Australian Government

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CLIMATE CHANGE Q&A

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What is the Intergovernmental Panel on Climate Change (IPCC) Report?

The IPCC is a global intergovernmental body examining climate science. On 27 September 2013 it released the first part of its three-part Fifth Assessment Report (AR5), which comes six years after the fourth assessment report (AR4).

The first part of AR5 — Working Group I (WGI) — reviews the scientific literature on the physical basis of climate change. The second part — WGII — scheduled to be released in March 2014, will review impacts, adaptation, and vulnerabilities to climate change. The third part — WGIII — will review mitigation, and is scheduled to be released in April 2014.

There were 209 Lead Authors and 50 Review Editors working on the WGI report. More than 600 additional experts were invited to be Contributing Authors and to provide additional specific knowledge or expertise in a given area. The WGI contribution was also reviewed by 1,089 experts and 38 governments in a multi-stage process drawing a total of 54,677 comments.

Australian authors feature prominently in all the Assessment Reports with 40 Australian authors from universities, the Bureau of Meteorology and the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and other research organisations currently engaged in the AR5.

To provide policy makers with the most up-to-date climate change evidence, the report includes the assessment of an additional 9,200 scientific publications since AR4.

Is the information presented in AR5 different from AR4?

The AR5 WGI report strengthens confidence in the work presented in AR4, which concluded that global warming is occurring, and that human activity is a chief contributor to this change.

The report puts past, current and future greenhouse gas (GHG) emissions in a context of an overall 'budget' of emissions that can be 'expended' before running the risk of pushing global warming beyond a threshold thought to represent 'dangerous' warming.

The threshold adopted by the international community to avoid 'dangerous' warming is 2 degrees Celsius above 'pre-industrial' average global temperatures.

The report includes chapters on sea level change, the carbon cycle and climate phenomena such as monsoons, and the El Niño and La Niña events associated with the El Niño-Southern Oscillation (ENSO) changes to tropical climate.

The report confirms that multi-year Arctic sea ice minimum has shrunk by about 10 per cent per decade on average since 1979.[1]

The report shows that scientists are now able to account for the causes of sea level rise more accurately due to updated estimates of increasing ocean heat content, which causes water to expand, and ice sheet melting, which transfers water from ice on land to the ocean.[2]

How much energy is trapped by the extra greenhouse gases added to the atmosphere?

The Earth receives solar energy from the sun. Part of that energy is immediately reflected into space by clouds, snow and other reflective surfaces. The remaining solar energy heats up ocean and land surfaces.

The Earth in turn emits energy in the form of infrared radiation — a form of heat. Some of that outgoing energy is absorbed by greenhouse gases (GHGs), and is re-emitted into the Earth's atmosphere and warms the Earth's surface enough for liquid water, and life to exist. Without this effect the Earth's average temperature would be minus 18 degrees Celsius.

The incoming (solar) and outgoing (infrared) energy is balanced, allowing the maintenance of temperatures amenable for human life.

GHGs added to the atmosphere as a result of industrial activity and land-use practices absorb approximately an extra 1.3 per cent of the outgoing energy the Earth must emit to balance incoming solar energy. It is this extra energy that is not being emitted into space, but is rather re-emitted back to Earth, that is causing the atmosphere, oceans, land and ice to warm.

This global warming is slightly reduced by the addition of sulphate aerosols to the atmosphere from fossil-fuel burning and volcanoes. These aerosol particles block a small percentage of the incoming sunlight.[3]

How much CO_2 have humans added to the atmosphere?

Since ~1750 – beginning of the Industrial Era (measured in air bubbles in ice cores)[4]	~2 trillion tonnes CO_2[5]
Since 1958 – precise records of CO_2 emissions began at Mauna Loa, Hawaii	~1 trillion tonnes CO_2[6]

The IPCC report says the warming trend in air temperature has slowed over the past 15 years, so how can scientists claim that the last decade is the hottest on record?

The distinction to bear in mind is the difference in timescale: what happens within the 15-year period — short-term variability — versus what happens from decade to decade.

From 1998 through 2012 there has been slower warming. However, decade-on-decade warming has not stopped (Figure 1).

Each successive decade from 1963-1972 to the present is warmer than the previous decade.

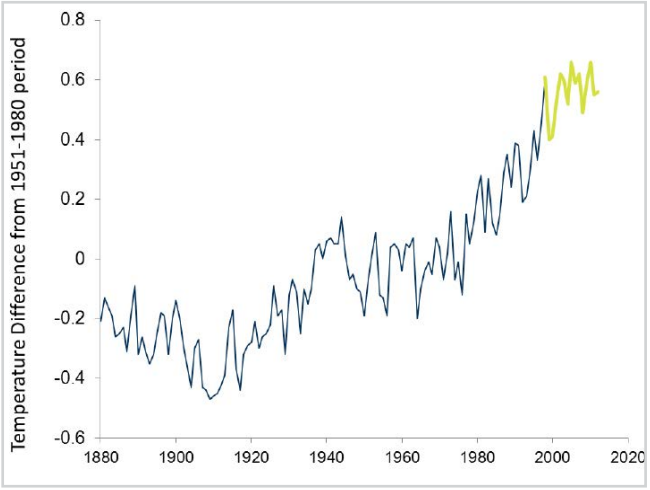

Figure 1. *Variation in mean annual surface temperatures, compared to the 1951 - 1980 period (degrees Celsius) from 1880 through 1997(blue) and from 1998 through 2012 (green).*

Source: NASA

Why do media reports and some scientific papers refer to a 'warming hiatus' or 'pause'?

The terms 'hiatus' and 'pause' refer to the fact that from 1998 to 2012 warming was slower than the overall rate of warming since the 1960s.

The continued input of GHGs during the period from 1998 to 2012 suggests that, all else being equal, surface temperature should have continued to rise. However, other factors, apart from GHGs, influence the climate system on year-to-year and even decadal time scales. These include:

- Changes in the sun's energy output. The Earth has been experiencing a solar minimum from a peak in activity in 2000 to the present.[3] Solar minima mean that less energy is released by the sun and therefore less energy is entering the Earth's atmosphere.[3]
- Increased aerosol and dust from human and natural sources reflecting more incoming solar energy back into space may also have led to lower temperatures during this period. Examples include an increase in sulphate aerosols from coal burning.[7]
- Cycles within the ocean-atmosphere system such as the La Niña phase of ENSO, which redistribute heat within the climate system, for example into the deep ocean.[8]

Changes in deep ocean heat content may account for the 'hiatus' in warming due to the fact that ~90 per cent of the extra heat put into the climate system by GHGs has been stored in the ocean.

The fact that the temperature in the deep ocean has increased, while the rate of surface warming has slowed during the past 15 years may be related to La Niña. The wind patterns associated with La Niña cause cooler sea-surface temperature in the eastern tropical Pacific Ocean, which has a large influence on average global surface temperature. Those wind patterns also shift the distribution of heat in the ocean by 'driving' heat into the deeper layers of the ocean.

Models suggest that the strong La Niña episodes of the past 15 years may have slowed the warming of the global atmosphere, and accelerated the transfer of heat into the deep ocean.

Does the slower rise in temperature over the past 15 years mean the Earth is actually cooling now?

Even though the rate of warming in the atmosphere has slowed during the past decade, there are other very strong signs that global warming is continuing. These include:

- Warming of the oceans has not slowed and this is where most of the extra heat in the climate system is accumulating. [9]
- The major land ice sheets in Greenland and Antarctica, and Arctic sea ice continue to melt. [10]

Does the slower rise in temperature over the past 15 years point to an error in climate science?

The many factors influencing climate are part of our evolving understanding of the climate system and its complexity.

A number of natural processes in the atmosphere, influence the climate system, but many are difficult to capture in computer models and future projections:

- El Niño and La Niña operate on yearly to decadal time scales and cannot presently be completely captured by computer models.
- Solar and volcanic activity also influence the climate, but are difficult (solar output) or impossible (volcanoes) to predict and therefore to incorporate into climate projections.

Does the slower rise in temperature over the past 15 years challenge the theory that humans are having an impact on climate?

Global warming has patterns, in space and time, consistent with increased emissions of GHGs into the atmosphere. The patterns are not consistent with the warming that would be caused by other processes, such as increases in solar output or decreased emission of volcanic ash.

AR5 updates multiple lines of evidence — warming ocean, melting ice, decreasing snow cover, and warming permafrost — that the climate system is exhibiting warming in a pattern that points to human influence. These lines of evidence are part of the reason for the increased confidence in the theory expressed by the 2013 AR5 report that humans are having an impact on climate, relative to the 2007 AR4.

If the climate system is influenced by naturally occurring variations beyond our control, how can changing human behaviour have any impact?

There are both natural and human effects on the climate system. We cannot alter the natural effects on the climate system, but we can control human impacts on climate. We can slow the rate of emissions of GHGs into the atmosphere.

References

A full list of references is available at www.chiefscientist.gov.au

For the full IPCC AR5 WGI report see http://www.ipcc.ch/report/ar5/wg1/

For an overview of climate change see the Office of the Chief Scientist's Occasional Paper 8: *Climate Change: The Story so Far*, available at www.chiefscientist.gov.au