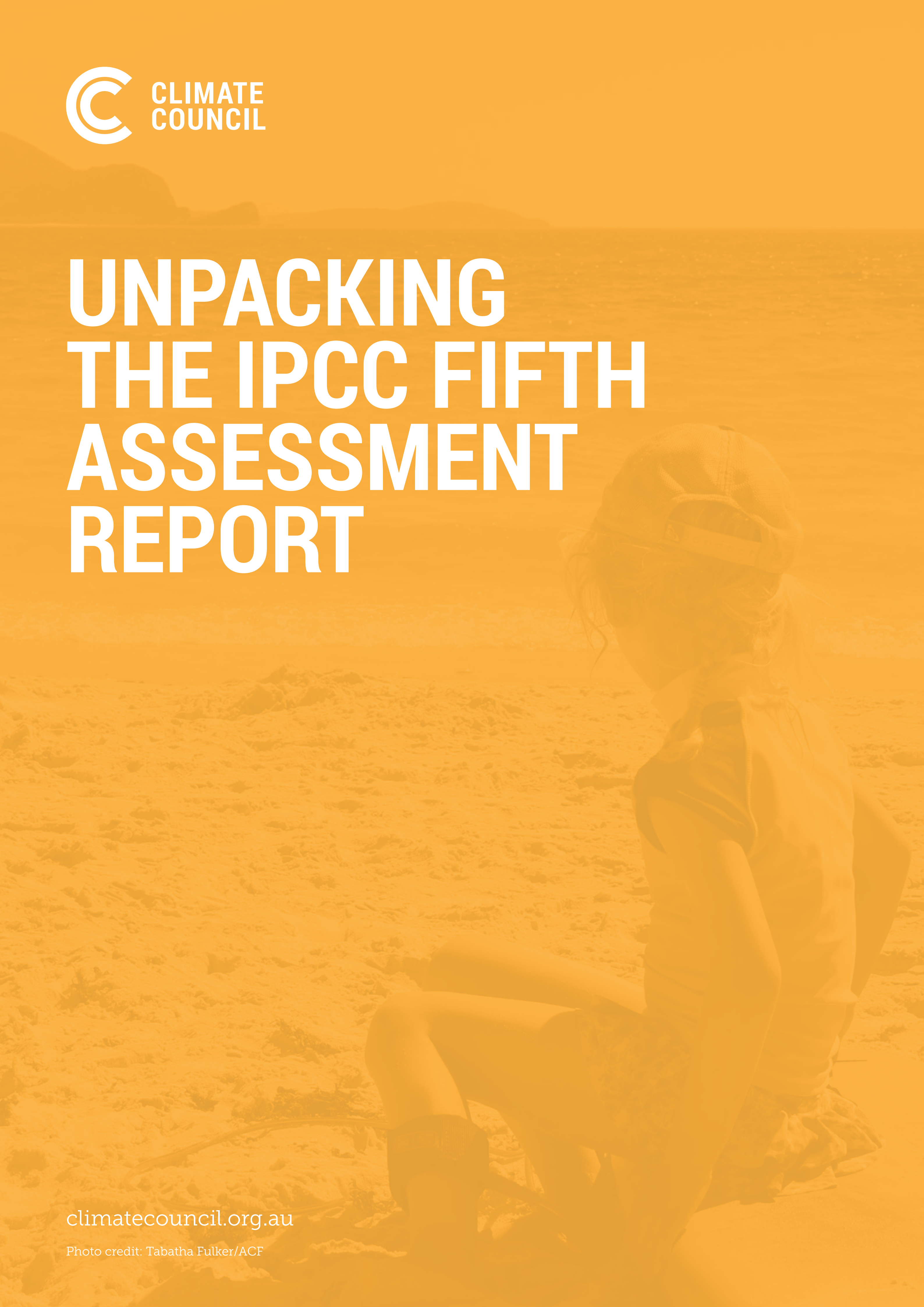

CLIMATE COUNCIL

UNPACKING THE IPCC FIFTH ASSESSMENT REPORT

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Photo credit: Tabatha Fulker/ACF

The Intergovernmental Panel on Climate Change (IPCC) is the most authoritative international body on climate science. Every five–seven years the IPCC publishes an Assessment Report that provides a comprehensive summary of the physical science of climate change, the impacts, and mitigation strategies. The first part of this, the physical science, was released on the 27th of September 2013.

This latest report has been complied by eight hundred scientists on a voluntary basis and brings together the most comprehensive and authoritative scientific assessment of the fundamental science of climate change.

This Climate Council summary provides a brief run down of the main findings of the IPCC report and dispels two of the myths that have been circulating in the media in the lead up to its release.

Please note all figures are contained in the appendix.

Download the full report at www.ipcc.ch

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Professor Will Steffen, Climate Councillor

KEY MESSAGES

1. Our understanding of the climate system has only continued to strengthen in the last six years. Ocean and air temperature are rising, mass from glaciers and ice sheets is being lost, and sea level is rising.

2. Scientists are more certain than ever that increasing global temperatures since 1950 have been caused primarily by human activities.

3. A warming climate is increasing the frequency and severity of many extreme weather events and is changing rainfall patterns, creating risks for human well-being, the economy and the environment.

4. Stabilising the climate system will require substantial and sustained reductions of carbon dioxide (CO_2) emissions. We will have to decarbonise the economy.

This graphic was created by the Climate Council and is not part of the IPCC report. It does draw on the IPCC and other sources.

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1. OBSERVATIONS OF A CHANGING CLIMATE

Our understanding of the climate system has only continued to strengthen in the last six years. Ocean and air temperature are rising, mass from glaciers and ice sheets is being lost, and sea level is rising.

The global average air temperature has risen by about 0.85°C since the beginning of the 20th century, and continues to rise. The period 2001–2010 was the hottest decade on record (FIG 1).

The ocean absorbs over 90% of the extra heat trapped by the rising concentration of greenhouse gases, vastly more than all of the other components of the climate system combined. As a result, the ocean has warmed since the 1970s, the period with widespread ocean observational systems, with much of the heat stored in the upper 700 metres (FIG 2). More recently, observations show warming in the deep ocean below 3000 metres in the North Atlantic and Southern Ocean.

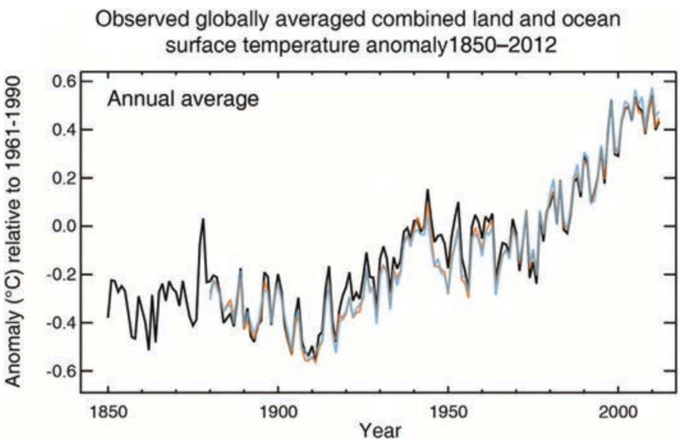
Glaciers and ice sheets around the world are shrinking and losing mass. The combined rate of mass loss from the large polar ice sheets on Greenland and Antarctica has risen to about 350 billion tonnes per year for the period 2002–2011.

The annual average sea ice extent over the Arctic Ocean has decreased at a rate of 3.5 to 4.1% per decade over the period 1979–2012 (FIG 3). Overall since 1950 the sea ice extent dropped to nearly half. The extent of multi-year sea ice (ice that exists through the summer) has decreased by over 11% per decade. These rates are unprecedented in the last 1,450 years.

The ocean continues to acidify. The pH (a measure of acidity/alkalinity) of seawater has decreased by 0.1 since the beginning of the industrial era, corresponding to an increase in acidity of 26%.

Sea level has risen by 19 cm over the 1900–2010 period (FIG 4), and at an increased rate over the period since 1993. The rate of sea-level rise over the last century is unusually high in the context of the last 2,000 years.

FIG 1: GLOBAL SURFACE TEMPERATURE INCREASE OVER TIME:



Observed global average combined land and ocean temperature anomalies from three surface data sets (black—HadCRUT4, yellow—MLOST, blue—GISS). Anomalies are relative to the mean of 1961–1990.

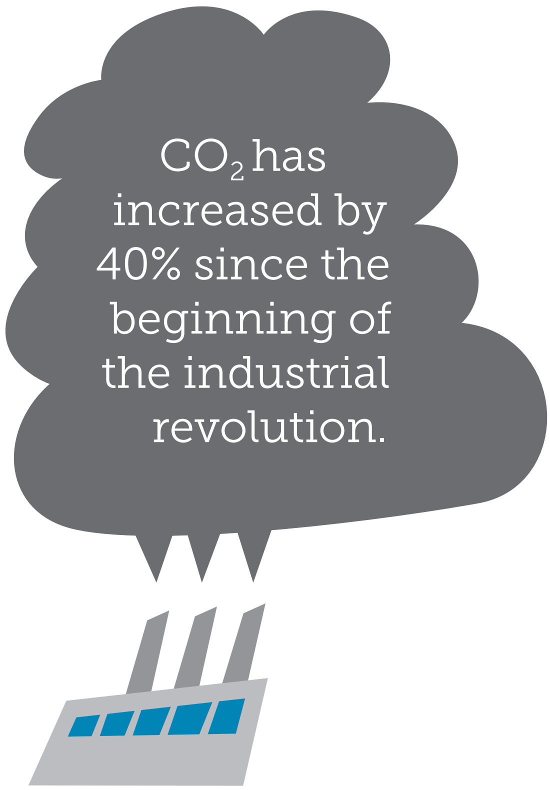
2. CAUSE OF THE WARMING CLIMATE

Scientists are more certain than ever that the warming since 1950 has been caused primarily by human activities.

The primary cause of the observed changes in the Earth's climate are human activities—mainly the burning of fossil fuels (coal, oil and gas) but also agriculture and land clearing. Robust and compelling evidence has been complied over many decades to show this.

The atmospheric concentration of carbon dioxide (CO_2), the most important long-lived greenhouse gas, has increased by 40% since the beginning of the industrial revolution. CO_2 levels are now at higher levels than at any other time in human history. The concentrations of other important greenhouse gases, such as methane and nitrous oxide, have also increased significantly as a result of human activities.

Climate models allow us to simulate a changing climate. We can use climate models to work out the extent of human influence on the climate by testing which factors are causing the changes we are observing. The models do this by simulating the climate with only natural factors included and then with both natural and human factors included. The model simulations are then compared with observations, for instance, the actual global temperature rise over the last century up to the present (FIG 5). The comparisons clearly show that the observed warming trends can only be explained when greenhouse gas emissions from human activities are included in the climate models.



3. RISKS FROM A DESTABILISED CLIMATE SYSTEM

A warming climate is increasing the frequency and severity of many extreme weather events and is changing rainfall patterns, creating risks for human well-being, the economy and the environment.

This latest IPCC report has confirmed and strengthened the key findings of the 2012 IPCC Special Report on extreme events:

Extremes: many extreme weather events have become more frequent and more intense since 1950.

Heatwaves: hot days and nights have increased over most land areas around the world. Many regions, including Australia, have experienced longer and more intense heatwaves. As temperatures continue to increase, heatwaves are expected to occur more often and persist for longer.

Heavy rainfall: the IPCC states that: "It is likely that more land areas have experienced increases in the frequency, intensity or amount of heavy precipitation than have experienced decreases." This means that there is a trend toward heavier rainfall events. In the future extreme rainfall events are likely to become more intense and frequent over many areas around the world.

Coastal flooding: the incidence of coastal flooding has likely increased since 1970, exacerbated by rising sea levels. If emissions continue to increase unabated, sea level could rise by nearly 1 m by 2100 (FIG 6), compared to its average level between 1986–2005. Sustained warming could eventually lead to the loss of the entire Greenland ice sheet, with a long-term rise in sea level of up to 7 m.

4. STABILISING THE CLIMATE SYSTEM

Stabilising the climate system will require substantial and sustained reductions of CO_2 emissions.

The speed and extent at which the climate continues to change—ocean and air temperature, sea level, snow and ice cover, and the frequency and severity of extreme weather—will depend on how much more CO_2 and other greenhouse gases we emit into the atmosphere from today.

Most nations of the world have agreed that a global temperature rise above 2°C relative to the pre-industrial value poses unacceptably high risks to humanity. The observed temperature rise is already nearing 1°C, halfway to that limit.

If emissions continue to track at the top of the IPCC scenarios, global temperature could rise by up to 5.4°C by 2100, relative to pre-industrial levels (FIG 7).

Limiting global temperature increase to 2°C requires limiting total post-industrial carbon emissions from all sources to 1000 billion tonnes. By 2011 about half of this budget had already been emitted.

However, the available carbon budget may actually be smaller when the projected warming effects of non-CO_2 greenhouse gases and the possible release of methane from melting permafrost and ocean sediments are considered.

WHAT IS THE CARBON BUDGET?

To stabilise the climate at the 2°C policy target, the carbon budget is the maximum amount of carbon dioxide from human sources that can be released into the atmosphere.

In summary, to have a good chance of stabilising the climate at a global temperature rise of no more than 2°C, substantial and sustained reductions in global carbon emissions are required.

MYTH-BUSTING

DISPELLING THE MISREPRESENTATIONS OF THE IPCC

1. THE 'PAUSE' IN WARMING

Myth: The Earth has stopped warming since 1998.

Reality: The Earth has warmed significantly over the last century, and particularly strongly since 1970.

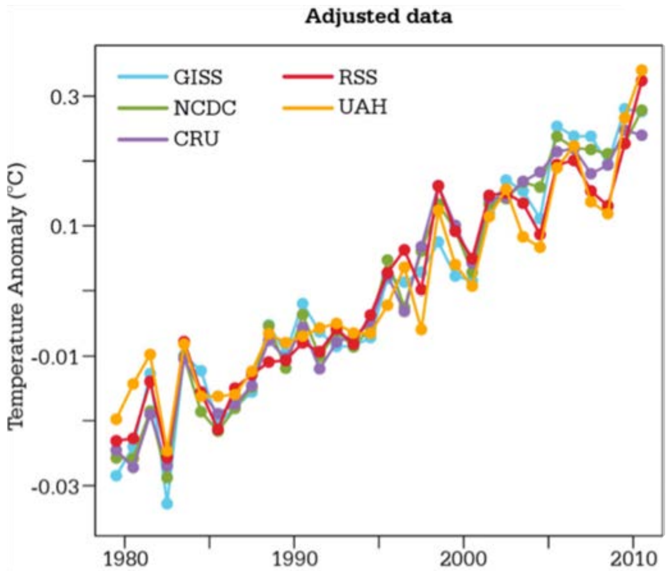
Greenhouse gases have trapped increasing amounts of heat in the climate system—the ocean, air, land surface, and snow and ice—over the last 200 years, and especially since 1950.

When most people hear about the Earth warming, they think of the air only. Actually the ocean is the big-ticket item, taking up the vast majority of the extra heat trapped by greenhouse gases. Over 90% of the warming since the mid-20th century has occurred in the ocean, and the heat content of the ocean has risen steadily since about 1970 (FIG 2).

The rates of (i) sea-level rise; (ii) decrease in extent of Arctic sea ice; and (iii) mass loss from the Greenland and Antarctic ice sheets have all increased in the period from the 1990s to the present compared to earlier periods.

Air temperature also continues to rise. In terms of global average air temperature, each of the last three decades has been warmer than all preceding decades since 1850 and the decade 2001–2010 has been the warmest. In contrast to the more steady rise in ocean temperature, air temperature has fluctuated more strongly—sometimes rising strongly, sometimes rising more slowly—due to natural factors. The surface air temperature accounts for only 3% of the additional heat trapped by greenhouse gases. The rate of rise is currently 0.05°C per decade for the 1998-2012 period, compared to the trend of 0.12°C per decade since 1951. When the trend for the 1998-2012 period is adjusted for the known effects of short-term natural factors, the underlying warming trend due to increasing greenhouse gases is much clearer and shows no signs of slowing over that period (FIG 8).

FIG 8: WARMING TREND FROM 1980–2012:



Temperature data from different sources (GISS: NASA Goddard Institute for Space Studies; NCDC: NOAA National Climate Data Center; CRU: Hadley Centre/Climate Research Unit UK; RSS: data from Remote Sensing Systems; UAH: University of Alabama at Huntsville) corrected for short-term temperature variability (variation in solar intensity, aerosols from volcanoes, and variation in phases of the El Niño-Southern Oscillation phenomenon). Source: Foster, G. and Rahmstorf, S. (2011). Global temperature evolution 1979–2010. Environmental Research Letters. doi: 10.1088/1748-9326/6/4/044022

2. THE SENSITIVITY OF THE CLIMATE TO INCREASING GREENHOUSE GAS CONCENTRATIONS

Myth: The climate is less sensitive to increases in greenhouse gas concentrations than we earlier thought.

Reality: There has been no significant change in the estimates of climate sensitivity reported by the IPCC.

The concept of equilibrium climate sensitivity (ECS) is a complex scientific concept and is often misinterpreted in media coverage. ECS is an estimate of the amount of temperature rise that would result from a doubling of CO_2 concentration in the atmosphere after the climate system has reached a new equilibrium state.

The range of estimated ECS in this IPCC report, 1.5-4.5°C, is slightly larger than that reported in the previous report in 2007, 2.0-4.5°C.

The decrease in the lower end of the range by 0.5°C reflects recent estimates using the multi-decadal records of atmosphere and ocean temperature change since the mid-20th century. Note, however, there has been no lowering of the upper end of the range.

Estimates of ECS using climate model simulations and observational records from past climate changes (e.g., the transition of the Earth from the last ice age to the present warm period) give estimates towards the mid and upper end of the range of ECS, while methods based on observations over the past several decades give estimates towards the lower end of the range. Each method has it advantages and disadvantages, and all have significant uncertainties.

The IPCC AR5 does not give an estimate of the "most likely" value of ECS. Thus, claims that the IPCC has "downgraded" earlier estimates of ECS are not correct.

APPENDIX

Note: All data and figures used in this report are taken from the IPCC AR5 Working Group 1 Summary for Policy Makers, except for Figure 8, where the reference is given in full in the caption.

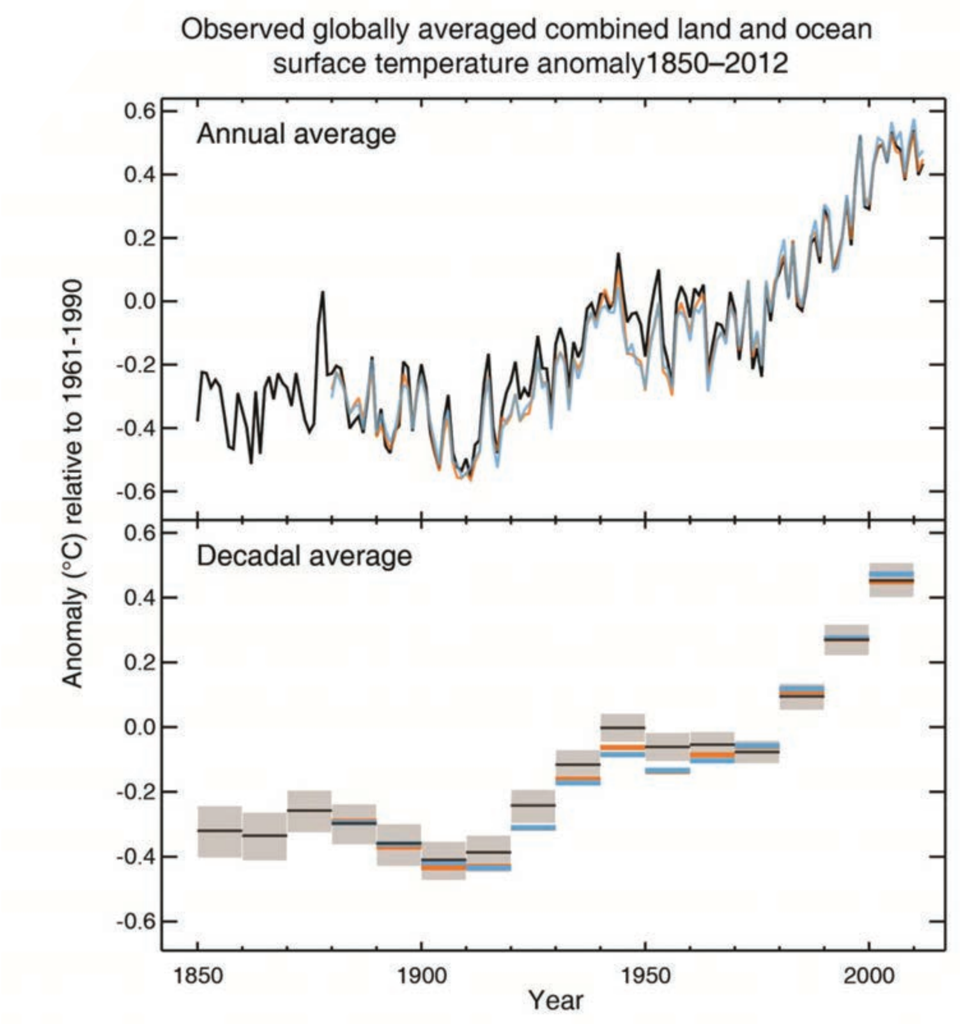


Figure 1 (more detail): Observed global average combined land and ocean temperature anomalies from three surface data sets (black—HadCRUT4, yellow—MLOST, blue—GISS). Top panel: annual average values, bottom panel: decadal average values including the estimate of uncertainty for HadCRUT4. Anomalies are relative to the mean of 1961–1990.

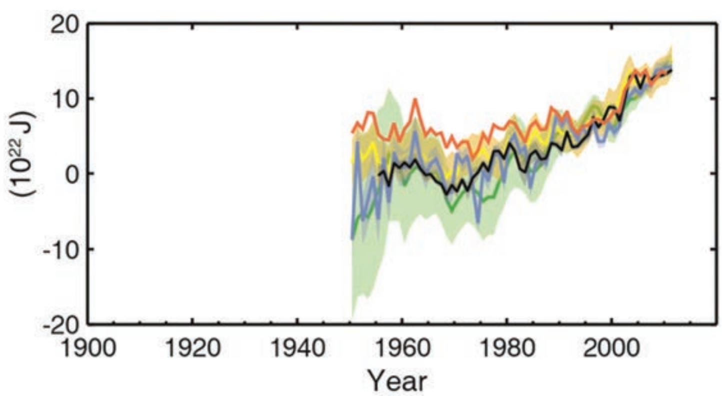


Figure 2: Change in global average upper ocean heat content normalised to 2006–2010, and relative to the average of all datasets for 1971.

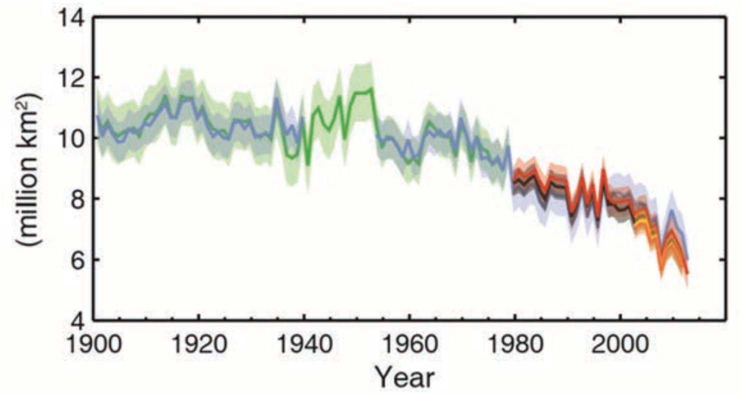


Figure 3: Arctic July-August-September average sea ice extent.

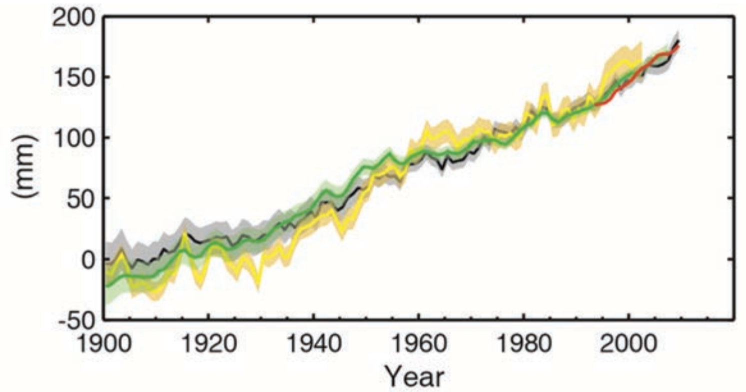


Figure 4: Global average sea level relative to the 1900–1905 average of the longest running dataset, and with all datasets aligned to have the same value in 1993, the first year of satellite altimetry data. All time-series (coloured lines) show annual values and, where assessed, uncertainties are indicated by different shades of grey.

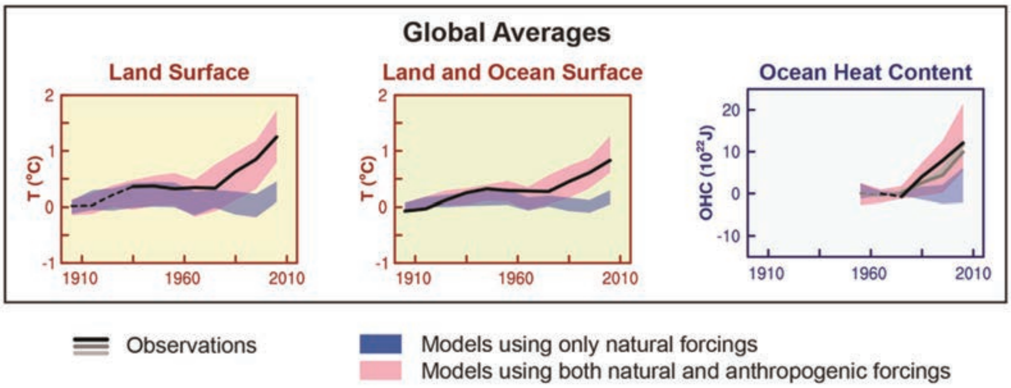


Figure 5: Comparison of observed and simulated climate change based on time series of three large-scale indicators in the atmosphere and the ocean: continental land surface air temperature (left panel); combined land and ocean surface air temperature (middle panel); and ocean heat uptake (right panel). All are global averages. All time-series are decadal averages, plotted at the centre of the decade. For the land surface temperature panel, the observation is a dashed line at the left because the spatial coverage of the area being examined is less than 50%. For the ocean heat content panel, the dashed observation line indicates a period where data coverage is only adequate, and this uncertainty is larger. Model results shown are CMIP5 multi-model averages and ensemble ranges, with shaded bands indicating the 5 to 95% confidence intervals.

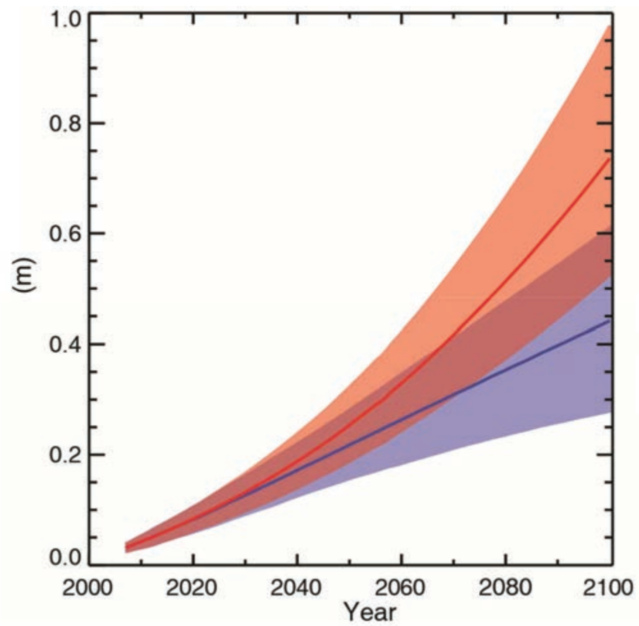


Figure 6: Projections of global average sea level change over the 21st century relative to 1986–2005 from the combination of CMIP5 and process-based models, for the two emissions scenarios RCP2.6 and RCP8.5. The assessed likely range is shown as a shaded band. The assessed likely ranges for the average over the period 2081–2100 for all RCP scenarios are given as coloured vertical bars, with the corresponding average value given as a horizontal line.

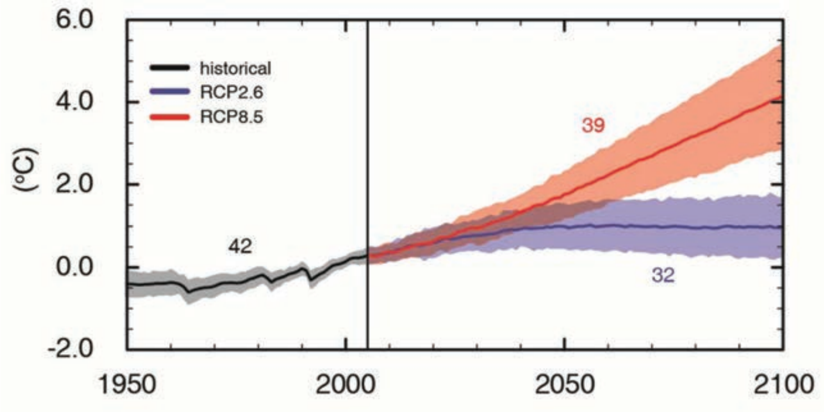


Figure 7: CMIP5 multi-model simulated time-series from 1950 to 2100 for change in global annual average surface temperature relative to 1986–2005. To convert the projections to a pre-industrial baseline, add 0.61°C. Time series of projections and a measure of uncertainty (shading, minimum-maximum range) are shown for scenarios RCP2.6 (blue) and RCP8.5 (red). Black (grey shading) is the modelled historical evolution using historical reconstructed forcings. The average and associated uncertainties averaged over 2081-2100 are given for all RCP scenarios as coloured vertical bars. The numbers of CMIP5 models used to calculate the multi-model average is indicated.

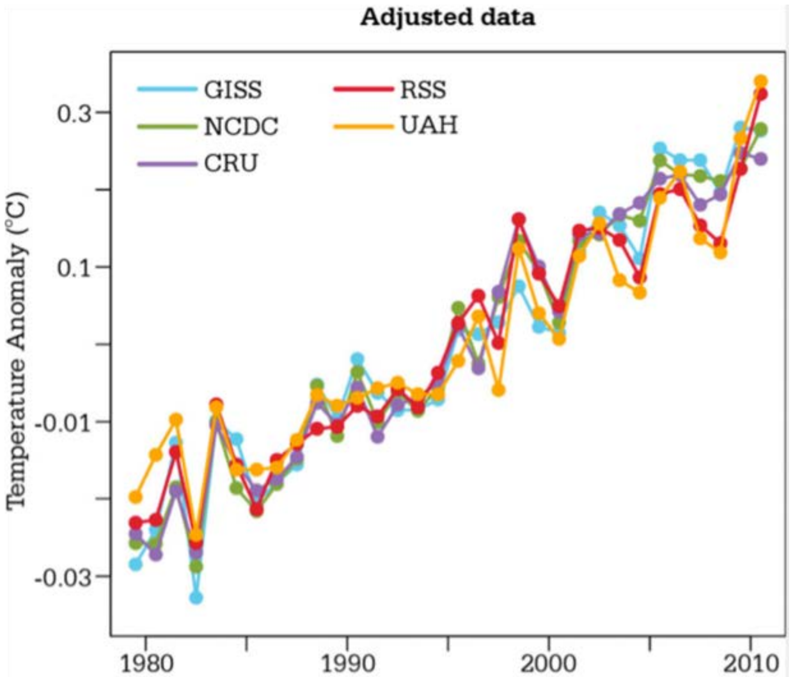


Figure 8: Temperature data from different sources (GISS: NASA Goddard Institute for Space Studies; NCDC: NOAA National Climate Data Center; CRU: Hadley Centre/ Climate Research Unit UK; RSS: data from Remote Sensing Systems; UAH: University of Alabama at Huntsville) corrected for short-term temperature variability (variation in solar intensity, aerosols from volcanoes, and variation in phases of the El Niño-Southern Oscillation phenomenon). Source: Foster, G. and Rahmstorf, S. (2011). Global temperature evolution 1979–2010. Environmental Research Letters. doi: 10.1088/1748-9326/6/4/044022

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