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Moving beyond scientific agreement

An Editorial comment on "Climate Change: a profile of US climate scientists' perspectives"

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Climate scientists and the Intergovernmental Panel on Climate Change (IPCC) have recently been the focus of much media scrutiny. The public and political discourse around anthropogenic climate change seems likely only to intensify in the future, and thus the reported views of the scientific community must be clearly documented and communicated. In this issue of *Climatic Change*, Rosenberg and colleagues provide an informative and insightful snapshot of the climate science community. Their survey findings are exceptionally timely and largely vindicate the IPCC's conclusions about the state of scientific understanding. The nuances of their demographic analysis seem sure to open the door to future studies in the area. They present a thorough and cogent landscape of the surveyed climate scientist population. Two large questions, however, loom in the background of their study. First, who decides the appropriate population of researchers to sample from and what are the beliefs and credentials of those outside their delineation of climate scientists? This challenge to a study like this is most commonly construed as the "publication bias" argument that researchers who disagree with the mainstream paradigm do not get published in academic journals and then don't get counted in a survey such as this. Second, and perhaps more important, does communicating the scientific "consensus" on climate change louder or clearer have a substantial impact? In this Editorial Comment, I examine several insights of the Rosenberg et al. study and provide an additional viewpoint about the context of the study and questions motivated by the study.

Rosenberg and colleagues (hereafter R10) provide a detailed and well-analyzed portrait of US climate scientists and their perspectives. They surveyed 883 researchers with a voluntary, multi-modal empirical survey and asked the researchers about their demographic statistics such as age and political leaning, views on the causes and severity of global warming, and views on proposed policy actions to

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mitigate and adapt to climate change. They selected respondents based on authorship on any journal article from 1995–2004 in 13 peer-reviewed journals that highlight climate change research. While the selection of journals and time period examined are both arbitrary, this method should nonetheless capture a wide array of relevant researchers.

The authors find that US climate scientists overwhelmingly echo the conclusions and perspectives of the IPCC. A vast majority of surveyed scientists strongly agreed or agreed that global warming was underway (~94%), that human activities were accelerating warming (~88%), and that scientific uncertainty does not obviate the need for policy action on global warming (~91%). Surveyed climate scientists held beliefs about the severity and timing of climate change impacts, potential for US adaptation, and the importance of mitigation largely consistent with the IPCC. As a group, they strongly support many mitigation options, though this varies by political ideology.

In many senses, R10 vindicates both the conclusions and the process of the IPCC. If the study had found large discrepancies between surveyed US climate scientists' views and IPCC conclusions, this could indicate a potential selection bias in the survey's selection or in IPCC author selection. However, R10's results in fact suggest that the IPCC's conclusions accurately reflect those of the US climate science community and that bolsters confidence in the IPCC assessment process. Even where scientific debate still exists, for instance in the magnitude and extent of future climate change, the IPCC's conclusions are spot-on in capturing the current state of understanding scientific community. The authors fail to answer one obvious question here, however, which is how many of their 468 scientists were in fact IPCC authors. The degree of overlap between these two groups will ultimately determine whether R10 provides an independent validation of scientists' views or simply a clear snapshot of the same scientists, which can be nonetheless useful for the policy discussion.

The demographic statistics comprise a fascinating facet in R10's analysis. The authors survey scientists' employment (federal agency vs. university), research orientation (applied vs. theoretical), academic training (atmospheric sciences, ecology, or oceanography), primary expertise (data modeling, analysis, field observations and satellite observations), age ($\leq$45 years or $\geq$46 years), and political views (liberal, moderate, or conservative). They then conduct bivariate analyses to test the role of these attributes in shaping scientists' perspectives. Of these comparisons, very few of the categories significantly influence researcher's perspectives in any substantial way except political views, and this only on policy responses to climate change, not the underlying science. This is heartening news. It suggests striking agreement around the core scientific questions of anthropogenic climate change, regardless of a scientist's training, research orientation, primary expertise, current employment, age, or political views. The detectable effect of political views in policy responses to mitigation and adaptation, where conservative scientists were generally less likely to favor direct regulation approaches, is to be expected, as such decisions are largely political in nature.

While the climate science community is largely united in their perspectives around the core scientific questions, climate scientists as a population are a highly homogenous group. The surveyed scientists consisted of a staggering 85% male, close to 60% over age 45, and predominantly liberal. The authors did not survey race or

ethnicity, but such homogeneity is likely to be present in those categories as well. These results suggest that the community could do much, much better in encouraging more diversity in the field.

This study certainly makes a clear contribution to clarifying the perspectives of US climate scientists for the public and political discourse. But as we consider farther and farther from the pages of academic journals, two important questions arise that set a study like this in context. Understanding these questions and the dimensions around them can greatly improve the efficacy of studies such as R10. First, what about the skeptics? How do we reasonably delineate who constitutes an "expert," in this case a climate scientist, and who does not? In other words, far more people than the 883 researchers queried claim to be experts in climate science, including climate change skeptics/contrarians, when we consider the larger public discourse around anthropogenic climate change. Some will charge that academic journals and peer-review are part of a scientific cabal that subverts opposing viewpoints. These contrarian arguments can have a large impact on the public's understanding and views of climate change. A complementary method that directly examines the climate change skeptics/contrarians and their credentials speaks to this question and lends more weight to the analyses presented by R10. Second, does communicating scientific agreement around climate change lead to any meaningful shifts in public perception or policy progress? Put simply, I argue that the previous approach of quantifying scientific agreement encapsulated by Oreskes (2004) and R10 falls short of spurring action on climate change and we must consider new tactics.

The issues of who constitutes an expert, what is relevant expertise in an area, and what role should experts play in decision-making have been explored in the social studies of science literature (e.g. Collins and Evans 2002; Jasanoff 2003; Rip 2003). In the case of climate change, the concepts of expertise and credentials are marshaled frequently by all factions in the public discourse. I argue that we must consider the broadest net of expertise, including directly assessing the credentials of the climate contrarians because they have greatly influenced the public understanding of anthropogenic climate change (McCright and Dunlap 2003; Jacques et al. 2008; Malka et al. 2009). A recent controlled study demonstrates the potential impact of contrarian researchers. The authors showed some subjects an interview with only a mainstream scientist and others an interview with both a mainstream scientist and a climate change contrarian. Viewing the clip with a contrarian made subjects (1) less likely to believe that global warming is happening, (2) less likely to believe that scientists agree that global warming is happening, (3) less likely to believe global warming is a serious issue, and (4) less likely to support government action to deal with global warming (Malka et al. 2009).

Who are the climate change skeptics/contrarians and what are their credentials? I present here the flipside of the coin presented by Rosenberg and colleagues. All data presented are based off a dataset compiled comprehensibly from 12 of the most prominent statements and letters that dispute the conclusions of the IPCC (see Anderegg et al. 2010 for full details). On average, researchers skeptical of the IPCC's conclusions regarding anthropogenic climate change have substantially fewer publications in the climate literature and substantially fewer citations on their top-cited papers, even when considering all papers. Around 80% of the skeptics group have published fewer than 20 publications in climate, compared to less than 10% of IPCC AR4 Working Group I authors (Anderegg et al. 2010).

Climate change skeptics/contrarians tend to be an even more homogenous group. Men comprise 98.7% (465 of 471) of climate change skeptics and, based on the data available for ~60% of the community, skeptics received their PhD's an average of 10 years earlier (1977 versus 1987) than mainstream scientists. Thus, if one assumes a minimum age of receiving a PhD of 27, the average age of skeptics is around 60, and that of mainstream is around 50, which aligns with the mean age of 48 documented by R10. Others have indirectly documented the political leanings of leading climate contrarians. Jacques and colleagues found that over 92% (130 of the 141) of English-language books espousing environmental skepticism were published by conservative think tanks, or written by authors affiliated with those think tanks (Jacques et al. 2008).

While this provides interesting and hitherto unpublished information about the contrarian community, I have not directly addressed the "publication bias" criticism. I suggest two lines of reasoning that address this concern, one epistemological and another quantitative. For the current mainstream tenets of anthropogenic climate change to be a product of a broad-scale cabal, peer-reviewed papers by skeptical scientists, especially those threatening to the main paradigm, would have to be systematically suppressed and rejected, regardless of the data presented. Nearly everyone, from famous scientists to journal reviewers to graduate students, would be implicated as a participant. But in reality, the incentives of scientific epistemology are exactly the opposite (Gleick et al. 2010). Every scientist wants to be the next Darwin, the next Einstein. All young scientists dream of truly changing the way we think about the world, climate science, or redefining and redirecting a field. The common charge that "they're all doing it for the grant money" is laughable when one considers the potential funding capacity of typical grant agencies such as National Science Foundation compared to the capacity of private corporations who would rather not see climate legislation.

The second response takes a demographic and quantitative perspective. If such a cabal were occurring, we could look at the background and credentials of climate contrarians and skeptics and expect these to be largely similar to those of the mainstream scientists. Substantial differences between the background of mainstream and skeptical scientists would indicate that skeptical scientists are on average published much less frequently either due to less relevant expertise or lack of data, rather than an oppressive cabal.

From the above comprehensive dataset of skeptical researchers, I selected 50 scientists at random and classified their academic training in similar categories as R10 to be comparable. Those that were clearly outside the domain of natural sciences or had no documented doctoral degree were dropped, as in R10. However, these researchers without clear natural science qualifications comprised 30% of the skeptical community, as opposed to an estimated 5% of the mainstream community in R10 (45 researchers out of 929 investigated) (Fig. 1). Of these dropped researchers, 80% had no documented doctoral degree. Examining the remaining skeptical researchers shows stark contrasts with that of the mainstream scientific community. Atmospheric scientists comprise only 20% of skeptical researchers, compared to 43% of the mainstream community, and ecologists comprise 0% of the selected subsample, compared to 11% in R10 (Fig. 2). Geologists, not counted explicitly in R10 but tallied here, comprise a much larger percentage of the skeptical community (25.7%), surpassing atmospheric scientists. These estimates are in line with other more

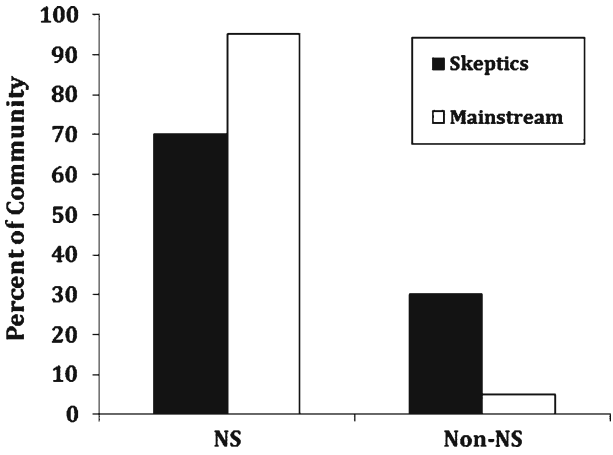

Fig. 1 Percent of mainstream and skeptical community categorized by natural scientists (NS) and not natural scientists or undocumented doctoral degree (Non-NS)

thorough examinations of the credentials, background, and expertise of skeptical researchers (Anderegg and Harold 2009).

Thus, climate change skeptics comprise a small proportion of US climate scientists and those that do publish in academic journals have on average much lower expertise in climate change science than IPCC authors (Rosenberg et al. 2010; Doran and Zimmerman 2009; Anderegg et al. 2010). I argue here that data about the training and background of these skeptical researchers indicates that these publishing differences are much more likely due less relevant expertise than to any sort of peer-review suppression.

The second question is harder to answer. Does communicating the science more loudly or clearly accomplish anything? To be sure, studies such as R10 that clarify the state of the scientists' perspectives provide a clear and quantitative baseline. But it's becoming abundantly clear that scientific agreement isn't enough to motivate meaningful action on climate change. Perhaps this stands in contrast with the 26–

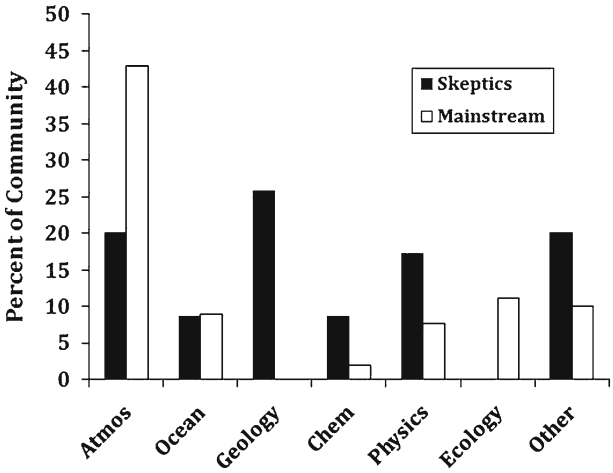

Fig. 2 Percent of mainstream and skeptical community categorized by academic training. Data of mainstream scientists from Rosenberg et al. 2010

48% of climate scientists that feel that their work is relevant to very relevant to policy makers in various fields, though scientists certainly understand that relevancy of research does not guarantee its use in policy.

I advocate a candid, inclusive, and humble path for making the next step. Scientific epistemology has a strong claim to answer questions about the evidence for global warming or attribution to human causes. But science has little or no special role in determining should we act to curtail climate change and how should we act. This path must be picked up by economists, social scientists, ethicists, humanists, and the general public.

Climate scientists typically lament that if the public only were educated about the science, impacts, and risks of climate change, they would support action. There certainly are a multitude of barriers to effective communication of climate change risks, including the efforts of the aforementioned climate contrarians (Malka et al. 2009). With these in mind, it's time to better engage communities outside the natural sciences. Social psychologists, behavioral economists, political scientists, historians, and educators among many others all have much to contribute. But climate scientists must understand that natural science holds no special place at this table and must be committed collaborating inside and outside academia.

Ultimately, however, people disagree about climate change and what to do about it for many reasons, few of them scientific in nature (Hulme 2009). Here is where the net must be broadest. What does climate change mean for artists, farmers, bird-watchers, hunters, Christians or Hindus? These are but a few of the groups that must be engaged with climate change to lead to meaningful action. Future research examining the perspectives and motivations of stakeholder groups such as these with regard to climate change could help pave a path to forging coalitions and generating broader and more effective results than simply communicating the science.

I laud the contribution of Rosenberg and colleagues. Studies such as this provide a well-needed note of clarity in the current confusion in the public discourse around climate change. But scientific consensus can only take us so far. The time has come to be asking harder questions about what to do when scientific agreement isn't enough and to move beyond the scientific consensus.

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