Human activity continues to warm the planet over the past 16 years

What The Science Says:
Short term surface temperature trends are strongly influenced by natural and other factors which may mask the slow but inexorable anthropogenic warming trend. However the total energy of the climate system continues to increase.

Climate Myth: No warming in 16 years

"...there has been no increase in the global average surface temperature for the past 16 years" (Judith Curry and David Rose)

Update 26/05/2013: The '16 years' video, originally linked from this article, is not representative of the scientific consensus. In fact the short term trends are rather more complicated. The problem is explained in more detail in this article.

Humans have continued to contribute to the greenhouse warming of the planet over the past 16 years. The myth arises from two misconceptions. Firstly, it ignores the fact that short term temperature trends are strongly influenced by a variety of natural factors and observational limitations which must be analyzed to isolate the human contribution. Secondly it focuses on one small part of the climate system (the atmosphere) while ignoring the largest part (the oceans). We will address each of these errors in turn.

Can we isolate the human contribution to the 16 year trend?

Climate scientists have traditionally looked at climate over long periods - 30 years or more. However the media obsession with short term trends has focussed attention on the past 15-16 years. Short term trends are much more complex because they can be affected by many factors which cancel out over longer periods. In a recent interview James Hansen noted *"If you look over a 30-40 year period the expected warming is two-tenths of a degree per decade, but that doesn't mean each decade is going to warm two-tenths of a degree: there is too much natural variability"*.

The list of factors which can affect short term temperature trends is extensive, and some of them can rival the global warming signal in magnitude over short periods. They can be divided into 3 categories: observational biases, natural influences and human influences.

Observational biases

1. Coverage bias. The HadCRUT4 and NOAA temperature records don't cover the whole planet. Omitting the Arctic in particular produces a cool bias in recent temperatures. (e.g. Hansen et al 2006, Folland et al 2013). The video avoided this problem by using GISTEMP. However the issue affects the Foster and Rahmstorf analysis of the other records.

2. Sea surface temperature bias. The GISTEMP and NOAA temperature records don't include corrections for the transition from warm-biased engine room measurements to buoy measurements over the past 15 years. This produces a cool bias in recent temperature trends, although this result is based on only one study (Kennedy et al 2012).

Natural influences

1. Volcanic eruptions. The recovery from the Pinatubo eruption is responsible for a short term warming.

GCMs predict that this is a significant contribution to recent warming. However Neely et al (2013) find evidence of a significant cooling contribution from recent volcanoes.

2. The El Nino oscillation. The recent run of La Niñas produces a moderate cooling effect.
3. The solar cycle. The current low solar activity produces a small cooling effect.
4. Longer term oscillations, including the AMO and PDO.
5. Changes in ocean heat uptake. A number of recent papers have found evidence that heat has been going into the oceans rather than the atmosphere recently, see in particular Balmaseda et al (2013), Guemas et al (2013), Nuccitelli et al (2012) and Levitus et al (2012) (and also used in Otto et al, 2013).

Human influences

An increase in other industrial emissions. Unlike long-lived greenhouse gasses such as CO2, short-lived atmospheric constituents can cause significant short term fluctuations in the rate of warming. Chinese aerosol emissions have varied significantly over the past 16 years (Klimont et al 2013). Murphy (2013) finds that the direct cooling effect of these emissions has been limited, however secondary effects on clouds are still uncertain.

Implications

In order to reliably detect a change in the underlying rate of warming, it is necessary to separate out all of these contributions. While attempts have been made at this calculation, (for example Lean and Rind 2008 and Foster and Rahmstorf 2011), there remain significant uncertainties, for example in the duration of the volcanic response and the contribution of recent volcanoes.

The fundamental mechanism of global warming is a change in the top-of-atmosphere energy balance, and as a result the energy content of the climate system provides a more direct measure of global warming which avoids many of these problems, although the observational record is shorter and less complete (e.g. Church et al 2011).

The rest of the climate system

Focusing on surface air temperatures also misses more than 90% of the overall warming of the planet (Figure 2).

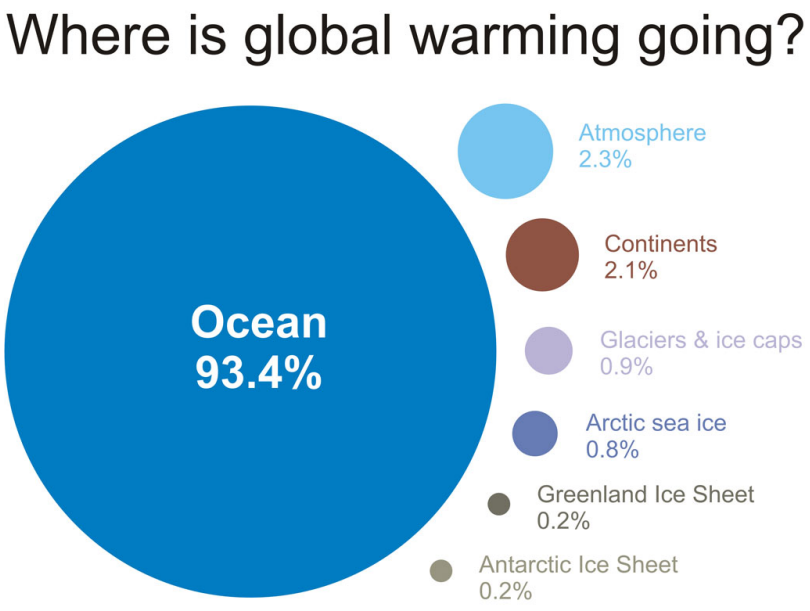

Figure 2: Components of global warming for the period 1993 to 2003 calculated from IPCC AR4 5.2.2.3.

Nuccitelli et al. (2012) considered the warming of the oceans (both shallow and deep), land, atmosphere, and ice, and showed that global warming has not slowed in recent years (Figure 3).

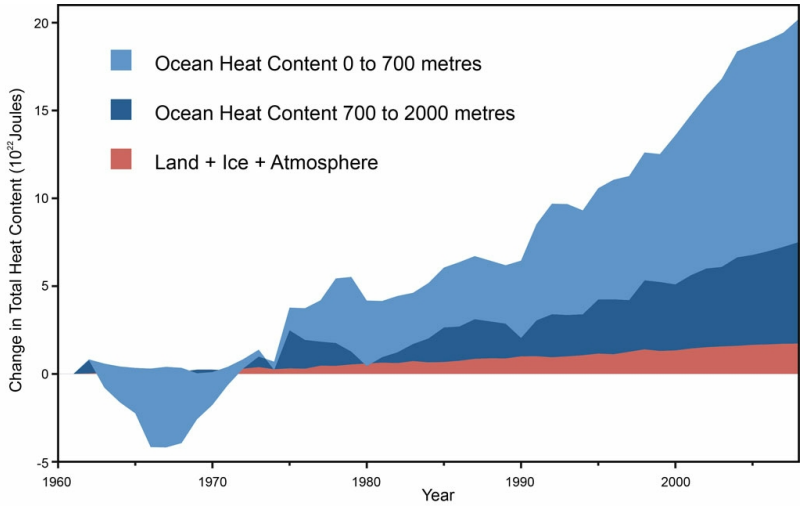

Figure 3: Land, atmosphere, and ice heating (red), 0-700 meter OHC increase (light blue), 700-2,000 meter OHC increase (dark blue). From Nuccitelli et al. (2012).

References

- Foster and Rahmstorf (2011), *Global temperature evolution 1979–2010* doi:10.1088/1748-9326/6/4/044022
- Nuccitelli et al. (2012) *Comment on Ocean heat content and Earth's radiation imbalance. II. Relation to climate shifts* doi:10.1016/j.physleta.2012.10.010

Advanced rebuttal written by Kevin C

Update July 2015:

Here is a related lecture-video from Denial101x - Making Sense of Climate Science Denial

[*see video at **this link**.*]

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arget="_blank">Schneider et al. 2019.

The modelling shows how oceanic stratocumulus decks become unstable and break up into scattered cumulus clouds. That occurs at greenhouse gas levels of around 1,200 ppm (fig. 2). When that happens, the ocean surface below the clouds warms abruptly because the cloud shading is so diminished. In the model, the extra solar energy absorbed as stratocumulus decks break up, over an area estimated to cover about 6.5% of the globe, is enough to cause a further ~8^{o}C of global warming. After the stratocumulus decks have broken up, they only re-form once CO_2 levels have dropped substantially below the level at which the instability first occurred.

These results point to the possibility that there is a previously undiscovered, potentially strong and nonlinear feedback, lurking within the climate system. These findings may well help to solve certain palaeoclimatic problems, such as the super-Hothouse climate of the Palaeocene-Eocene, some 50 million years ago. It's been hard to fully explain that event, given that estimates of CO_2 levels at the time do not exceed 2,000 ppm. Present climate models do not reach that level of warmth with that amount of CO_2. But the fossil record presents hard evidence for near-tropical conditions in which crocodilians thrived - in the Arctic. Something brought about that climate shift!

The quantitative aspects of stratocumulus cloud-deck instability remain under investigation. However the phenomenon appears to be robust for the physical reasons described by Schneider and co-authors. Closer to the present, the recent acceleration of global warming may be partly due to a decrease in aerosols. Aerosols produce smaller and more numerous cloud droplets. These have the effect of increasing the reflectivity and hence albedo of low cloud-tops (fig. 3). It follows that if aerosol levels decrease, the reverse will be the case. Of considerable relevance here are the limits on the sulphur content of ship fuels, imposed

by the International Maritime Organization in early 2015. These regulations were further tightened in 2020. An ongoing fall in aerosol pollution, right under the marine stratocumulus decks, would be expected to occur. As a consequence, the size and amount of cloud droplets would change, cloud top albedo would decrease and there would be increased absorption of solar energy by Earth. That would be on top of the existing greenhouse gas-caused global warming. James Hansen discussed this in a recent communication (PDF) here.

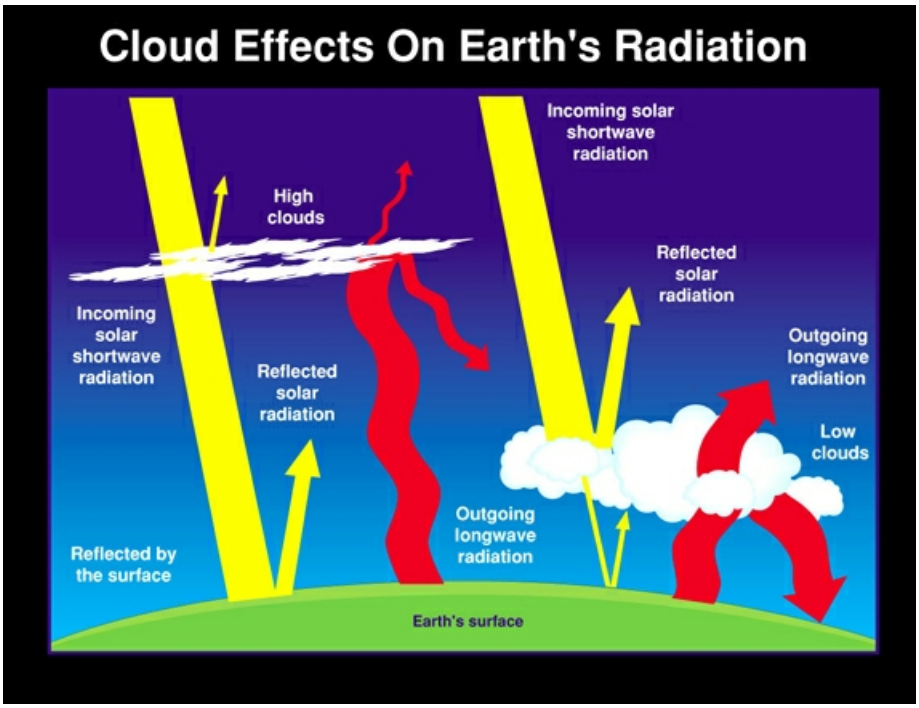

Fig. 3: NASA graphic depicting the relationship between clouds, incoming Solar radiation and long-wave Infrared (IR) radiation. High clouds composed of ice crystals reflect little sunlight but absorb and emit a significant amount of IR. Conversely low clouds, composed of water droplets, reflect a great deal of sunlight and also absorb and emit IR. Any mechanism that reduces low cloud-top albedo will therefore increase the sunlight reaching the surface, causing additional warming.

In their Sixth Assessment Report, the IPCC also points out that the concentration of aerosols in the atmosphere has markedly increased since the pre-industrial era. As a consequence, clouds now reflect more incoming Solar energy than before industrial times. In other words, aerosols released by human activities have had a cooling effect. That cooling effect has countered a lot of the warming caused by increases in greenhouse gas emissions over the last century. Nevertheless, they also state that this counter-effect is expected to diminish in the future. As air pollution controls are adopted worldwide, there will be a reduction in the amount of aerosols released into the atmosphere. Therefore, cloud-top albedo is expected to diminish. Hansen merely suggests this albedo-reduction may already be underway.

Skeptical Science explains the science of global warming and examines climate misinformation through the lens of peer-reviewed research. The website won the Australian Museum 2011 Eureka Prize for the Advancement of Climate Change Knowledge. Members of the Skeptical Science team have authored peer-reviewed papers, a college textbook on climate change and the book Climate Change Denial: Heads in the Sand. Skeptical Science content has been used in university courses, textbooks, government reports on climate change, television documentaries and numerous books.