In 2004, Naomi Oreskes published a paper in *Science* investigating the level of agreement in the peer-reviewed literature on climate change (Oreskes 2004). Among the 928 'global climate change' papers published between 1993 to 2003, not a single paper rejected the scientific consensus that humans were causing global warming. This result was featured by Al Gore in his Oscar winning film, *An Inconvenient Truth*.

This was the first of several papers investigating scientific consensus among climate scientists. A survey of over 3000 Earth scientists found that the higher the expertise in climate science, the greater the level of agreement on humanity's role in climate change (Doran and Zimmerman 2009). Among climate scientists actively publishing climate research, 97% agreed that humans were significantly changing global temperature.

A similar result was obtained two years later in a study collating public declarations on climate change (Anderegg et al. 2010). Among scientists who had published peer-reviewed research on global warming, around 97% endorsed the consensus.

When you consider that not a single national scientific organization in the world disputes the consensus, the conclusion is inescapable. The scientific agreement that humans are causing global warming is overwhelming and robust.

However, this conclusion has yet to seep into public consciousness. A 2012 survey of Americans found that 57% of the public disagree or are unaware of the scientific consensus (Pew 2012). There is a gaping chasm between public perception of consensus and the 97% reality.

In light of this, we decided to update Oreskes’ examination of the peer-reviewed literature by adding another decade of peer-reviewed research to the analysis. The period examined was 1991 to 2011. We also broadened the search by adding 'global warming' papers (Oreskes originally searched only 'global climate change' papers). The larger sample of over 12,000 papers allowed us to examine the evolution of consensus over the 21-year period.
Research was done by a team of volunteer researchers, all of them members of the Skeptical Science team. Skeptical Science is a website whose purpose is to refute climate misinformation with peer-reviewed science. This was a citizen science effort with a mix of team members, including a diversity of academics from all over the world. This included a climate scientist from Canada, chemistry and environmental scientists from the USA, a meteorologist from England and yours truly, a social scientist from Australia.

The initial challenge was maintaining motivation among the volunteers over several months, as we read and rated over 12,000 abstracts (not just once but twice in order to double check each others’ ratings). The work was tedious but not without its rewards - one rater reported feeling giddy when he encountered an abstract rejecting the consensus! I later learnt that there had been two similar efforts to measure the level of consensus in published climate papers. In both cases, the sample size was around 1000 papers. Both efforts were never completed. Had I known this, perhaps I wouldn't have been so ambitious with our sample size.

Another hiccup during the process was our website getting hacked (Lacatena 2014). Rather than cope with multiple email threads, we collaborate and discuss our research in a private web-based forum. Midway through the rating process, the forum was hacked and published online. This led to a number of bloggers poring over years' worth of private conversations, including discussions about our consensus research. The research was suspended for a short period while we relocated our forum and the online abstract rating system.

Our paper was rejected by the first two journals we submitted to. The reason? Establishing scientific consensus is stating the obvious. To paraphrase the reviews: tell us something we don't know! We worked hard to overcome this potential difficulty, including novel methods and results in our analysis. We invited authors of the climate papers in our analysis to categorize their own research, providing an independent measure of consensus. In our resubmission, we were careful to more strongly emphasize the novel aspects of our research.

Our paper was accepted by Environmental Research Letters, a journal launched in 2006 that already has an impact factor rivaling such prestigious journals as Geophysical Research Letters and Climatic Change. One of our priorities was making our paper open-access. Hiding it behind a pay wall would have been hideously unproductive, given our aim of increasing public awareness of consensus. The fee to make the paper open-access was USD$1,600. We put the call out for PayPal donations in a Skeptical Science blog post (Cook 2013a). It took 9 hours to raise the funds.

Once our paper (Cook et al. 2013) was published, our results generated a great deal of interest. Distributing press releases from the universities of myself and my coauthors led to media coverage in over 28 countries, including a number of non-English speaking countries (thank goodness for Google Translate). Interest peaked when President Obama's Twitter account tweeted about our research to 31 million followers (Obama 2013b). Several weeks later, President Obama mentioned the 97% consensus in a landmark speech on climate change (Obama 2013a).

Altmetrics is a website that measures chatter about scholar articles by monitoring mainstream media and social media outlets such as blogs and Twitter. Our paper was ranked as the 11th most talked about scholarly paper in 2013 (Altmetric 2014). Sadly, we were pipped out of the top ten by a paper about Sudoku. Our research was also listed in the top 5% of all scholarly papers. This last statistic, ranking the level of social media chatter on all academic papers ever published, does need to be taken with a grain of salt. There was no one in 1859 tweeting "OMG! Tyndall just discovered GHGs!"

Not all of the chatter was glowing. In less than a year, over 200 attacks on our research have been published. There have been blog posts, cartoons, reports, a YouTube video, a paper, TV interviews, and testimonies in government hearings. The one thing these attacks have in common is almost all were conducted by individuals or groups who reject the scientific consensus on human-caused global warming.
Why did our research provoke such strong reaction? Ours is the latest episode in over two decades of attacks on scientific consensus. In 1991, a fossil fuel group spent $510,000 on a PR campaign to reposition global warming as theory, not fact (Oreskes 2010). In recent years, the most common climate myth promoted by conservative columnists was "there is no consensus" (Elsasser and Dunlap 2013). Attacking the consensus is a central strategy by opponents of climate action.

Our research has also withstood some criticism from several academics that don't dispute the consensus. In these cases, I've been diligent in promptly and publicly responding to comments on our research by respected academics.

Law and psychology professor Dan Kahan questioned whether communicating the scientific consensus was an optimal approach, given that it may provoke a negative reaction from those dismissive of climate change (Kahan 2013). In response, I outlined the evidence for both the efficacy and importance of consensus messaging (Cook 2013b). Consensus information increases both acceptance of human-caused global warming (Lewandowsky, Gignac, and Vaughan 2013) and support for climate policy (Bolsen, Leeper, and Shapiro 2013). But crucially, consensus messaging was shown in an Australian experiment to partially neutralize the biasing influence of ideology with conservatives showing a greater increase in belief in human-caused global warming than liberals (Lewandowsky, Gignac, and Vaughan 2013). A study with U.S. participants found that the increase in perceived consensus in response to consensus information was greatest among conservatives (Kotcher et al. 2014).

Climate scientists at the Climate Change National Forum also questioned the value of the research, arguing that scientists should be discussing more nuanced questions than human-caused global warming (Forum 2014). In response, I pointed out that while the fundamental fact that humans are causing global warming was considered settled by scientists decades ago, the general public continue to be confused over even these fundamental elements of climate science (Pew 2012).

Climate scientist Mike Hulme argued that instead of discussing consensus, we should be talking about policy options (Hulme 2014). In a co-authored response, Stephan Lewandowsky and I argued that this was a counterproductive argument, given that those wishing to delay climate policy have focused on casting doubt on the consensus (Lewandowsky and Cook 2014). The entire point of reinforcing that the science on human-caused warming was settled was to move us to beyond the science to where the debate should be happening - what should we do about it?

Attacks on our research continue unabated. Those wishing to delay climate action will continue to cast doubt on the scientific consensus. At the same time, climate scientists and science communicators will continue to debate the most effective ways to communicate the realities of climate change. And social scientists continue to research the role of consensus messaging. I am part of this research strand, exploring the psychology of consensus and the impact of misinformation on public perceptions.

REFERENCES


Oreskes, N. 2010. *My facts are better than your facts,: spreading good news about global warming*.