



This is the print version of the [Skeptical Science](http://sks.to/model) article '[Models are unreliable](http://sks.to/model)', which can be found at <http://sks.to/model>.

How reliable are climate models?

What The Science Says:

Models successfully reproduce temperatures since 1900 globally, by land, in the air and the ocean.

Climate Myth: Models are unreliable

"[Models] are full of fudge factors that are fitted to the existing climate, so the models more or less agree with the observed data. But there is no reason to believe that the same fudge factors would give the right behaviour in a world with different chemistry, for example in a world with increased CO₂ in the atmosphere." ([Freeman Dyson](#))

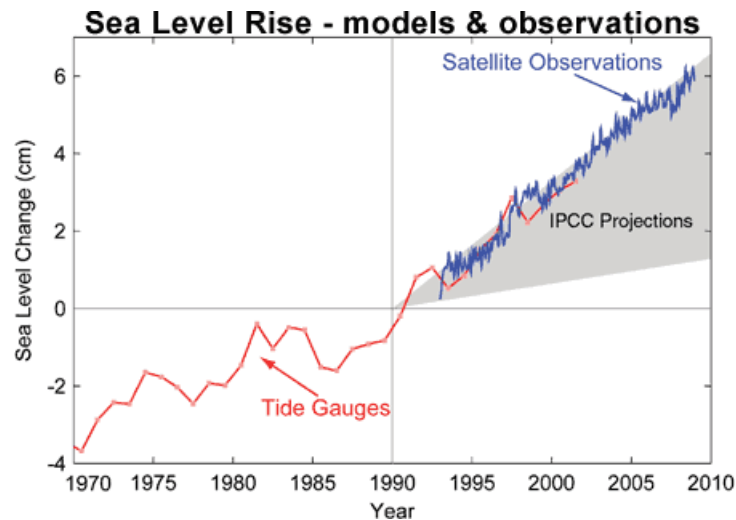
Climate models are mathematical representations of the interactions between the atmosphere, oceans, land surface, ice – and the sun. This is clearly a very complex task, so models are built to estimate *trends* rather than events. For example, a climate model can tell you it will be cold in winter, but it can't tell you what the temperature will be on a specific day – that's weather forecasting. Climate *trends* are weather, averaged out over time – usually 30 years. Trends are important because they eliminate – or "smooth out" – single events that may be extreme, but quite rare.

Climate models have to be tested to find out if they work. We can't wait for 30 years to see if a model is any good or not; models are tested against the past, against what we know happened. If a model can correctly predict trends from a starting point somewhere in the past, we could expect it to predict with reasonable certainty what might happen in the future.

So all models are first tested in a process called *Hindcasting*. The models used to predict future global warming can accurately map past climate changes. If they get the past right, there is no reason to think their predictions would be wrong. Testing models against the existing instrumental record suggested CO₂ must cause global warming, because the models could not simulate what had already happened *unless* the extra CO₂ was added to the model. All other known forcings are adequate in explaining temperature variations prior to the rise in temperature over the last thirty years, while none of them are capable of explaining the rise in the past thirty years. CO₂ does explain that rise, and explains it completely without any need for additional, as yet unknown forcings.

Where models have been running for sufficient time, they have also been proved to make accurate predictions. For example, the eruption of Mt. Pinatubo allowed modellers to test the accuracy of models by feeding in the data about the eruption. The models successfully predicted the climatic response after the eruption. Models also correctly predicted other effects subsequently confirmed by observation, including greater warming in the Arctic and over land, greater warming at night, and stratospheric cooling.

The climate models, far from being melodramatic, may be conservative in the predictions they produce. For example, here's a graph of sea level rise:



Observed sea level rise since 1970 from tide gauge data (red) and satellite measurements (blue) compared to model projections for 1990-2010 from the IPCC Third Assessment Report (grey band). (Source: [The Copenhagen Diagnosis, 2009](#))

Here, the models have understated the problem. In reality, observed sea level is tracking at the upper range of the model projections. There are [other examples of models being too conservative](#), rather than alarmist as some portray them. All models have limits - uncertainties - for they are modelling complex systems. However, all models improve over time, and with increasing sources of real-world information such as satellites, the output of climate models can be constantly refined to increase their power and usefulness.

Climate models have already predicted many of the phenomena for which we now have empirical evidence. Climate models form a reliable guide to potential climate change.

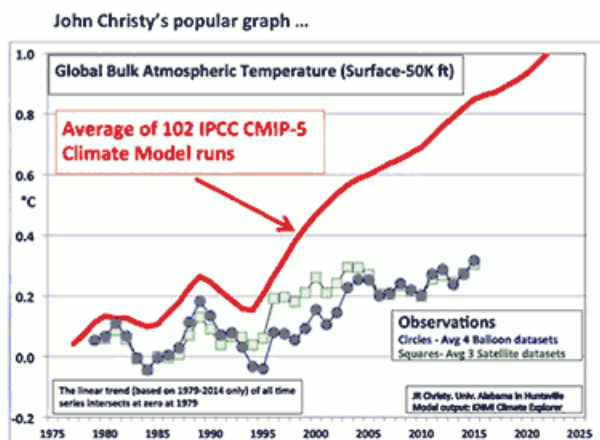
Mainstream climate models have also accurately projected global surface temperature changes. Climate contrarians have not.

[see video at [this link](#).]

Various global temperature projections by mainstream climate scientists and models, and by climate contrarians, compared to observations by NASA GISS. Created by Dana Nuccitelli.

A [2019 study](#) led by Zeke Hausfather evaluated 17 global surface temperature projections from climate models in studies published between 1970 and 2007. [The authors found](#) "14 out of the 17 model projections indistinguishable from what actually occurred."

There's one chart often used to argue to the contrary, but it's got some serious problems, and ignores most of the data.



Update July 2015:

Here is a related lecture-video from [Denial101x - Making Sense of Climate Science Denial](#)

Additional video from the MOOC

Dana Nuccitelli: [Principles that models are built on.](#)



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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.



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