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Understanding the Global Warming Debate

Likely you have heard the sound bite that “97% of climate scientists” accept the global warming “consensus”. Which is what gives global warming advocates the confidence to call climate skeptics “deniers,” hoping to evoke a parallel with “Holocaust Deniers,” a case where most of us would agree that a small group are denying a well-accepted reality. So why do these “deniers” stand athwart of the 97%? Is it just politics? Oil money? Perversity? Ignorance?

We are going to cover a lot of ground, but let me start with a hint.

In the early 1980's I saw Ayn Rand speak at Northeastern University. In the Q&A period afterwards, a woman asked Ms. Rand, “Why don't you believe in housewives?” And Ms. Rand responded, “I did not know housewives were a matter of belief.” In this snarky way, Ms. Rand was telling the questioner that she had not been given a valid proposition to which she could agree or disagree. What the questioner likely should have asked was, “Do you believe that being a housewife is a morally valid pursuit for a woman.” That would have been an interesting question (and one that Rand wrote about a number of times).

In a similar way, we need to ask ourselves what actual proposition do the 97% of climate scientists agree with. And, we need to understand what it is, exactly, that the deniers are denying.

It turns out that the propositions that are “settled” and the propositions to which some like me are skeptical are NOT the same propositions.

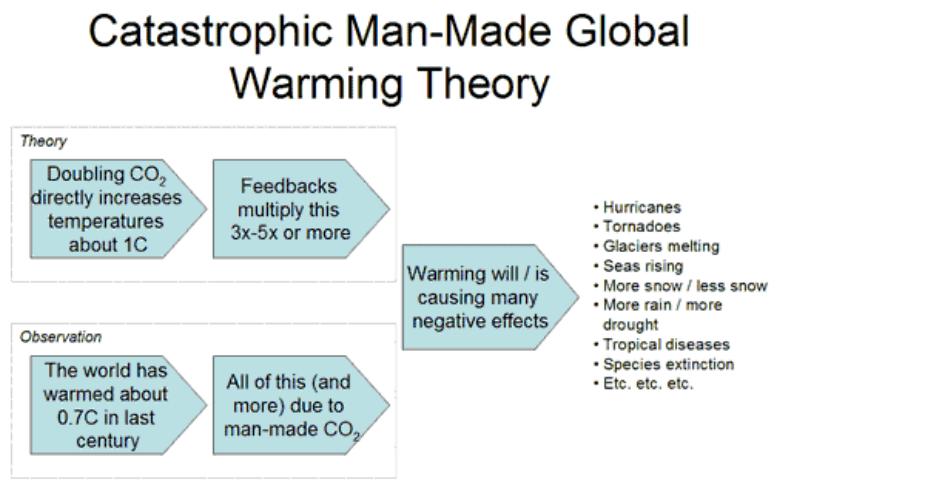
Understanding that mismatch will help explain a lot of the climate debate.

The Core Theory

Let's begin by putting a careful name to what we are talking about. We are discussing the hypothesis of “catastrophic man-made global warming theory.” We are not just talking about warming but warming that is somehow man-made. And we are not talking about a little bit of warming, but enough that

the effects are catastrophic and thus justify immediate and likely expensive government action.

In discussing this theory, we'll use the UN's Intergovernmental Panel on Climate Change (IPCC) as our main source. After reading through most of the IPCC's last two reports, I think it is fair to boil the logic behind the theory to this picture:



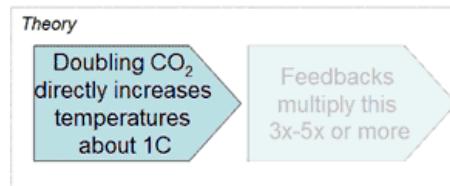
As you can see, the theory is actually a chain of at least three steps:

1. CO₂, via the greenhouse effect, causes some warming.
2. A series of processes in the climate multiply this warming by several times, such that most of the projected warming in various IPCC and other forecasts come from this feedback, rather than directly from the greenhouse gas effect of CO₂.
3. Warming only matters if it is harmful, so there are a variety of theories about how warming might increase hazardous weather (e.g. hurricanes, tornadoes, floods, droughts), raise sea levels, or affect biological processes.

In parallel with this theoretical work, scientists are looking for confirmation of the theory in observations. They have a variety of ways to measure the temperature of the Earth, all of which have shown warming over the past century. With this warming in hand, they then attempt to demonstrate how much of this warming is from CO₂. The IPCC believes that much of past warming was from CO₂, and recent work by IPCC authors argues that only exogenous effects prevented CO₂-driven warming from being even higher.

This is just a summary. We will walk through each step in turn.

CO₂ as a Greenhouse Gas



The first step in the theory is the basic greenhouse gas theory — that CO₂ will raise the temperature of the Earth as its concentration increases (through a process of absorption and re-radiation that we will not get into).

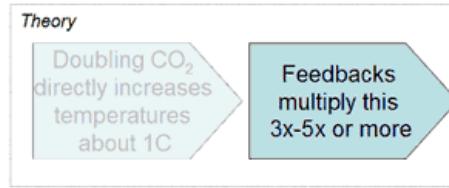
It's probably irresponsible to call anything in a science so young as climate "settled," but the fact that increased atmospheric CO₂ will warm the Earth by some amount is pretty close to being universally accepted.

More debatable is how much warming will occur. We have measurements of warming from laboratory experiments, but these are hard to translate directly to the complex climate system. The generally accepted value for direct greenhouse gas warming from CO₂ is something like 1-1.2C per doubling of CO₂ concentrations in the atmosphere, and most past IPCC reports have settled on a number in this range.

While some of the talk-show-type skeptics have tried to dispute this greenhouse theory, most of what I call the science-based skeptics do not, and accept a number circa 1C for the direct warming effect of a doubling of CO₂.

So what's the problem? Why the debate? Isn't this admission a "game over" for the skeptics? Actually, no. To understand this, let us do a bit of extrapolation. Current CO₂ concentrations in the atmosphere today are around 390ppm, or about 0.039%. But even if we were to hit a relatively pessimistic level of 800ppm by the end of the century, this would, by the numbers above, imply a warming of about one degree. While potentially undesirable, a degree of warming is hardly catastrophic. The catastrophe comes from the second chained theory.

The Positive Climate Feedback Theory



As the Earth warms, we expect there to be changes that may further accelerate or decelerate the warming. These are called feedbacks. Take one example — as the Earth warms, there will likely be less snow and ice coverage of the Earth. Snow and ice tend to reflect heat back into space more than does bare land or water, so that this loss could add additional warming above and beyond the initial warming from CO₂. On the opposite end of the scale, many plants grow faster with warmer air and more airborne CO₂, and such growth could in turn reduce atmospheric carbon and slow expected warming.

It turns out the critical feedback involves water vapor. While CO₂ is indeed a greenhouse gas, it is a weak one when compared to water vapor. Rising temperatures may increase evaporation and therefore the amount of water vapor in the air, thus adding powerful greenhouse gasses to the atmosphere and accelerating warming. On the other hand, water evaporated by rising temperatures may form more clouds that shade the Earth and help to reduce temperatures. Whether future man-made global warming is catastrophic depends a lot on the balance of these effects.

The IPCC assumed that strong positive feedbacks dominated, and thus arrived at numbers that implied that feedbacks added an additional 2-4 degrees to the 1 degree from CO₂ directly. So in the IPCC numbers, at least two thirds of the future warming comes not from the basic greenhouse gas effect but a second independent theory that the Earth's climate is dominated by strong positive feedbacks. Other more alarmist scientists have come up with feedback numbers even higher. When Al Gore says that we will see a tipping point where temperatures will run away, he is positing that feedbacks

will be nearly infinite (a phenomenon we can hear with loud feedback screeches from a microphone).

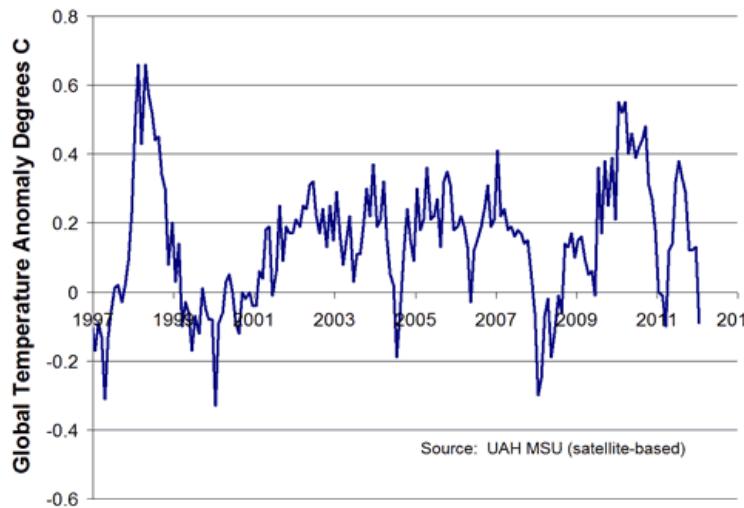
But the science of this positive climate feedback theory is far from settled. Just as skeptics are probably wrong to question the basic greenhouse gas effect of CO₂, catastrophic global warming advocates are wrong to overestimate our understanding of these feedbacks. Not only may the feedback number not be high, but it might be negative, as implied by some recent research, which would actually reduce the warming we would see from a doubling of CO₂ to less than one degree Celsius. After all, most long-term stable natural systems (and that would certainly describe climate) are dominated by negative rather than positive feedbacks.

Nice Theory, But What Do We Actually See Happening?



At some point, theorizing becomes stale unless the theories are supported by observations. And the most important single observation relative to catastrophic man-made global warming theory is that the world has indeed warmed over the last century, by perhaps 0.7C, coincident with the period mankind has burned a lot of fossil fuels.

Some skeptics have tried, relatively futilely I think, to deny that the world is warming at all. Certainly skeptics have a lot of evidence that this measured warming may be exaggerated — there are some serious flaws in our surface temperature measurement system today and almost certainly much worse flaws in the numbers from, say, 1900 to which we are comparing current readings. But radically new technologies, such as satellites, that are not susceptible to these same flaws and coverage gaps have still measured an upward drift in temperatures over the last 30 years.



When looking at the historic temperature record, skeptics today tend to focus more on the fact that temperatures have leveled off over the last 10-15 years. Both sides of the debate play annoying games with cherry-picked end-points and graph scales to try to support their arguments, but most reasonable people look at the graph above of the last 15 years and will agree temperatures

have been relatively flat. Even more important for scientists (since the oceans are a much larger heat reservoir than the atmosphere) is the fact that the new ARGO floating temperature stations have measured little or no increase in ocean heat content since they were put in service in 2003.

These facts actually lead to one of my favorite examples of the two sides in the debate talking past each other (this example actually played out in the editorial pages of the Wall Street Journal over the past several weeks).

Skeptics will say, "temperatures have been flat for 10-15 years." Global warming advocates will respond, "the last decade has seen some of the hottest temperatures in the last 100 years." Both statements are actually correct.

Imagine spending all day climbing to the top of a tall plateau. Walking around on the plateau, with every step, it is correct to say that you are at the highest point you have been all day, but it is also correct to say you are no longer climbing.

Whichever the case, the flat surface temperatures and ocean heat content create a real problem for the man-made catastrophic global warming theory. There is no reason why warming should take a break, and we are starting to hear more frequently, even among catastrophic global warming supporters, discussion of "the missing heat."

Attributing the Action of Complex Systems to Individual Inputs



A couple of years ago, the Obama Administration was tasked with figuring out how many jobs, if any, were created by the stimulus. Just adding up jobs at firms that had received government cash was not good enough — the theory of the Keynesian stimulus is that there is a multiplier (similar to the positive feedback in climate) that creates far more jobs than just the ones that can be directly measured. But how do we count these jobs? We don't have any sort of measuring device to tell us that one job would or would not have existed if, say, Solyndra had not gotten stimulus money.

What the Administration did was this: they took a computer model, the same one that originally said the stimulus would be effective, and plugged in the actual spending numbers to get a modeled job creation number. As political messaging, this made perfect sense. As science, the notion of checking a theoretical model's output with additional runs of the same model, rather than observational data, certainly leaves something to be desired. But to be fair, it's a tough problem — how does one sort out the effect of changing one variable in a complex system where hundreds, thousands, maybe even millions of other variables are changing simultaneously?

This is the problem scientists face in trying to determine the causes of the 0.7C warming over the last century. And, ironically, the IPCC's main argument was very similar to the way the stimulus was scored. They took computer models, which by their own admission left out a lot of the complexity in the climate, and ran them with and without manmade CO₂ in

the 20th century. Their conclusion: only man's CO₂ could have caused the measured warming. Skeptics like to describe this logic slightly differently: the IPCC says it had to be CO₂ because they couldn't think of anything else it could be.

So could it be anything else? Skeptics will argue that the period of rapid temperature increase the IPCC studied was relatively short, basically the 20 years from 1978 to 1998. Skeptics will point out that the world experienced a near identical pace of temperature increase from 1910-1940, well before our modern society began emitting CO₂ in earnest, casting into doubt whether the more recent increase was truly unprecedented and only possible given manmade CO₂.

Further, skeptics like to point to at least four other climate factors that might reasonably have contributed to the 0.7C of warming:

- Solar output, which was higher in the second half of the 20th century than the first
- Ocean cycles, like the Pacific Decadal Oscillation, which were in their warm period during the critical warming period from 1978-1998 that so worried the IPCC
- Continued recovery from the Little Ice Age, which bottomed out world temperatures in the 17th and 18th centuries
- Man's land use, including agriculture and urbanization

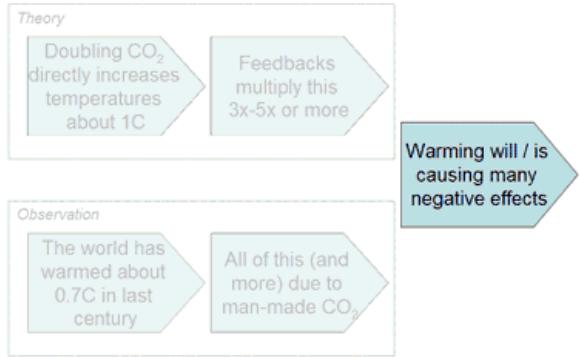
All told, there is no doubt that CO₂ is helping to warm the planet, but skeptics are reluctant to ascribe all of the last century's warming to this one cause when there were so many other forces working in the same direction.

The problem for global warming supporters is they actually need for past warming from CO₂ to be higher than 0.7C. If the IPCC is correct that based on their high-feedback models we should expect to see 3C of warming per doubling of CO₂, looking backwards this means we should already have seen about 1.5C of CO₂-driven warming based on past CO₂ increases. But no matter how uncertain our measurements, it's clear we have seen nothing like this kind of temperature rise. Past warming has in fact been more consistent with low or even negative feedback assumptions.

To defend the hypothesis of strong positive climate feedback, global warming supporters must posit that there are exogenous climate effects that are in fact holding down the increase due to CO₂. Thus has been born the theory of man-made sulfate aerosols, basically pollution from burning dirty fuels, that is keeping the Earth cool. When the rest of the world gets around to reducing these emissions as has the US, the theory goes, then we will see rapid catch-up warming. Skeptics point out that no one really has any idea of the magnitude of the cooling from these aerosols, and that, ironically, every global warming model just happens to assume exactly the amount of cooling from these aerosols that is needed to make their models match history.

Skeptics call this their "plug variable."

Hurricanes and Tornadoes and Lions and Tigers and Bears, Oh My



Certainly changing atmospheric temperatures, and perhaps even more importantly, changes in ocean temperatures, can be expected to have knock-on effects, both negative and positive (yes, I know the suggestion of positive effects borders on heresy, but don't you think folks in higher latitudes might appreciate longer growing seasons?) Skeptics argue, however, that too often the studies of these effects suffer from one of four types of mistakes:

1. ***Measurement Technology Bias*** – Improvements in our ability to accurately count or measure a phenomenon is mistaken for a real underlying change in the frequency of the phenomenon. A great example is tornadoes. The count of annual tornadoes appears to have increased over the last fifty years, but this increase is almost entirely due to Doppler radar and other technologies identifying previously unrecognized twisters. If one looks solely at larger tornadoes (class F3-F5) that were unlikely to be overlooked even with older technologies, annual counts are flat to slightly down over the last fifty years.
2. ***One sample makes a trend*** – This is less a flaw of any particular formal study and more a flaw in media coverage and among catastrophic global warming advocates (e.g. Al Gore). Individual extreme weather events are pointed to as proof of climate shifts, even when summary statistics show no such thing. For example, individual hurricanes like Katrina are pointed to as proof that global warming is increasing hurricane frequency and severity, when in fact measures of hurricane frequency and total energy (e.g. total cyclonic energy) have actually been decreasing over the last several years, to near all-time lows.
3. ***What is normal*** – Trends in certain variables are labeled as “abnormal” or “unprecedented” or “not natural” despite our having an extraordinarily short history of measurements such that it is almost impossible for us to say with any confidence exactly what “normal” is. In some cases, recent trends are labeled abnormal or unprecedented even when that trend appears to be long-standing and pre-date man-made CO₂. A great example is glacier retreat. We have good measurements showing substantial retreats in glaciers dating all the way back to the late 1700s (at the end of the little ice age). However, recent retreats in these same glaciers are portrayed as new and shocking and man-made, rather than in context of a longer-term trend (the exact same situation obtains with sea levels).
4. ***Everything looks like a nail*** – Climate is an extremely complex system with many, many variables changing simultaneously. It's a big, complicated engine we really don't understand that takes all these inputs and spits out certain outputs (e.g. snow in Washington today). Like a religious zealot that sees the face of God in his piece of toast, some observers seem to be able to magically attribute particular weather outcomes to the action of one single variable out of these millions. Even more amazingly, time after time, it seems to be the exact same variable, man-made CO₂, that is unilaterally creating the result.

Conclusion

So let's come back to our original question — what is it exactly that skeptics “deny.” As we have seen, most don't deny the greenhouse gas theory, or that

the Earth has warmed some amount over the last several years. They don't even deny that some of that warming has likely been via man-made CO₂. What they deny is the catastrophe — they argue that the theory of strong climate positive feedback is flawed, and is greatly exaggerating the amount of warming we will see from man-made CO₂. And, they are simultaneously denying that most or all of past warming is man-made, and arguing instead that the amount that is natural and cyclic is being under-estimated.

So how about the “97% of scientists” who purportedly support global warming? What proposition do they support? Let's forget for a minute a variety of concerns about cherry-picking respondents in studies like this (I am always reminded by such studies of the quote attributed, perhaps apocryphally, to Pauline Kael that she couldn't understand how Nixon had won because no one she knew voted for him). Let's look at the actual propositions the 97% agreed to in one such study conducted at the University of Illinois. Here they are:

- “ 1. When compared with pre-1800s levels, do you think that mean global temperatures have generally risen, fallen, or remained relatively constant?
- 2. Do you think human activity is a significant contributing factor in changing mean global temperatures?

The 97% answered “risen” and “yes” to these two questions. But depending on how one defines “significant” (is 20% a significant factor?) I could get 97% of a group of science-based skeptics to agree to the same answers.

So this is the real problem at the heart of the climate debate — the two sides are debating different propositions! In our chart, proponents of global warming action are vigorously defending the propositions on the left side, propositions with which serious skeptics generally already agree. When skeptics raise issues about climate models, natural sources of warming, and climate feedbacks, advocates of global warming action run back to the left side of the chart and respond that the world is warming and greenhouse gas theory is correct. At best, this is a function of the laziness and scientific illiteracy of the media that allows folks to talk past one another; at worst, it is a purposeful bait-and-switch to avoid debate on the tough issues.

Postscript: I wrote more on this topic in a [previous discussion of the science of the skeptics position here](#). These topics, with charts, data, and sources, are expanded substantially in a [video presentation here](#).

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