This is the print version of the Skeptical Science article 'Trenberth can't account for the lack of warming', which can be found at http://sks.to/trenberth.

Trenberth talks about energy flows and global warming

What The Science Says:
Trenberth's views are clarified in the paper "An imperative for climate change planning: tracking Earth's global energy". We know the planet is continually heating due to increasing carbon dioxide but that surface temperature sometimes have short term cooling periods. This is due to internal variability and Trenberth was lamenting that our observation systems can't comprehensively track all the energy flow through the climate system.

Climate Myth: Trenberth can't account for the lack of warming
in one e-mail, a top "warmist" researcher admits it's a "travesty" that "we can't account for the lack of warming at the moment." As it happens, the writer of that October 2009 e-mail —Kevin Trenberth, a lead author of the warmist bible, the 2007 Intergovernmental Panel on Climate Change (IPCC) report—told Congress two years ago that evidence for manmade warming is "unequivocal." He claimed "the planet is running a 'fever' and the prognosis is that it is apt to get much worse." But Trenberth's "lack of warming at the moment" has been going on at least a decade. (Michael Fumento)

This has been most commonly interpreted (among skeptics) as climate scientists secretly admitting amongst themselves that global warming really has stopped. Is this what Trenberth is saying? If one takes a little time to understand the science that Trenberth is discussing, his meaning becomes clear.

If you read the full email, you learn that Trenberth is actually informing fellow climate scientists about a paper he'd recently published, An imperative for climate change planning: tracking Earth's global energy (Trenberth 2009). The paper discusses the planet's energy budget - how much net energy is flowing into our climate and where it's going. It also discusses the systems we have in place to track energy flow in and out of our climate system.

Trenberth states unequivocally that our planet is continually heating due to increasing carbon dioxide. This energy imbalance was very small 40 years ago but has steadily increased to around 0.9 W/m^2 over the 2000 to 2005 period, as observed by satellites. Preliminary satellite data indicates the energy imbalance has continued to increase from 2006 to 2008. The net result is that the planet is continuously accumulating heat. Global warming is still happening.

Next, Trenberth wonders with this ever increasing heat, why doesn't surface temperature continuously rise? The standard answer is "natural variability". But such a general answer doesn't explain the actual physical processes involved. If the planet is accumulating heat, the energy must go somewhere. Is it going into melting ice? Is it being sequestered deep in the ocean? Did the 2008 La Niña rearrange the configuration of ocean heat? Is it all of the above? Trenberth wants answers!

So like an obsessive accountant, Trenberth pores over the energy budget, tallying up the joules accumulating in various parts of the climate. A global energy imbalance of 0.9 W/m^2 means the planet is accumulating 145 x 10^{20} joules per year. The following list gives the amount of energy going into various parts of the climate over the 2004 to 2008 period:

- Land: 2 x 10^{20} joules per year

- Arctic sea Ice: 1 x 10^{20} joules per year
- Ice sheets: 1.4 x 10^{20} joules per year
- Total land ice: between 2 to 3 x 10^{20} joules per year
- Ocean: between 20 to 95 x 10^{20} joules per year
- Sun: 16 x 10^{20} joules per year (eg - the sun has been cooling from 2004 to 2008)

These various contributions total between 45 to 115 x 10^{20} joules per year. This falls well short of the total 145 x 10^{20} joules per year (although the error bars do overlap). Trenberth expresses frustration that observation systems are inadequate to track the flow of energy. It's not that global warming has stopped. We know global warming has continued because satellites find an energy imbalance. It's that our observation systems need to be more accurate in tracking the energy flows through our climate and closing the energy budget.

So what may be causing the discrepancy? As the ocean heat data only goes to 900 metre depth, Trenberth suggests that perhaps heat is being sequestered below 900 metres. There is support for this idea in a later paper von Schuckmann 2009. This paper uses Argo buoy data to calculate ocean heat down to 2000 metres depth. From 2003 to 2008, the world's oceans have been accumulating heat at a rate of 0.77 W/m^2. This higher trend for ocean heat would bring the total energy build-up more in line with satellite measurements of net energy imbalance.

A subsequent study by Balmaseda, Trenberth, and Källén (2013) determined that over the past decade, approximately 30% of ocean warming has occurred in the deeper layers, below 700 meters. This conclusion goes a long way to resolving the 'missing heat' discrepancy. There is still some discrepancy remaining, which could be due to errors in the satellite measurements, the ocean heat content measurements, or both. But the discrepancy is now significantly smaller, and will be addressed in further detail in a follow-up paper by these scientists.

Summary

So to summarise, Trenberth's email says this:

> *"The fact is that we can't account for the lack of warming at the moment and it is a travesty that we can't."*

After reviewing the discussion in Trenberth 2009, it's apparent that what he meant was this:

> *"Global warming is still happening - our planet is still accumulating heat. But our observation systems aren't able to comprehensively keep track of where all the energy is going. Consequently, we can't definitively explain why surface temperatures have gone down in the last few years. That's a travesty!"*

Skeptics use Trenberth's email to characterise climate scientists as secretive and deceptive. However, when one takes the trouble to acquaint oneself with the science, the opposite becomes apparent. Trenberth outlines his views in a clear, open manner, frankly articulating his frustrations at the limitations of observation systems. Trenberth's opinions didn't need to be illegally stolen and leaked onto the internet. They were already publicly available in the peer reviewed literature - and much less open to misinterpretation than a quote-mined email.

Intermediate rebuttal written by dana1981

Update July 2015:

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

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

The Skeptical Science website by Skeptical Science is licensed under a Creative Commons Attribution 3.0 Unported License.

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.

The Skeptical Science website by Skeptical Science is licensed under a Creative CommonsAttribution 3.0 Unported License.