How reliable are the climate models?

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There are dozens of climate models. They have been run many times. The great majority of model runs, from the high-profile UK Met Office's *Barbecue Summer* to Roy Spencer's *Epic Fail* analysis of the tropical troposphere, have produced global temperature forecasts that later turned out to be too high. Why?

The answer is, mathematically speaking, very simple.

The fourth IPCC report [para 9.1.3] says : "*Results from forward calculations are used for formal detection and attribution analyses. In such studies, a climate model is used to calculate response patterns ('fingerprints') for individual forcings or sets of forcings, which are then combined linearly to provide the best fit to the observations."*

To a mathematician that is a massive warning bell. You simply cannot do that. [To be more precise, because obviously they did actually do it, you cannot do that and retain any credibility]. Let me explain :

The process was basically as follows
(1) All known (ie. well-understood) factors were built into the climate models, and estimates were included for the unknowns (The IPCC calls them *parametrizations* - in UK English : parameterisations).
(2) Model results were then compared with actual observations and were found to produce only about a third of the observed warming in the 20th century.
(3) Parameters controlling the unknowns in the models were then fiddled with (as in the above IPCC report quote) until they got a match.
(4) So necessarily, about two-thirds of the models' predicted future warming comes from factors that are not understood.

Now you can see why I said "You simply cannot do that": When you get a discrepancy between a model and reality, you obviously can't change the model's known factors - they are what they are known to be. If you want to fiddle the model to match reality then you have to fiddle the unknowns. If your model started off a long way from reality then inevitably the end result is that a large part of your model's findings come from unknowns, ie, from factors that are not understood. To put it simply, you are guessing, and therefore your model is unreliable.

OK, that's the general theory. Now let's look at the climate models and see how it works in a bit more detail.

The Major Climate Factors

The climate models predict, on average, global warming of 0.2 deg C per decade for the indefinite future.

What are the components of climate that contribute to this predicted future warming, and how well do we understand them?

ENSO (El Nino Southern Oscillation) : We'll start with El Nino, because it's in the news with a major El Nino forecast for later this year. It is expected to take global temperature to a new high. The regrettable fact is that we do not understand El Nino at all well, or at least, not in the sense that

we can predict it years ahead. Here we are, only a month or so before it is due to cut in, and we still aren't absolutely sure that it will happen, we don't know how strong it will be, and we don't know how long it will last. Only a few months ago we had no idea at all whether there would be one this year. Last year an El Nino was predicted and didn't happen. In summary : Do we understand ENSO (in the sense that we can predict El Ninos and La Ninas years ahead)? No. How much does ENSO contribute, on average, to the climate models' predicted future warming? 0%.

El Nino and La Nina are relatively short-term phenomena, so a 0% contribution could well be correct but we just don't actually know. There are suggestions that an El Nino has a step function component, ie. that when it is over it actually leaves the climate warmer than when it started. But we don't know.

Ocean Oscillations : What about the larger and longer ocean effects like the AMO (Atlantic Multidecadal Oscillation), PDO (Pacific Decadal Oscillation), IOD (Indian Ocean Dipole), etc. Understood? No. Contribution in the models : 0%.

Ocean Currents : Are the major ocean currents, such as the THC (Thermohaline Circulation), understood? Well we do know a lot about them - we know where they go and how big they are, and what is in them (including heat), and we know much about how they affect climate - but we know very little about what changes them and by how much or over what time scale. In summary - Understood? No. Contribution in the models : 0%.

Volcanoes : Understood? No. Contribution in the models : 0%.

Wind : Understood? No. Contribution in the models : 0%.

Water cycle (ocean evaporation, precipitation) : Understood? Partly. Contribution in the models : the contribution in the climate models is actually slightly negative, but it is built into a larger total which I address later.

The Sun : Understood? No. Contribution in the models : 0%. Now this may come as a surprise to some people, because the Sun has been studied for centuries, we know that it is the source of virtually all the surface and atmospheric heat on Earth, and we do know quite a lot about it. Details of the 11(ish) year sunspot cycle, for example, have been recorded for centuries. But we don't know what causes sunspots and we can't predict even one sunspot cycle ahead. Various longer cycles in solar activity have been proposed, but we don't even know for sure what those longer cycles are or have been, we don't know what causes them, and we can't predict them. On top of that, we don't know what the sun's effect on climate is - yes we can see big climate changes in the past and we are pretty sure that the sun played a major role (if it wasn't the sun then what on Earth was it?) but we don't know how the sun did it and in any case we don't know what the sun will do next. So the assessment for the sun in climate models is : Understood? No. Contribution in the models : 0%. [Reminder : this is the contribution to predicted future warming]

Galactic Cosmic Rays (GCRs) : GCRs come mainly from supernovae remnants (SNRs). We know from laboratory experiment and real-world observation (eg. of Forbush decreases) that GCRs create aerosols that play a role in cloud formation. We know that solar activity affects the level of GCRs. But we can't predict solar activity (and of course we can't predict supernova activity either), so no matter how much more we learn about the effect of GCRs on climate, we can't predict them and therefore we can't predict their effect on climate. And by the way, we can't predict aerosols from other causes either. In summary for GCRs : Understood? No. Contribution in the models : 0%.

Milankovich Cycles : Milankovich cycles are all to do with variations in Earth's orbit around the

sun, and can be quite accurately predicted. But we just don't know how they affect climate. The most important-looking cycles don't show up in the climate, and for the one that does seem to show up in the climate (orbital inclination) we just don't know how or even whether it affects climate. In any case, its time-scale (tens of thousands of years) is too long for the climate models so it is ignored. In summary for Milankovich cycles : Understood? No. Contribution in the models : 0%. (Reminder : "Understood" is used in the context of predicting climate).

Carbon Dioxide (CO2) : At last we come to something which is quite well understood. The ability of CO2 to absorb and re-emit a specific part of the light spectrum is well understood and well quantified, supported by a multitude of laboratory experiments. [NB. I do not claim that we have perfect understanding, only that we have good understanding]. In summary - Understood? Yes. Contribution in the models : about 37%.

Water vapour : we know that water vapour is a powerful greenhouse gas, and that in total it has more effect than CO2 on global temperature. We know something about what causes it to change, for example the Clausius-Clapeyron equation is well accepted and states that water vapour increases by about 7% for each 1 deg C increase in atmospheric temperature. But we don't know how it affects clouds (looked at next) and while we have reasonable evidence that the water cycle changes in line with water vapour, the climate models only allow for about a third to a quarter of that amount. Since the water cycle has a cooling effect, this gives the climate models a warming bias. In summary for water vapour - Understood? Partly. Contribution in the models : 22%, but suspect because of the missing water cycle.

Clouds : We don't know what causes Earth's cloud cover to change. Some kinds of cloud have a net warming effect and some have a net cooling effect, but we don't know what the cloud mix will be in future years. Overall, we do know with some confidence that clouds at present have a net cooling effect, but because we don't know what causes them to change we can't know how they will affect climate in future. In particular, we don't know whether clouds would cool or warm in reaction to an atmospheric temperature increase. In summary, for clouds : Understood? No. Contribution in the models : 41%, all of which is highly suspect.

Summary

The following table summarises all of the above:

Factor	Understood?	Contribution to models' predicted future warming
ENSO	No	0%
Ocean Oscillations	No	0%
Ocean Currents	No	0%
Volcanoes	No	0%
Wind	No	0%
Water Cycle	Partly	(built into Water Vapour, below)
The Sun	No	0%
Galactic Cosmic Rays (and aerosols)	No	0%
Milankovich cycles	No	0%
Carbon Dioxide	Yes	37%

Water Vapour	Partly	22% but suspect
Clouds	No	41%, all highly suspect
Other (in case I have missed anything)		0%

The not-understood factors (water vapour, clouds) that were chosen to fiddle the models to match 20th-century temperatures were both portrayed as being in reaction to rising temperature - the IPCC calls them "feedbacks" - and the only known factor in the models that caused a future temperature increase was CO2. So those not-understood factors could be and were portrayed as being caused by CO2.

And that is how the models have come to predict a high level of future warming, and how they claim that it is all caused by CO2. The reality of course is that two-thirds of the predicted future warming is from guesswork and they don't even know if the sign of the guesswork is correct. ie, they don't even know whether the guessed factors actually warm the planet at all. They might even cool it (see Footnote 3).

One thing, though, is absolutely certain. The climate models' predictions are very unreliable.

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Footnotes

1. If you still doubt that the climate models are unreliable, consider this : The models typically work on a grid system, where the planet's surface and atmosphere are divided up into not-very-small chunks. The interactions between the chunks are then calculated over a small time period, and the whole process is then repeated a mammoth number of times in order to project forward over a long time period (that's why they need such large computers). The process is similar to the process used for weather prediction but much less accurate. That's because climate models run over much longer periods so they have to use larger chunks or they run out of computer power. The weather models become too inaccurate to predict local or regional weather in just a few days. The climate models are less accurate.

2. If you still doubt that the climate models are unreliable, then perhaps the IPCC themselves can convince you. Their Working Group 1 (WG1) assesses the physical scientific aspects of the climate system and climate change. In 2007, WG1.said "*we should recognise that we are dealing with a coupled nonlinear chaotic system, and therefore that the long-term prediction of future climate states is not possible.*"

3. The models correctly (as per the the Clausius-Clapeyron equation) show increased atmospheric water vapour from increased temperature. Water vapour is a greenhouse gas so there is some warming from that. In the real world, along with the increased water vapour there is more precipitation. Precipitation comes from clouds, so logically there will be more clouds. But this is where the models' parameterisations go screwy. In the real world, the water cycle has a cooling effect, and clouds are net cooling overall, so both an increased water cycle and increased cloud cover will cool the planet. But, as it says in the IPCC report, they had to find a way to increase

temperature in the models enough to match the observed 20th century temperature increase. To get the required result, the parameter setttings that were selected (ie, the ones that gave them the "*best fit to the observations*"), were the ones that minimised precipitation and sent clouds in the wrong direction. Particularly in the case of clouds, where there are no known 'rules', they can get away with it because, necessarily, they aren't breaking any 'rules' (ie, no-one can prove absolutely that their settings are wrong). And that's how, in the models, cloud "feedback" ends up making the largest contribution to predicted future warming, larger even than CO2 itself.

4. Some natural factors, such as ENSO, ocean oscillations, clouds (behaving naturally), etc, may well have caused most of the temperature increase of the 20th century. But the modellers chose not to use them to obtain the required "*best fit*".If those natural factors did in fact cause most of the temperature increase of the 20th century then the models are barking up the wrong tree. Model results - consistent overestimation of temperature - suggest that this is the case.

5. To get their "*best fit*", the chosen fiddle factors (that's the correct mathematical term, aka fudge factors) were "*combined linearly*". But as the IPCC themselves said, "*we are dealing with a coupled* ***nonlinear*** *chaotic system".* Hmmmm ....