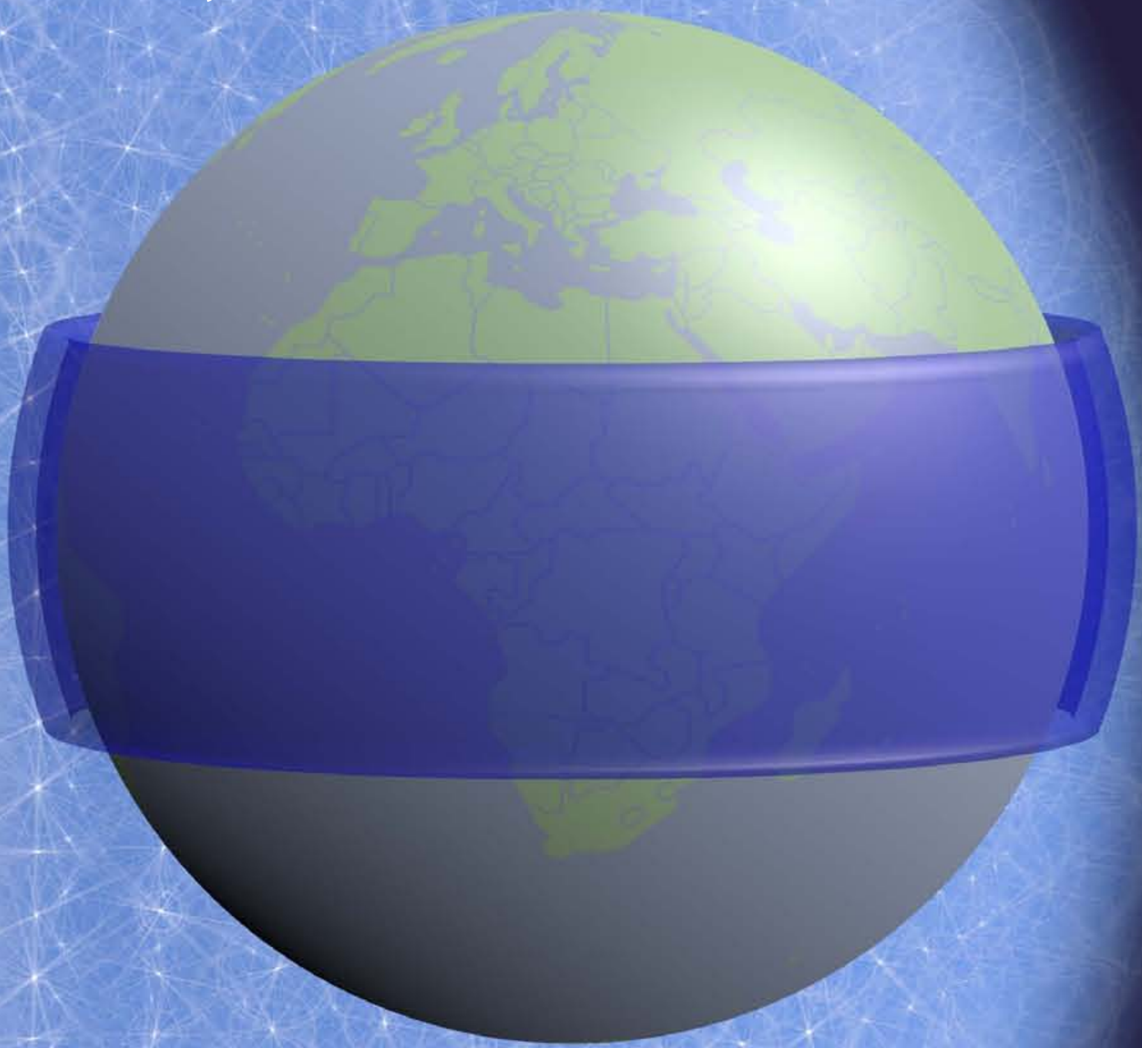
THE TROPICAL SKIES
Falsifying climate alarm

John Christy



The Global Warming Policy Foundation
GWPF Note 17

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About the author

Dr John R. Christy is the director of the Earth System Science Center, Distinguished Professor of Atmospheric Science and Alabama State Climatologist at the University of Alabama in Huntsville, where he has been employed for over 30 years. His responsibilities include managing a science centre with over 80 employees, working on several research projects ranging from developing and launching space-based instruments to studying impacts of significant weather events in developing countries, to high-resolution studies of air pollution (air-chemistry and meteorology). His own research concerns developing, constructing and refining global and regional climate data records that can be used to test claims of climate variability and change and to understand the climate's sensitivity to various forcing factors. This work has resulted in almost 100 peer-reviewed publications.

This paper is based a talk given by Dr Christy at the Palace of Westminster on 8 May 2019.

1 Measuring the greenhouse effect

When I grew up, science was defined as a method of discovering information. You would make a claim or a hypothesis, and then you would test that claim against independent data. If it failed, you rejected your claim and you started over again. In other words your hypothesis was not good information. But nowadays, if someone makes a claim about the climate, and someone like me falsifies it, rather than abandoning the hypothesis, that person tends to just yell louder that their claim is right. They find it difficult to look at what data might say about their beloved hypothesis.

I'm referring to the climate's response to the emission of extra greenhouse gases as a result of our combustion of fossil fuels. In terms of scale – and this is important – we want to know the impact on the climate of an extra 0.5 units of forcing, amongst all the other forcings, some of which are over 100 units each. So we're trying to figure out the signal of an extra 0.5 of a unit amidst these large and variable natural flows of energy.

Figure 1 shows the problem. The sun, in yellow, sends 100 units of energy to Earth per second, with about 70 energy units absorbed: 23 by the atmosphere and 47 by the surface. There are about 750 million units in a column of the atmosphere one square metre in area, so we're talking about small numbers compared to the vast reservoir of these energies.

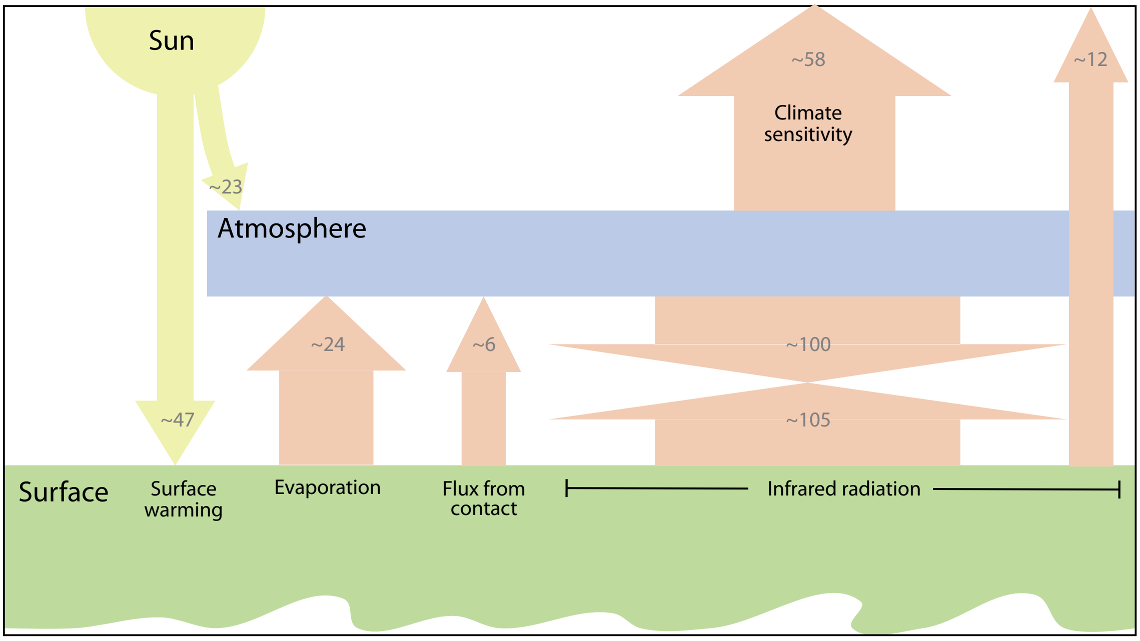


Figure 1: The greenhouse effect

1 unit $\approx$ 3.4 W/m^2. Values per AR5 Fig. 2.11

Energy leaves the surface in a number of ways: evaporation of water or the flux from contact with the air, but infrared radiation is a big one here. The surface sends up about 105 units that the atmosphere absorbs, but the atmosphere sends back about 100 units, so the net exchange between the two is 5 units. About 70 units are emitted back to space, 58 from the atmosphere, and 12 directly from the surface. This is the same number that was absorbed from the sun at the start, so the system is in balance. Note that the surface is in balance too, with the number of incoming units equal to the number outgoing.[1]

The extra carbon dioxide we have added to the atmosphere amounts to about an extra 0.5 of a unit of the 100 downwelling from the air, so we are trying to assess the effect of this small quantity when we have hundreds of units going back and forth, and varying by much more than half a unit over time. In other words, evaporation might be 24 one month, but it might be 26 the next. Radiation from the surface might be 105, or it could be 102. So now you see that 0.5 of a unit is almost in the noise level of what happens.

The climate variable that you want to study – so you can understand where these joules of energy are being deposited and accumulated is the tropospheric temperature. You want to know what that deep atmosphere is doing, because if you are out in space and you tune your eyeball to the thermal energy band and look back at the Earth, you're seeing mostly the atmosphere. That's the metric you want to use, and we'll talk about that in a moment.

Let's just look at the surface now and think of it as a tug of war (Figure 2). On the left you see, in blue, the things that make the surface cooler; in other words, the units of energy that leave the surface. At times they will be bigger than the warming influences, shown on the right, in red. If this happens, then the Earth will cool. But then, a few months later, the red guys pull more, because they have more power. In other words, more energy is absorbed, and there is warming. The diagram is to scale, so you can see that downward infrared radiation is the biggest warming influence on the surface, as well as solar radiation. Now, how big is our half a unit – the tiny figure on the right? We're trying to work out if this little guy even makes a difference in this huge tug of war of energy at the surface.

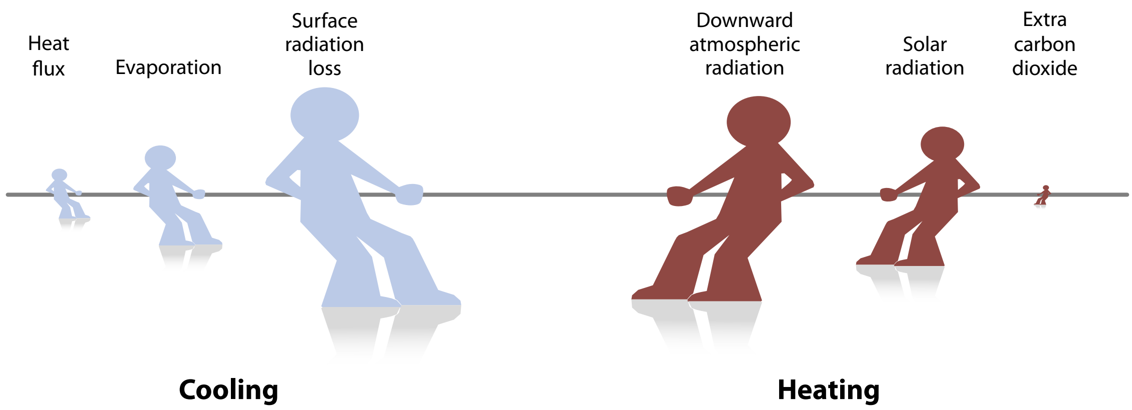


Figure 2: Global warming at the surface is like a tug of war.

2 The importance of the troposphere

So it's a hard problem, and it needs very precise measurements. The problem should be made simpler if you look at the troposphere, from where most of the Earth's heat leaves the planet. By monitoring changes here, we can essentially count the joules of energy in the atmospheric system over time, so it's a direct metric of the greenhouse effect.

[1] Outgoing = 24 + 6 + 105 + 12 = 147. Incoming = 47 + 100 = 147.

With the greenhouse effect, we want to know how many units of energy are being collected, and accumulated in the atmosphere. In 1994, my colleague Dick McNider and I wanted to test the climate models, which at the time had indicated that the warming rate should be 0.35°C per decade. That's what James Hansen's model said, and it's what other models said too. Dick and I didn't think that Hansen's value was likely, and neither did we trust the surface temperature datasets, because there were no measurements for most of the Earth and because what measurements had been collected were 'inhomogeneous'; in other words, they were inconsistently recorded. But we had 15 years of satellite data, and we thought maybe we could do something with that. However, there were problems with the satellite data too. There were volcanic eruptions that affected it, and there were El Niños too. But after correcting for these issues, we came up with an estimate for the underlying greenhouse warming trend of 0.09°C per decade, or about a quarter of the level predicted by climate models.

In 2017, Dick and I wanted to re-check our work from 1994. The time series was by then 37.5 years long. Figure 3 shows the results. The top line is the actual temperature of the global troposphere, with the range of original 1994 study shown as the shaded area. We were able to calculate and remove the El Niño effect, which accounts for a lot of the variance, but has no trend to it. Then there are these two dips in global temperature after the El Chichón and Mt Pinatubo eruptions. Volcanic eruptions send aerosols up into the stratophere, and these reflect sunlight, so fewer units of energy get in and the earth cools. I developed a mathematical function to simulate this, as shown in Figure 3d.

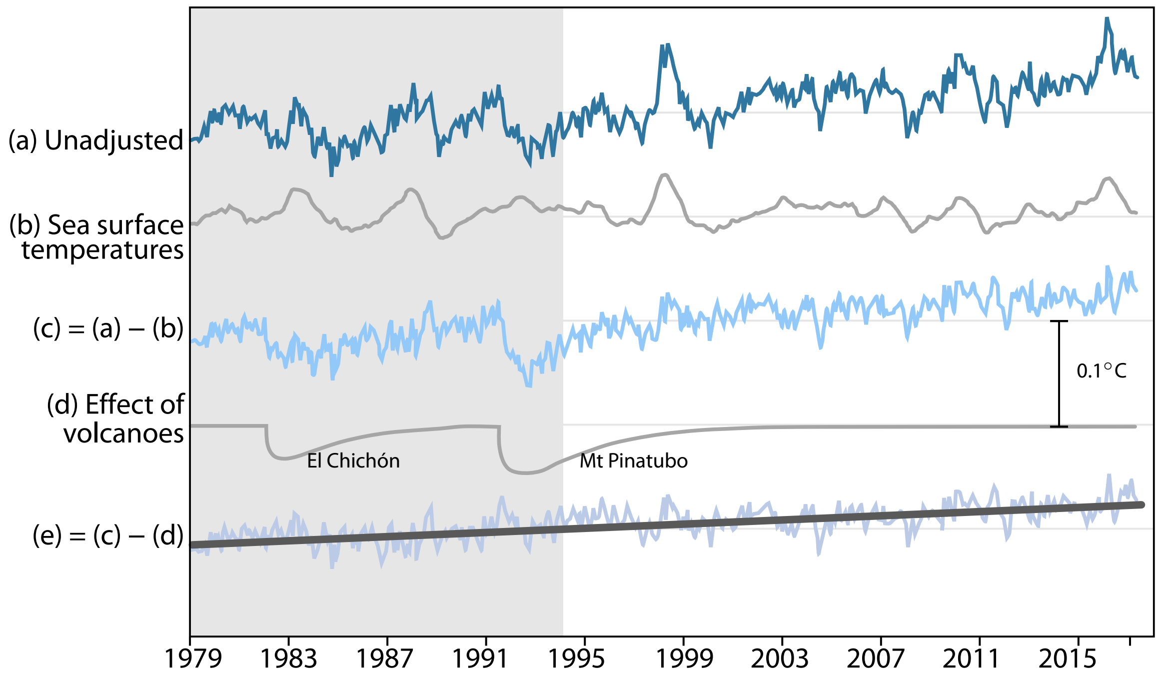


Figure 3: Updating the estimate.
Redrawn from Christy and McNider 2017.

After eliminating the effect of volcanoes, we were left with a line that was approximately straight, apart from some noise. The trend, the dark line in Figure 3e, was 0.095°C per decade, almost exactly the same as in our earlier study, 25 years before. Dick and I are very proud of the fact that the science we did so long ago has been confirmed and affirmed.

The warming trend we found suggests we are having a relatively minor impact on global temperatures. From the IPCC, we know what the forcing was over that 37.5 years – how many extra greenhouse gas molecules there were and what forcing they would represent. We also know about the effect of aerosols. Taking all this data together, we can calculate what I call – and we were the first to use this term – the 'tropospheric transient climate response'. In other words: how much temperature actually changes due to extra greenhouse gas forcing. The calculation includes a major assumption, namely that there are no natural variations left in the temperature data, and in particular that there are no long-term natural variations. It's a huge assumption, but it allows us to move on.

Our result is that the transient climate response[2] – the short-term warming – in the troposphere is 1.1°C at the point in time when carbon dioxide levels double. This is not a very alarming number. If we perform the same calculation on the climate models, you get a figure of 2.31°C, which is significantly different. The models' response to carbon dioxide is twice what we see in the real world. So the evidence indicates the consensus range for climate sensitivity is incorrect.

3 Another metric

But is there any another metric you can use to test climate models regarding the response to that 0.5 units of extra energy forcing? Ross McKitrick and I set out to find one. We needed a response to greenhouse forcings that had the following features:

- The response is seen in all models as a dominant characteristic.
- The response is not there when extra greenhouse gases are not included (control and experiment are always different in the same way).
- The relevant observations should not have been used in the development of the model.
- The relevant observations should be available from multiple, independent sources.

The requirement that the observations should not have been used in the model development means that surface temperature records are unsuitable, because they are used to 'tune' climate model results.

The metric we eventually decided to use was the temperature of the atmosphere between 30,000 and 40,000 feet, in the tropics from 20°N to 20°S. Think of a ring of air all the way around the tropics (Figure 4).

Figure 5 is an example from the Canadian climate model. The x-axis is latitude, with the North Pole on the right, the South Pole on the left, and the tropics in the middle. The y-axis is effectively the altitude. The colours represent different predicted warming trends over the period from 1979–2017. So this climate model suggests that significant warming should already have occurred at a height between 30,000 and 40,000 feet. That's the big red area in the centre. So this is a visual representation of the metric that we're going to look at.

The satellites measure microwave emissions from oxygen, at around the 55 GHz band, from which we can derive a temperature. They measure from 20°N to 20°S and through a wide range of altitudes, as represented by the unshaded column in the centre of the picture. This covers the red dot, which means that we can test the hypothesis of rapid warming between 30,000 and 40,000 feet.

[2] The transient climate response is the temperature rise if you increase carbon dioxide levels at 1% per year over 70 years.

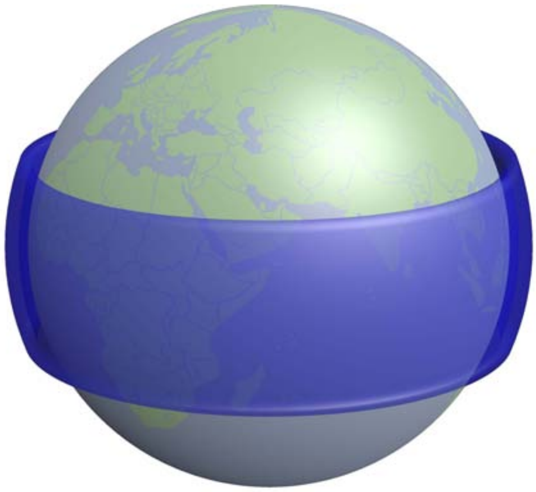


Figure 4: The tropical troposphere.

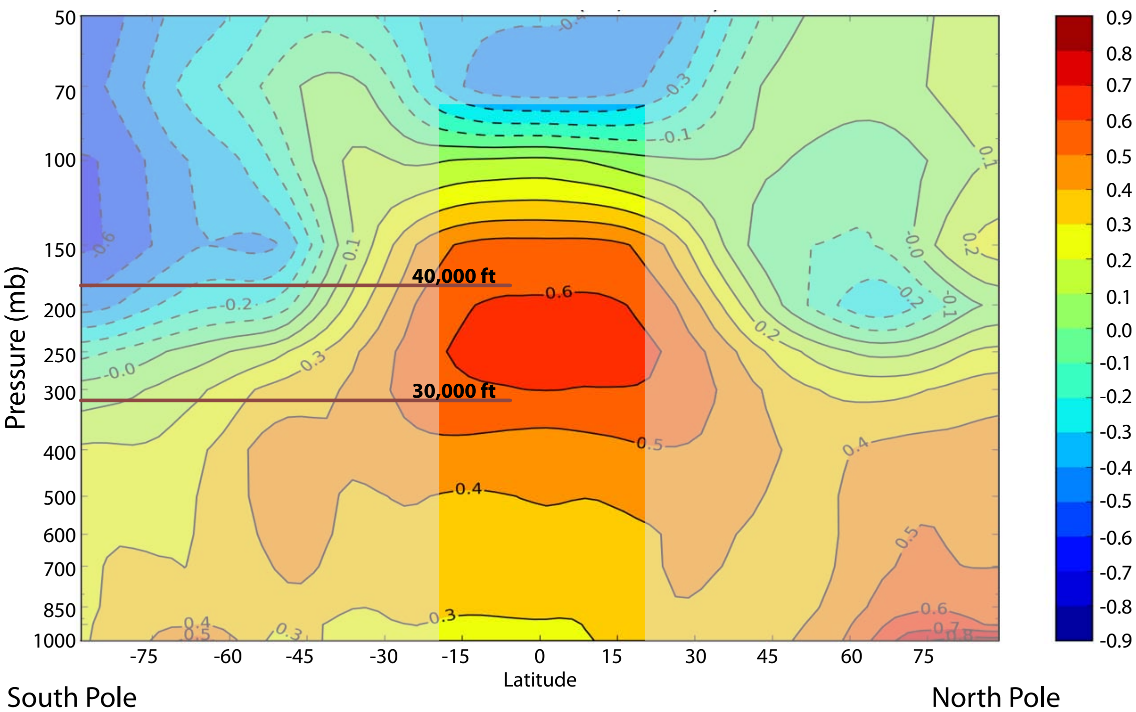


Figure 5: The hot spot in the Canadian model.
The *y*-axis is denominated in units of pressure, but the scale makes it linear in altitude.

Almost all of the models show such a warming, and none show it when extra greenhouse gas forcing is not included. Figure 6 shows the warming trends from 102 climate models, and the average trend is 0.44°C per decade. This is quite fast: over 40 years, it amounts to almost 2°C, although some models have slower warming and some faster. However, the real-world warming is much lower; around one third of the model average.

Figure 7 shows the model projections in pink and different observational datasets in

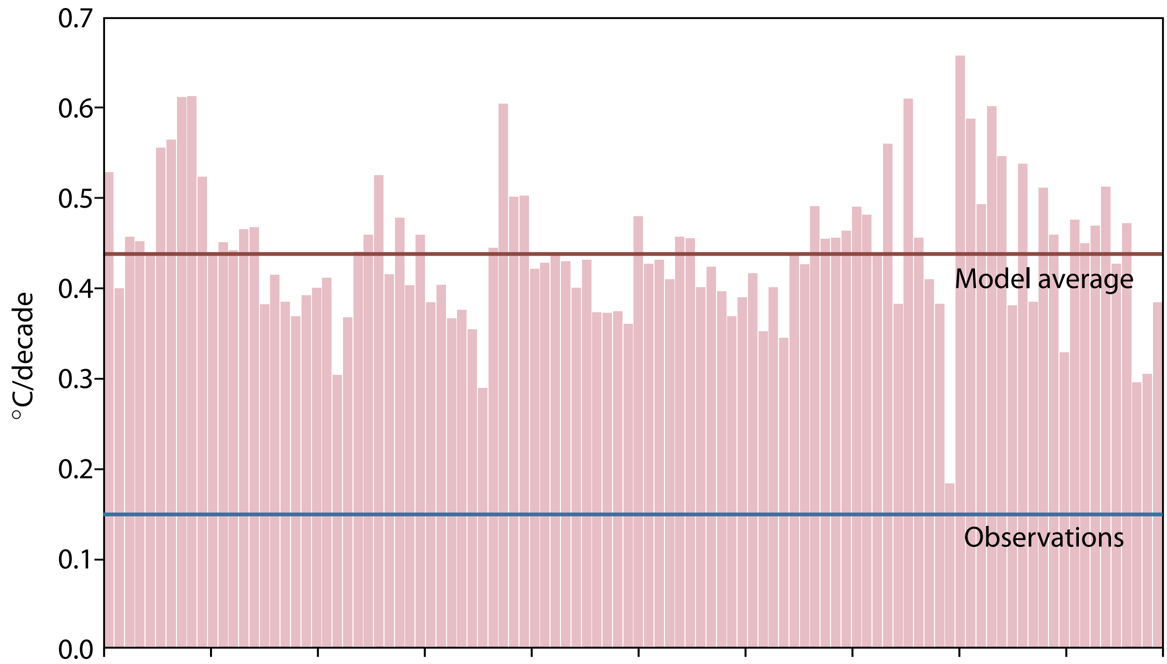


Figure 6: Tropical troposphere warming trends in 102 climate models.
CMIP5 models, trends for 1979–2017, 20°N–20°S, 300-200 hPa.

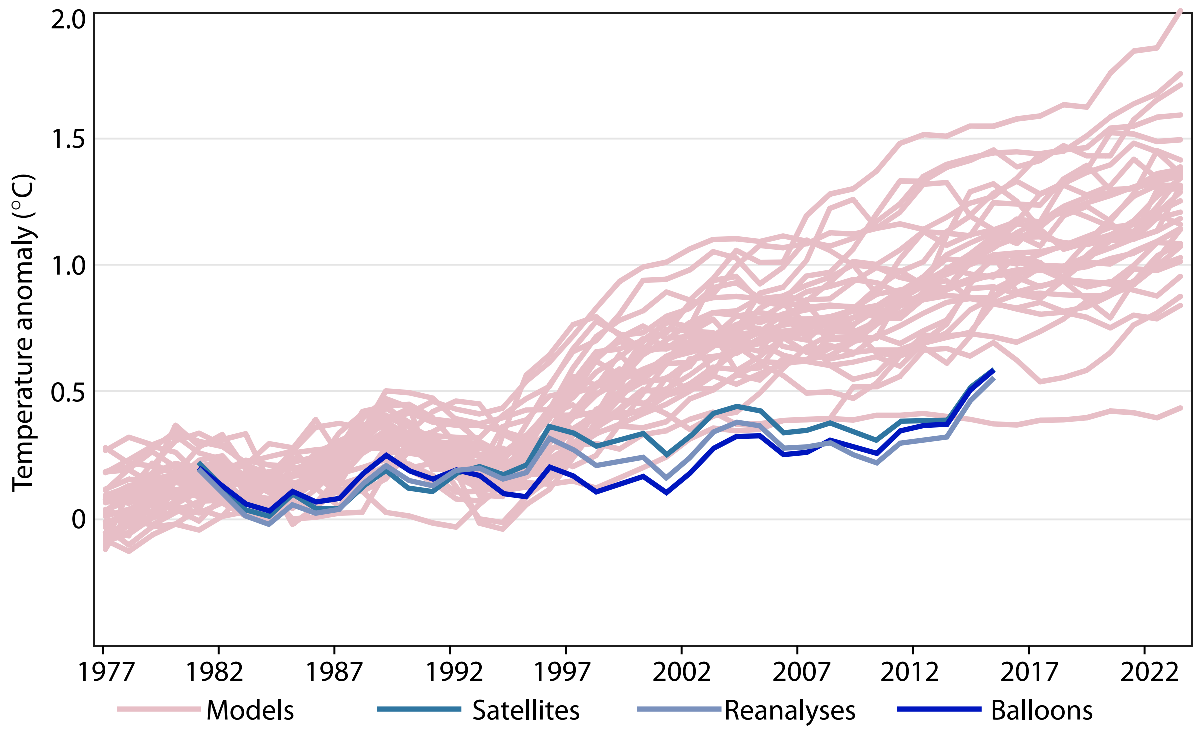


Figure 7: Tropical mid-tropospheric temperatures, models vs. observations.
Models in pink, against various observational datasets in shades of blue. Five-year averages 1979–2017. Trend lines cross zero at 1979 for all series.

shades of blue. You can also easily see the difference in warming rates: the models are warming too fast. The exception is the Russian model, which has much lower sensitivity to carbon dioxide, and therefore gives projections for the end of the century that are far from alarming. The rest of them are already falsified, and their predictions for 2100 can't be trusted. If an engineer built an aeroplane and said it could fly 600 miles and the thing ran out of fuel at 200 and crashed, he wouldn't say 'Hey, I was only off by a factor of three'. We don't do that in engineering and real science. A factor of three is huge in the energy balance system. Yet that's what we see in the climate models.

We are just starting to see the first of the next generation of climate models, known as CMIP6. These will be the basis of the IPCC assessment report, and of climate and energy policy for the next 10 years. Unfortunately, as Figure 8 shows, they don't seem to be getting any better. The observations are in blue on the left. The CMIP6 models, in pink, are also warming faster than the real world. They actually have a higher sensitivity than the CMIP5 models; in other words, they're apparently getting worse! This is a big problem.

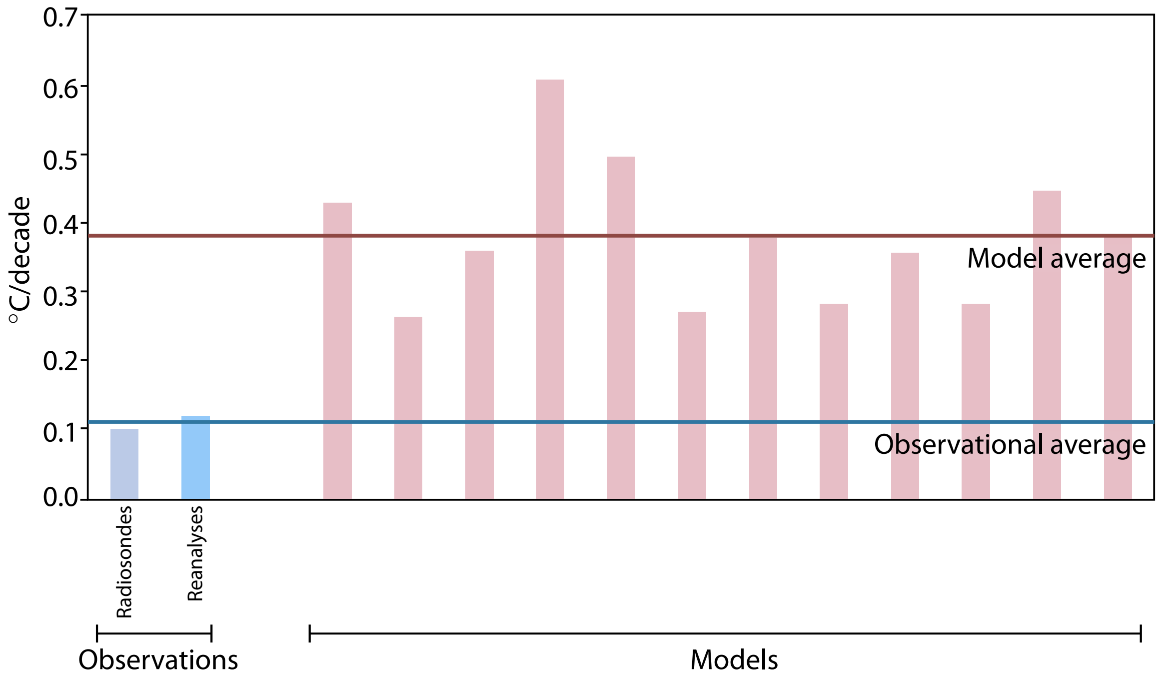


Figure 8: Warming in the tropical troposphere according to the CMIP6 models.
Trends 1979–2014 (except the rightmost model, which is to 2007), for 20°N–20°S, 300–200 hPa.

Why is this happening? Heat escapes to space up an air column through the atmosphere. In the climate models, if you warm that air column by 1 °C, only 1.4 W/m^2 escapes to space. My colleague Roy Spencer has estimated that the figure in the real world is around 2.6 W/m^2. In other words, whenever there's a blip of warming, the models are trapping too much heat, allowing it to accumulate over time rather than escape to space, as happens in the real world.

4 Hiding the problem

People have known about these problems with the models for a long time. In 2000, I was involved in a report sponsored by the US National Academy of Sciences that pointed out the mismatch between warming in the models and in real life. As we put it at the time:

> A more definitive reconciliation of modelling observed temperature changes awaits improvement of the models used to simulate the atmospheric response to the natural and human induced forces.

As you have seen already, this reconciliation has not yet occurred. The IPCC is well aware of the problem, but in the Fifth Assessment Report (2013) they avoided drawing attention to it. In my review comments on the report, I pointed out the mismatch and said that the claims the IPCC was making would not stand up to serious cross-examination. Of course, the IPCC review process is not cross-examination, and the lead authors, carefully selected so that the correct message is delivered, have the final say.

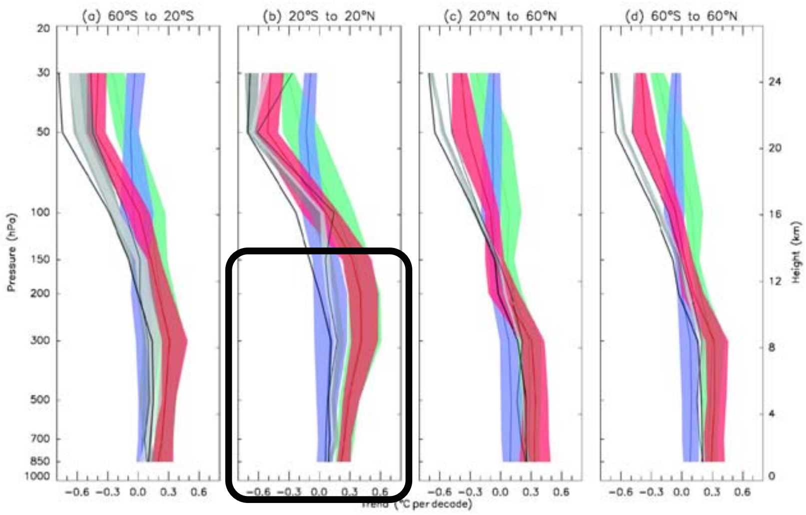
In response to my objections, the IPCC inserted a new graph, but they buried it in the supplementary materials, which would be published long after the main report. This is shown in Figure 9a. It shows predicted and observed temperature trends right through the atmosphere, from surface to stratosphere, and for different latitudinal bands. We are interested in the tropical troposphere, which is the area highlighted.

Figure 9b is an enlargement of this part of the graph, and is somewhat simplified too to make the discrepancy clear. The further right you go, the faster is the warming and, similarly, to the left is cooling. The red colour is for the models when incorporating both natural and anthropogenic forcings. The grey is the range of the observations. There is no overlap at all. The blue band is the model runs that left out any extra greenhouse forcing. Remarkably, these runs predicted the actual outcome quite well, but this was never ever mentioned anywhere in the main text of the report.

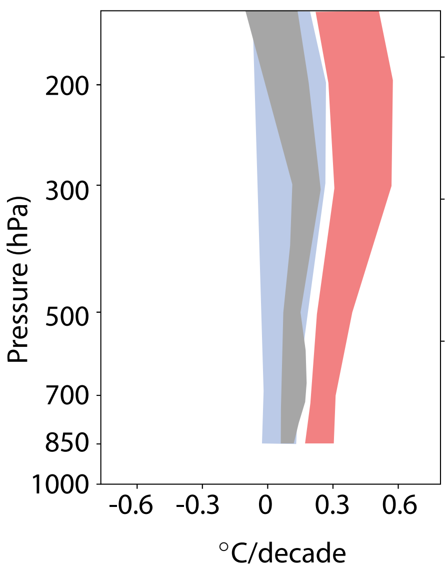
So the rate of accumulation of joules of energy in the tropical troposphere is significantly less than predicted by the CMIP5 climate models. Will the next IPCC report discuss this long-running mismatch? There are three possible ways they could handle the problem:

- The observations are wrong, the models are right.
- The forcings used in the models were wrong.
- The models are failed hypotheses.

I predict that the 'failed hypothesis' option will not be chosen. Unfortunately, that's exactly what you should do when you follow the scientific method.



(a) The IPCC's figure, with the tropical troposphere highlighted



(b) Enlargement and simplification of the tropical troposphere

Figure 9: The tropical troposphere in the Fifth Assessment Report.

The coloured bands represent the range of warming trends. Red is the model runs incorporating natural and anthropogenic forcings, blue is natural forcings only. The range of the observations is in grey.

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Our main focus is to analyse global warming policies and their economic and other implications. Our aim is to provide the most robust and reliable economic analysis and advice. Above all we seek to inform the media, politicians and the public, in a newsworthy way, on the subject in general and on the misinformation to which they are all too frequently being subjected at the present time.

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