

Climate Scientists Virtually Unanimous: Anthropogenic Global Warming Is True

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James Lawrence Powell¹

Abstract

The extent of the consensus among scientists on anthropogenic global warming (AGW) has the potential to influence public opinion and the attitude of political leaders and thus matters greatly to society. The history of science demonstrates that if we wish to judge the level of a scientific consensus and whether the consensus position is likely to be correct, the only reliable source is the peer-reviewed literature. During 2013 and 2014, only 4 of 69,406 authors of peer-reviewed articles on global warming, 0.0058% or 1 in 17,352, rejected AGW. Thus, the consensus on AGW among publishing scientists is above 99.99%, verging on unanimity. The U.S. House of Representatives holds 40 times as many global warming rejecters as are found among the authors of scientific articles. The peer-reviewed literature contains no convincing evidence against AGW.

Keywords

global warming, climate change, consensus, peer review, history of science

Introduction

Does the consensus among scientists on anthropogenic global warming (AGW) matter to society? President Obama evidently believes it does: In May 2013, he tweeted, “Ninety-seven percent of scientists agree: #climate change is real, man-made, and dangerous.” In contrast, Senator Ted Cruz, chairing a meeting of the Senate Subcommittee on Space, Science, and Competitiveness in December 2015, dismissed the significance of the consensus by saying that, “In the year 1615 if you asked scientists, 97% of them would say the sun rotated around the Earth” (Atkin, 2015).

Though scientists in the 17th century did not practice the scientific method and believed any number of things that today we know to be false, Senator Cruz’s remark did contain a kernel of truth. Scientists have been wrong before, so how can we assess whether they are right today about AGW? Given the threat that global warming poses to future generations, possibly even to civilization itself, this is a vital question.

The claim of a 97% consensus derives from several peer-reviewed studies, but primarily from an article by Cook et al. (2013). If the claim were true, then since no climate scientist today could be without an opinion, 3% would reject AGW. Senator Cruz’s kernel of truth arises because even such a seemingly small percentage could weaken the case for action to prevent global warming. After all, were the majority always right, there would have been no scientific revolutions. Three examples from this century make the point. Until the 1960s, a tiny percentage of scientists believed that continents drifted; another tiny percentage that the impact of

meteorites, rather than volcanic eruptions, had created lunar craters; and still another that carbon dioxide emissions would cause global warming. In each case, though it took 50 years or more, new evidence finally proved that the small minorities had been right and the majority wrong (Oreskes, 1999; Powell, 2015; Weart, 2008). Overthrow of the ruling paradigm is the way of science, as Thomas Kuhn (1962) asserted more than a 50 years ago.

If 3% of publishing scientists reject AGW, then if one read, say, 100 journal articles, on average 3 would reject the theory. But as I will show below, to find even a single rejection, one must read several thousand articles. Based on the peer-reviewed literature then, the consensus on AGW cannot possibly be as low as 97%. The question is to find a method that can gauge it accurately.

Previous Studies of Consensus

Some studies have attempted to quantify the consensus by simply asking scientists their opinion. Doran and Zimmerman (2009) polled 10,257 geoscientists and received a 30.7% response rate. Overall, 90% of responders agreed that global temperatures have risen, while 82% agreed that the rise is mainly due to human activities. Of those judged most expert

¹National Physical Science Consortium, Los Angeles, CA, USA

Corresponding Author:

James Lawrence Powell, National Physical Science Consortium, USC-RAN, 3716 S. Hope Street, Los Angeles, CA 90007, USA.
Email: jpowell@usc.edu

in climate science, 96.2% (77 of 79) agreed with the first statement and 97.4% (75 of 77) with the second.

In early 2015, the Pew Research Center queried members of the American Association for the Advancement of Science, reporting that 87% of those responding agree that, “The Earth is getting warmer because of human activity.” But the response rate was only 18.8% and nearly half those who responded were from “Bio/Medical sciences,” a group whose members are unlikely to be expert in climate science (Pew Research Center, 2015).

Anderegg, Prall, Harold, and Schneider (2010) reviewed scientific assessment reports and multisignatory statements, dividing the signatories into two groups: those “convinced by the evidence (CE) of [AGW] and those unconvinced by the evidence (UE).” They found that, “The UE group comprises only 2% of the top 50 climate researchers as ranked by expertise (number of climate publications), 3% of researchers of the top 100, and 2.5% of the top 200, excluding researchers present in both groups.” Anderegg et al. (2010) concluded that, “97–98% of the climate researchers most actively publishing in the field support the tenets of ACC [AGW] outlined by the Intergovernmental Panel on Climate Change” (p. 12107).

These three studies confirm that there is a strong consensus on AGW, but because of some combination of small sample size, reliance on fallible opinion, and inclusion of nonexperts, they fail to reveal the strength.

Fortunately, in contrast to most areas of human affairs, in science we do not have to rely on opinion: We have the peer-reviewed, evidence-based scientific literature, authored by experts. To assess the state of a science, it is to that literature that we must turn.

Cook et al. (2013)

Cook et al. (2013) used the peer-reviewed literature to produce the most widely quoted study of the consensus on AGW. They employed the Thomson-Reuters Web of Science to review the titles and abstracts of peer-reviewed articles from 1991 to 2011 with the keywords “global climate change” and “global warming,” classifying the resulting articles into seven categories according to the strength of the expressed endorsement or rejection of AGW. Cook et al. reported that, “Among abstracts *expressing a position* [emphasis added] on AGW, 97.1% endorsed the consensus position that humans are causing global warming.” It is from this study that the world has come to believe that the scientific consensus on AGW is 97%. But I argue that the Cook et al. method and result are misleading for the following reasons.

First, consensus as defined and commonly understood means “agreement.” Cook et al. (2013), however, redefined consensus to mean *stated* agreement. No matter how clearly an abstract revealed that the author accepts AGW, if the abstract did not “express on opinion on AGW,” specifically

by “address[ing] or mention[ing] the cause of global warming,” Cook et al. classified it as having “no position” and omitted it from their calculation. Of the 11,944 articles in their database, they labelled 7,930 (66.4%) as taking no position and ruled them out of the consensus. But since the consensus, ipso facto, is what the majority agree with, one cannot rule out a two-thirds majority and still derive the consensus. If, for example, most of the authors of the nearly 8,000 articles that Cook et al. left out were to *accept* AGW, which I argue below they do, then the consensus is much higher than 97%. If most were to *reject* AGW, then there is no consensus. Which it is, Cook et al. did not settle and therefore they did not measure the consensus of acceptance of AGW.

Second, the core assumption of the Cook et al. (2013) method is that publishing scientists who accept a theory will say so: They will use language that “endorses” the theory. Cook et al. evidently did not test this assumption, for as I will show below a review of articles on other well-accepted theories shows that it is false.

Third, many authors, including many distinguished climate scientists, have articles in the Cook et al. (2013) no position category, even though we know these authors accept AGW. Many of those same authors also have articles in one or more of the three Cook et al. endorsing categories.¹ Dr. James Hansen, for example, has four articles in Category 1 (Explicit Endorsement With Quantification), six in Category 2 (Explicit Endorsement Without Quantification), and six in Category 3 (Implicit Endorsement), as well as six in Category 4 (no position). That Hansen has articles in Category 1 establishes that he accepts AGW. That Cook et al. place other Hansen articles in various other categories has nothing to do with whether he accepts AGW, but with the subject of a given article and whether that subject lent itself to the statement on causes that Cook et al. required. Hansen does not have multiple opinions about AGW, but only one opinion. This one example among many confirms that the Cook et al. method is about articles and their subject and language, not about whether their authors accept AGW and thus not about the true consensus.

Consensus in the Scientific Literature

Let us return to the question of whether authors routinely endorse the ruling paradigm of their discipline, the *sine qua non* of the Cook et al. (2013) method. Consider these examples from unpublished literature reviews that I have conducted using the methodology described below:

Plate Tectonics

This theory has been the ruling paradigm of geology for half a century. Of 500 recent articles that answer to the search topic “plate tectonics,” none rejected the theory nor did any endorse it directly.

Evolution

Of the 261 articles with abstracts in the run of the *Journal of Evolutionary Biology* from 2000 through 2014, none rejected Darwinian evolution nor did any endorse it directly.

Meteorite Impact

As recently as 1964, nearly every scientist who had studied the moon believed that her craters are volcanic. Then in July of that year, the first successful Ranger mission returned thousands of photographs showing that the moon exhibits craters ranging in size from the colossal to the microscopic, as well as other irrefutable evidence of impact. Except for a few senior holdouts, scientists quickly embraced the meteorite impact theory (Powell, 2015). A Web of Science search for “lunar craters” turns up 185 articles since 1920. I reviewed the abstracts of the most recent 100, which go back to 1997. None rejected meteorite impact as the cause of lunar craters nor did any endorse impact directly.

Environmental Research Letters

To come at the question from a different angle, I used the Web of Science to review articles from a single journal, *Environmental Research Letters*, for 2013 and 2014, searching under “global warming” and “climate change.” I found 283 unique articles. None rejected AGW and only one might be said to endorse the theory. Its title, “The role of reduced aerosol precursor emissions in driving near-term warming,” is self-explanatory. The authors concluded that “In the near-term, as in the long-term, GHG [greenhouse gas] increases are the dominant driver of warming.” In my opinion, this is not an endorsement but simply a statement of a scientific finding of the kind one might find in any number of articles.

The Cook et al. (2013) article was one of the 283. Even though we know these authors accept AGW, their own method places them in the no position category and rules them out of the consensus.

Paradigms

That publishing scientists almost never endorse their ruling paradigm should come as no surprise, for it follows directly from Thomas Kuhn’s (1962) model of progress in science. In *The Structure of Scientific Revolutions*, he defined “paradigms” as “universally recognized scientific achievements that for a time provide model problems and solutions to a community of practitioners” (p. viii). The phrase “universally recognized” means that except during brief periods of revolution, virtually all scientists in a field accept and work under the same ruling paradigm. It lies in the background of all they do, obviating the need to endorse it directly.

Applying the Cook et al. (2013) Method

In each of the examples above, there were no direct endorsements and no rejections. Would the Cook et al. (2013) method still work? No. To calculate their 97.1%, Cook et al. divided the number of endorsements by the total of endorsements plus rejections. But for these examples, that would leave us dividing zero by zero. If the method does not work in general, why should it work in the particular case of AGW?

Use of Rejection as the Criterion of Consensus

If endorsement is not a sound criterion, how might we use the peer-reviewed literature to measure consensus? I argue that we can use articles that clearly reject the theory to infer the percentage who accept it. Had Cook et al. (2013) done so, they would have calculated a consensus of 99.3%. This would have been the average over the 20 years of their survey. Here is my reasoning:

First, an author whose article turns up in a search under “global warming” has chosen to write about that topic. To publish in a peer-reviewed journal, that author must have evidence that bears on global warming.

Second, if that evidence cast doubt on AGW, that would be the point of the article and the author would describe and interpret the negative evidence. Were it convincing, the author would express strong doubt about AGW or even reject the theory. To turn the argument around, why have negative evidence on a topic, especially one as vital as AGW, publish on that topic, yet fail to mention that evidence? That would be dishonest and pointless.

Third, the history of science shows that scientific reputations are made by those who have successfully questioned the ruling paradigm. This is why we remember Copernicus and Galileo and not the inquisitors. It is why we venerate Alfred Wegener and not those who scorned and ridiculed him. The scientist who could falsify AGW would go down as one of the most celebrated in history. Anyone who had publishable evidence against AGW would not be shy about telling us.²

Methodology³

To find the number of recent articles that reject AGW, I used the following method:

- Web of Science Core Collection
- Enhanced Science Index
- Publication Years: 2013 and 2014
- Document Type: Article
- Topics: “Global warming” or “global climate change” or “climate change.”
- Remove duplicates by combining searches using the OR command.

- Export the search results to an Excel file.
- Review titles and abstracts looking for clear statements of rejection or that some process other than AGW better explains the observations.

Results and Conclusions

My search found 24,210 articles by 69,406 authors. In my judgment, only five articles rejected AGW: Avakyan (2013a, 2013b), Gervais (2014), Happer (2014), and Hug (2013). These represent a proportion of 1 article in 4,842 or 0.021%. With regard to the authors, 4 reject AGW: 1 in 17,352 or 0.0058%. As explained, I interpret this to mean that 99.99% of publishing scientists accept AGW: virtual unanimity.

Of course, what matters is not only how many articles reject AGW but also the quality of the evidence presented and the influence of those articles on science. The latter we can judge from the number of citations. As of January 2016, excluding self-citations, the five rejecting articles have been cited a total of once. The only possible conclusion is that there is no convincing evidence against AGW.

In the three historical examples with which I began—continental drift, meteorite impact, and global warming—decades passed without evidence sufficient to cause scientists to spurn their long-held beliefs. In contrast, today a massive amount of peer-reviewed evidence, thousands of articles written by tens of thousands of authors, supports AGW and there is no persuasive evidence against it. If such evidence existed, we would already know about it and not have to conduct a needle-in-the-haystack search in a vain attempt to find it.

Science can speak no more clearly: AGW is true. To further delay action to prevent global warming is to force science to bow to ideology and politics. Hitler, Mao, and Stalin all tried that, with results fatal for tens of millions. No one has summed up humanity's predicament better than Elizabeth Kolbert (2007): "It may seem impossible to imagine that a technologically advanced society could choose, in essence, to destroy itself, but that is what we are now in the process of doing" (p. 189).

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Notes

1. From the Cook et al. (2013) supplemental materials.
2. On a personal note, anyone who reads these many abstracts will come away with not the slightest doubt that their authors virtually to a person accept that humans are causing global warming. It is not only what they are writing about, it is the object of their precious time, energy, and in many cases,

their careers. How dumbfounded the thousands of authors that Cook et al. (2013) left out would be to find themselves labelled as having "no position" and ruled out of the consensus on the most important scientific question that humanity has ever faced.

3. Data sets available at <http://tinyurl.com/z8b9wof>

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Author Biography

James Lawrence Powell has a PhD from MIT in Geochemistry and is a former college president, museum director, and 12-year member of the U.S. National Science Board appointed first by President Reagan and then by President G. H. W. Bush. He is the author of several books. Asteroid 1987 SH7 is named for him.