

Has climate change stopped?



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From 1998 to 2013, the average temperature at the Earth's surface appeared to rise more slowly than in the previous few decades. This gave rise to the claim that global warming had stopped.

However, new evidence casts doubt on whether the 'pause', or 'slowdown', really existed. What's more, global warming is just one aspect of climate change; and none of the others, such as sea level rise, glacier melt or ocean temperature rise, show any sign of slowing down. More recently, each of the last three years has set a new record for global temperatures.



An ocean buoy measuring air temperature at the sea surface. Image: Wikipedia

What the record shows

Since records began in 1850, there has been a long-term trend of rising average global temperature. However, until recently scientists agreed that from 1998-2013, warming occurred at a slower rate than in previous decades. In 2013, the [Intergovernmental Panel on Climate Change](#) (IPCC) concluded that the most likely rate of warming from 1998 to 2012 was 0.05°C per decade, compared with an average of 0.12°C per decade between 1951 and 2012.

So what does this mean?

Due to natural short-term variability in the climate system, trends over short time periods are very sensitive to beginning and end dates. The choice of 1998 as the starting year for this analysis is controversial, because a [very strong El Niño event](#) made 1998 exceptionally warm. So analyses that begin in 1998 are inherently more likely to produce signs of a 'slowdown' than those beginning in the years either side.

Climatic variability also makes it difficult to draw meaningful trends over periods as short as 15 years. For example, the [global temperature record](#) shows periods of several decades when temperatures did not rise significantly, or even fell slightly. For example, cooling from the 1940s to the 1970s [was influenced](#) by rapid industrialisation following World War Two, resulting in [substantial increases](#) in the release of cooling aerosols, as well as natural climate variability.

Although a number of small volcanic eruptions and a tiny reduction in solar output may have contributed to the modern 'slowdown', scientists struggled to explain why the temperature appeared to rise more slowly during a

period when greenhouse gas concentrations were increasing substantially.

The [most prevalent theory](#) was that a greater proportion of the extra heat trapped in the Earth system by greenhouse gases was going into the ocean, and a smaller proportion into the atmosphere. [As the ocean absorbs and stores more than 90%](#) of the heat trapped by greenhouse gas emissions, it needs only a slight increase in ocean heat uptake to slow atmospheric warming markedly.

New evidence: does the record really show a slowdown?

[A landmark study](#) published in 2015 suggested the slowdown had never really existed, and was an artefact of imperfections in measurement and analysis. Conducted by the US National Oceanic and Atmospheric Administration (NOAA), this study included more comprehensive data from the fast-warming Arctic and an updated record of ocean surface temperatures.

However, a [more recent study](#) showed that between 1998-2013 a 'slowdown' of global warming was still present in the updated temperature records if the aerosol-induced cooling of the 1950s and 1960s is excluded from the reference period. Then in early 2017 came [another major US analysis](#) concluding, again, that the 'pause' was not real, just an artefact of previously imperfect measurements.

Put simply, scientists continue to discuss whether the 'global warming pause' was real, or not.

How will the 'slowdown' story end?

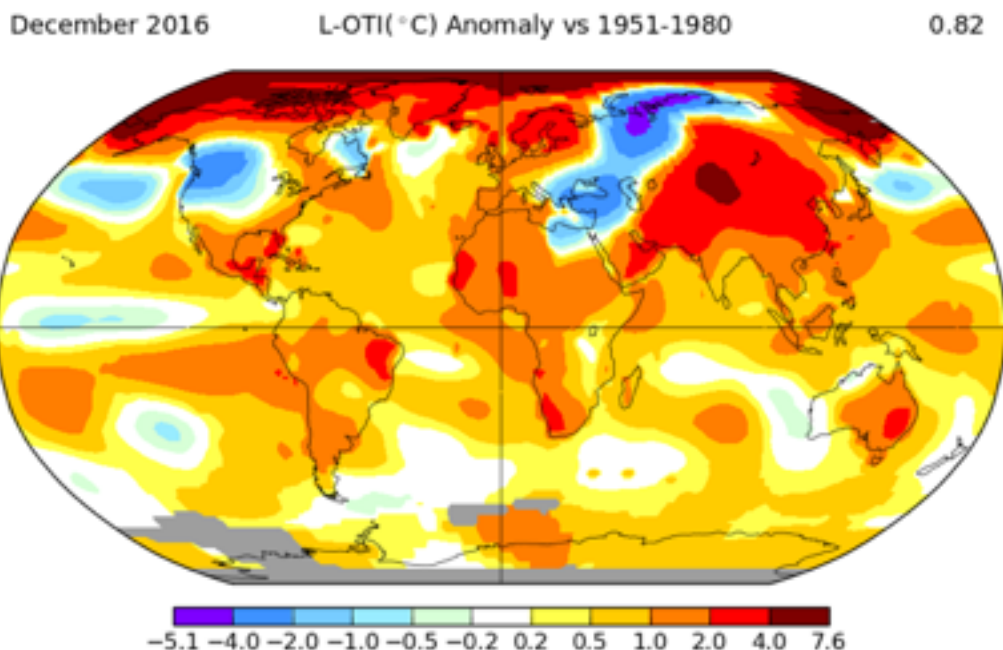
Whatever happened between 1998 and 2013, it is clear from the years since that warming has not stopped. The last three years (2014, [2015](#), [2016](#)) successively broke the record for the hottest year. Sixteen of the hottest 17 years on record have occurred since 2001. Recent NASA data suggests global warming since pre-industrial times is now more than 1°C.

Furthermore, there has been no 'pause' or 'slowdown' in the [rate at which greenhouse gas concentrations in the atmosphere are rising](#). All else being equal, rising greenhouse gas

concentrations are expected to cause increasing degrees of warming.

Perhaps the most important point, though, is that climate change involves far more than a rise in the Earth's surface temperature. The [ocean continues to warm, sea level continues to rise, ice continues to melt](#) – sea ice and permafrost in the Arctic, parts of the Antarctic icecap, and mountain glaciers. [Species continue to migrate](#) away from the Equator towards the poles.

All of these trends indicate that climate change continues, even though warming at the Earth's surface may have slowed to a certain extent for a certain period.



Temperature anomaly (difference) for December 2016 compared with the 1951-1980 baseline. Image: NASA GISS