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Letter to Senator Nick Minchin in response to his denial of climate change, March 2011:

Dear Senator Minchin,

I hear that you believe global warming and consequent climate change are no longer a concern because the world has not warmed in the last 10 years. If you will spare me the time to read this, I hope to prove to you that you are misinformed on both counts.

Has the warming stopped?

Looking at the graph for the last 130 years¹, several things are immediately obvious:

1. A marked upward trend
2. An acceleration in the trend in the second half, despite a pause - even a slight cooling - from 1945 to 1975.
3. A sample of only ten consecutive years is too short to be meaningful - it gives completely different results according to which decade you take.

How should one decide a minimum period worth interpreting? Here's one way. Over any consecutive few years you can see that the jitter is around 0.3 degrees. Since the average rate over the 100 years is 0.0075 deg/year, anything less than 40 years has to be questionable. (With proper statistical analysis you might bring it down to maybe 20 years, but you can see the principle.)

It's like watching waves on a beach: one minute's observation will not reliably tell you which way the tide is going.

This is enough to prove that even if the world had not warmed in the last ten years that would not be a reasonable basis for claiming that global warming is no longer an issue.

Moreover, any climate pundit who attempts to use the record since 2000 as evidence that warming has stopped immediately loses credibility.

That said, let's take a look at what *has* happened in the last ten years. Because of the jitter, you can make it look very different by picking precisely which start and end years you take. 1998 was unusually warm, well above the 1970-2000 trend. But 1999 was somewhat unusually cool. One way to be fair is to use sliding averages. One downside is that you lose the endpoints - we can't do an average for 2009 yet because we don't have the 2011 data. This means "last ten years" becomes 1999-2008. Lest anyone object that 1999 was unusually cool, let's make it 1997-2008 instead. Here's the result:

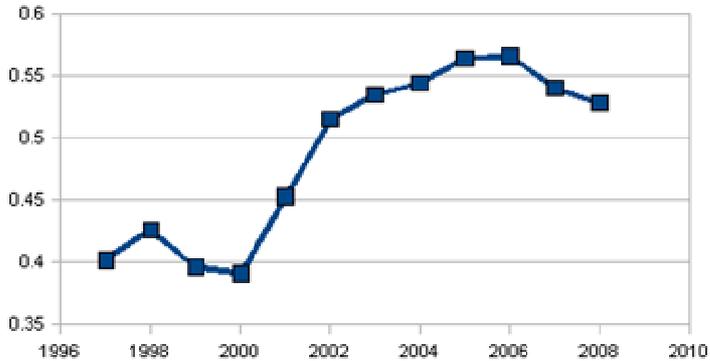


Illustration 1: Global surface temperature anomaly, weighted sliding average 1-4-6-4-1

Doesn't look like "no warming in last ten years" does it? At best, it is a *slowing down of the rate of increase*.

Will it speed up again?

It would help if we could find causes of the jitter and factor these out to produce clearer trends. And since climate theory says the increasing CO₂ should warm the planet, we should hope to find some cause for the slowing, even if it is only temporary. Indeed, the overall rise in the last 100 years is less than theory says the increase in CO₂ should have produced.

Here are some leading possibilities:

- *Reduced solar output*

We know that the sun varies over a cycle of roughly eleven years. Indeed, many denialists have tried to invoke increased heat from the sun to explain the warming, though at most that can explain some of the jitter². *The consensus is a swing of 0.1 degrees*³. The last peak was around 2000, and it has only just started to pull out of the minimum⁴. If this were having any detectable effect on the graph of the last ten years, it would explain some of the slowing.

- *Other atmospheric influences*

The atmosphere is a complex beast. It would only take a little stratospheric drying⁵, for example, to produce a noticeable cooling, and there are many more exotic chemicals in play. Sulphur emissions cool. If there's an explanation along these lines then it is no cause for complacency since, without geoengineering, it is *unlikely to persist, let alone keep getting stronger*.

- *Hidden warming*

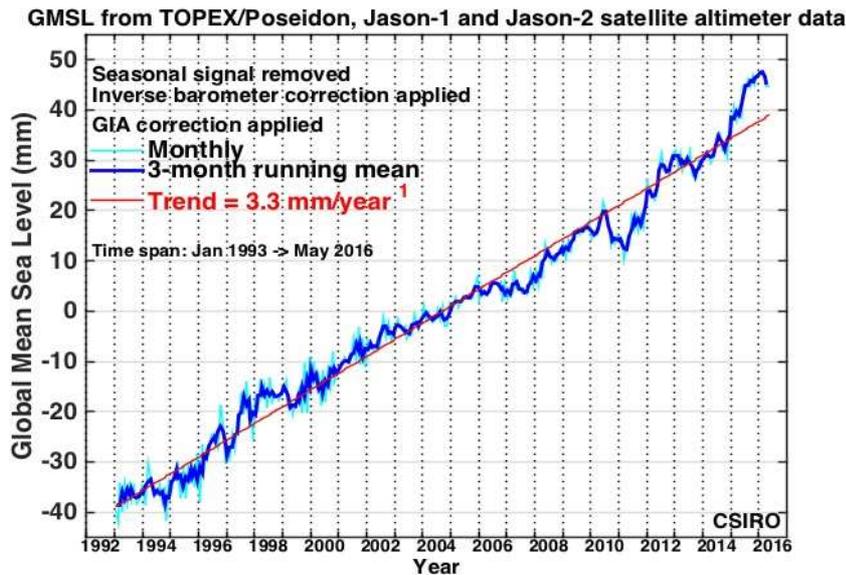
There is a bit of a trap in the term "global warming". It should perhaps be called global heating. When you apply heat to an ice-water mixture it does not get warmer in the sense of increased temperature. The absorbed heat turns some of the ice into water, the temperature staying at 0C.

This can be much harder to measure than surface temperature. Latest research indicates the *ice caps are melting faster than we thought*⁶.

Other hiding places are the deep ocean and under the icesheets. It's hard to measure temperature in such places, so the sampling may be inadequate.

Since melting ice and warming oceans both contribute to (and are the only known persistent causes of) sea level rise, that can be used as a proxy. We have good data for the last twenty years, and the trend is extremely clear^{7,8}. See the graphs below.

Researchers are also finding that *transfer of heat into the depths of icesheets is faster than had been thought*⁹.



- *Changed weather patterns*

As warming occurs, weather patterns can change. This may exacerbate the effects in some places, ameliorate them in others. It may serve as either a positive or negative feedback to global warming itself. Such a negative feedback could be responsible for the slowing in the last decade. But without understanding the mechanism, we've no way to know whether this is just a temporary respite.

So will it speed up again? *We've no reason to suppose it will not, and it always has done after similar slowings in the last 100 years.*

Suppose we'd been having this debate in 1970. The record to then much more strongly supported the notion that the warming had stopped, but look at what's happened since.

1<http://data.giss.nasa.gov/gistemp/graphs/>

2Houghton, J.T. ; Ding, Y.; Griggs, D.J. et al., eds (2001). "6.11 Total Solar Irradiance- Figure 6.6: Global, annual mean radiative forcings (1750 to present)". *Climate Change 2001: Working Group I: The Scientific Basis*. Intergovernmental Panel on Climate Change . http://www.grida.no/climate/ipcc_tar/wg1/fig6-6.htm.

3<http://www.fel.duke.edu/~scafetta/pdf/2005GL023849.pdf>

4<http://solarscience.msfc.nasa.gov/predict.shtml>

5<http://www.npr.org/templates/story/story.php?storyId=123075836>

6<http://www.enn.com/climate/article/42448>

7http://www.cmar.csiro.au/sealevel/sl_hist_last_15.html

8<http://www.aviso.oceanobs.com/en/news/ocean-indicators/mean-sea-level/products-images/index.html>

9<http://www.usnews.com/science/articles/2010/11/05/water-flowing-through-ice-sheets-accelerates-warming-could-speed-up-ice-flow-says-new-study>