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LETTER

The climate change consensus extends beyond climate scientists

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Abstract

The existence of anthropogenic climate change remains a public controversy despite the consensus among climate scientists. The controversy may be fed by the existence of scientists from other disciplines publicly casting doubt on the validity of climate science. The extent to which non-climate scientists are skeptical of climate science has not been studied via direct survey. Here we report on a survey of biophysical scientists across disciplines at universities in the Big 10 Conference. Most respondents (93.6%) believe that mean temperatures have risen and most (91.9%) believe in an anthropogenic contribution to rising temperatures. Respondents strongly believe that climate science is credible (mean credibility score 6.67/7). Those who disagree about climate change disagree over basic facts (e.g., the effects of CO_2 on climate) and have different cultural and political values. These results suggest that scientists who are climate change skeptics are outliers and that the majority of scientists surveyed believe in anthropogenic climate change and that climate science is credible and mature.

1. Introduction

One vexing and ongoing concern about climate change is the discrepancy between the public view about climate change and the view of climate scientists. Approximately 97% of active, publishing climate scientists believe[4] in anthropogenic climate change (Doran and Zimmerman 2009, Anderegg *et al* 2010) and about 97% of papers published about climate change with an explicit position on the existence of climate change affirm that it is occurring (Cook *et al* 2013). However, only approximately half of the American public believes in anthropogenic climate change (Leiserowitz *et al* 2010, Weber and Stern 2011). There are many reasons for public doubt in climate change, including cognitive and affective factors (Gifford 2011, McCright and Dunlap 2011) and media coverage that gives undue weight to the climate change controversy (Boykoff and Boykoff 2004, Boykoff 2007) or is influenced by political ideology (Dotson *et al* 2012). Scientists who are publicly skeptical about climate science and anthropogenic climate change may also contribute to public disbelief in climate change. These scientists often specialize in disciplines other than climate science and typically are not currently researching climate issues (Jacques *et al* 2008, Lahsen 2008, Anderegg *et al* 2010). Concern has been expressed (McCright and Dunlap 2003, Jacques *et al* 2008) that these scientific skeptics have added false scientific credibility to skepticism. But is it false? Are non-climate scientist skeptics representative of the broader scientific community? What influences scientists' belief in climate change? Though many scientific organizations have produced climate change position statements affirming the existence of anthropogenic climate change (Oreskes 2004), the drafting of these statements is at times controversial and is often done without directly polling membership (Stenhouse *et al* 2014). This question is especially significant in the

[4] In this manuscript we use the term 'belief' in a technical sense: beliefs are dispassionate, cognitive components of attitudes (Heberlein 2012) and represent people's understanding of something. People's 'beliefs' may or may not be consistent with accepted scientific facts.

United States, which is the second-largest global emitter of carbon dioxide (Boden *et al* 2013). Here, we report on a survey of biophysical scientists at universities in the Big 10 Conference, a group of large, research-oriented universities in the United States (see Methods section for more details on the sample). The results show that scientists across disciplines nearly unanimously believe in anthropogenic climate change, are highly certain that climate change is happening, and find climate science to be trustworthy and credible.

1.1. Values, knowledge, and climate change beliefs

Disagreement about climate change is rarely a simple dispute about facts. Indeed, people's interpretation of climate change information appears to be influenced by cognitive factors and motivated reasoning (Kellstedt *et al* 2008, Gifford 2011, Hart and Nisbet 2012, Kahan *et al* 2012, Carlton and Jacobson 2013, Carlton and Jacobson 2015). Notably, perceptions about risks such as climate change have been shown to be affected by where people fit on two cultural values scales: individualism versus communitarianism and hierarchicalism versus egalitarianism (Kahan *et al* 2008, Kahan *et al* 2012). People with more individualistic than communitarian values tend to believe that individuals (as opposed to communities) are responsible for their own well being without help or interference from society. People who hold more hierarchical than egalitarian values tend to believe that authority comes from strict social order based on characteristics such as race, gender, and class. These cultural values influence how people interpret information about risks. According to the cultural cognition hypothesis, hierarchical individualists are more skeptical of environmental risks, including climate change, because accepting these risks would undermine hierarchical individualists' belief in commerce and industry. Those who hold more egalitarian and communitarian values tend to perceive environmental risks more acutely because they feel that commerce and industry (the drivers of many environmental risks) promote individuals over the community (Kahan *et al* 2011, Kahan *et al* 2012). Cultural cognition appears to influence climate change beliefs among everyone, not just those who are uninformed about climate change or who have insufficient reasoning skills to properly evaluate the evidence for anthropogenic climate change. In fact, the effects of cultural cognition may actually increase with higher levels of science literacy, greater technical reasoning skills, and higher numeracy (Kahan *et al* 2012). Additionally, climate change beliefs may be influenced by sources of climate change information (Trumbo 1996, Boykoff and Boykoff 2004, Antilla 2005, Boykoff 2007) and mediated by trust in scientists (Hmielowski *et al* 2014).

Are scientists different? One might expect all scientists to agree with the consensus on climate change. However, evidence suggests that cognitive factors may influence scientists' climate change beliefs, as well. A qualitative study of three physicists who were prominent climate change skeptics suggested that their beliefs were influenced about the role of science in society and the elite nature of physics compared to other sciences (Lahsen 2008). However, the role of cognition and knowledge in scientists' climate change beliefs is unexplored. In this study, we examine scientists' beliefs about climate change and climate science to determine (1) whether or not scientists agree with the climate science consensus about climate change and (2) whether cognitive factors and trust in climate science influence scientists' beliefs.

2. Methods

We surveyed the biophysical science faculty of the Big Ten universities in the US to ascertain (1) their beliefs about climate change, (2) their beliefs about climate science, (3) where they get their scientific information, and (4) their cultural and political values. Questions to evaluate climate change perceptions were adapted from earlier climate change surveys (Zimmerman 2008, Doran and Zimmerman 2009, Leiserowitz *et al* 2013, Prokopy *et al* 2013). Cultural values questions were adapted from those used in a study on the cultural cognition of scientific consensus (Kahan *et al* 2011). The specific question text can be found in the appendix.

The questionnaire was pilot-tested with a diverse sample of over 200 biophysical scientists from universities not included in the actual study sample. Because of concerns about the potential negative impact of the cultural values questions on the rate of survey completion, we randomly distributed two versions of the questionnaire to equal portions of the final sample. The first version included questions regarding field of study, climate change perceptions, beliefs about climate science, cultural values, political identification, and other demographics. The second version was identical with the exception that it omitted the cultural values questions (i.e., all items included in Q27 and Q28 in the appendix).

2.1. Survey administration

The Big 10 universities consist of twelve (*sic*) large, research-oriented universities representing diverse faculty and students in the United States: Indiana University, Michigan State University, Northwestern University, Ohio State University, Pennsylvania State University, Purdue University, University of Illinois, University of Iowa, University of Michigan, University of Minnesota, University of Nebraska, and University of Wisconsin. The sampling frame was constructed by browsing each of the universities' main websites. Colleges and departments that fell under the categories of sciences, biological sciences, natural sciences,

physical sciences, earth sciences, agriculture, environmental sciences, natural resources, and other geosciences were selected for the study. Colleges based around engineering, architecture, liberal arts, technology, policy, law, business, education, fine and performing arts, health sciences, and animal sciences were excluded. Within each college, departments were identified that fell under the categories of biology, chemistry, physical sciences, environmental sciences, or geosciences. These departments included forestry and natural resources, fish and wildlife sciences, soil sciences, plant sciences, crop sciences, horticulture, atmospheric sciences, meteorology, geography, geology, entomology, biology, chemistry, physics, and astronomy. Climate scientists were not excluded from the sample. Some engineers who were not housed in engineering departments were in the final sample. Contact information for faculty members was located on departmental webpages. In order to standardize across universities, tenured, tenure track, visiting, and emeritus faculty members were included in the sampling frame. Emeritus faculty were included in the sample because prior work on scientists who were climate change skeptics tended to be from older generations (Lahsen 2008). Research and adjunct faculty were excluded from data collection because their listing on websites was inconsistent. The name, university, department, email, and phone number of each faculty member were recorded. Because email addresses were required to administer the questionnaire, faculty members without a listed email were not included. The final selection frame included 4816 names.

To create the sample, 2000 names were randomly selected from the list of scientists. An equal number of recipients were then randomly assigned to either group A, who received the questionnaire that included cultural values questions, or group B, who received the questionnaire excluding the cultural values questions. The survey was administered online using Qualtrics Survey Software. Links to the questionnaire were distributed through email in February and March of 2014. Based on survey administration best practices (Dillman *et al* 2008), up to three contacts (the initial email letter, a reminder email, and a final reminder) were made with recipients. Emails that bounced were removed from the sample and were not replaced with new addresses because of the relatively large sample size.

2.2. Data analysis

Differences among groups were determined using a t-test and were considered significant at $a = 0.05$. Following Kahan *et al* (2011), median splits were used to group respondents by cultural values. Logistic and multiple regressions were used to model climate change belief and certainty, respectively, using trust in climate science, proportion of climate change information coming from scientific literature, political orientation (1 = 'Very conservative', 5 = 'Very Liberal') as predictors and age, gender, amount of the respondent's research that concerns climate change, and number of courses taken as graduate or undergraduate in the following fields: chemistry, physics, earth/ocean/atmospheric sciences, math, biology, and engineering.

Data were analyzed using Stata version 12.1. Dot plots were created using Stata and the bean plots were created using the beanplot package in R version 3.0.

3. Results and discussion

After excluding invalid addresses (i.e., emails that bounced back), we surveyed a sample of 1868 scientists and received 698 responses (37.4% response rate). This response rate is slightly better than the prior work on climate scientists and climate change (30.7%, Doran and Zimmerman 2009). There were no significant differences in response rate between the survey version with the cultural values questions and the survey version without the cultural values questions. The results suggest a broad consensus that climate change is occurring: when asked 'When compared with pre-1800's levels, do you think that mean global temperatures have generally risen, fallen, or remained relatively constant?', 93.6% of respondents across all disciplines indicated that they thought temperatures have risen, 2.1% thought temperatures had remained relatively constant, 0.6% thought temperatures had fallen, and 3.7% indicated they had no opinion or did not know. Belief in climate change was relatively consistent across disciplines (range: 91.2%–100%, figure 1).

Most respondents believed that humans are contributing to the rise in temperatures. Of those who indicated that they believed temperatures have risen, 98.2% indicated they believe that 'human activity is a significant contributing factor in changing mean global temperatures'. Together, these two facts reveal that 91.9% of scientists surveyed believed in anthropogenic climate change. This number is slightly lower than the 96.2% of actively publishing climate scientists that believe that mean temperatures have risen and the 97.4% who believe that humans have a role in changing mean global temperatures (Doran and Zimmerman 2009).

Those who said that temperatures have risen were significantly more certain in their beliefs than those who did not (3.41 versus 2.40 on a 4-point scale, $t = -5.08$, $p < 0.001$). Scientists who believed in anthropogenic contribution to temperature rises and scientists who did not believe in an anthropogenic contribution were similarly certain in their beliefs (3.40 versus 3.3, $t = -0.57$, $p = 0.57$). Respondents who disagreed about whether temperatures had risen tended to have different beliefs about the relationship

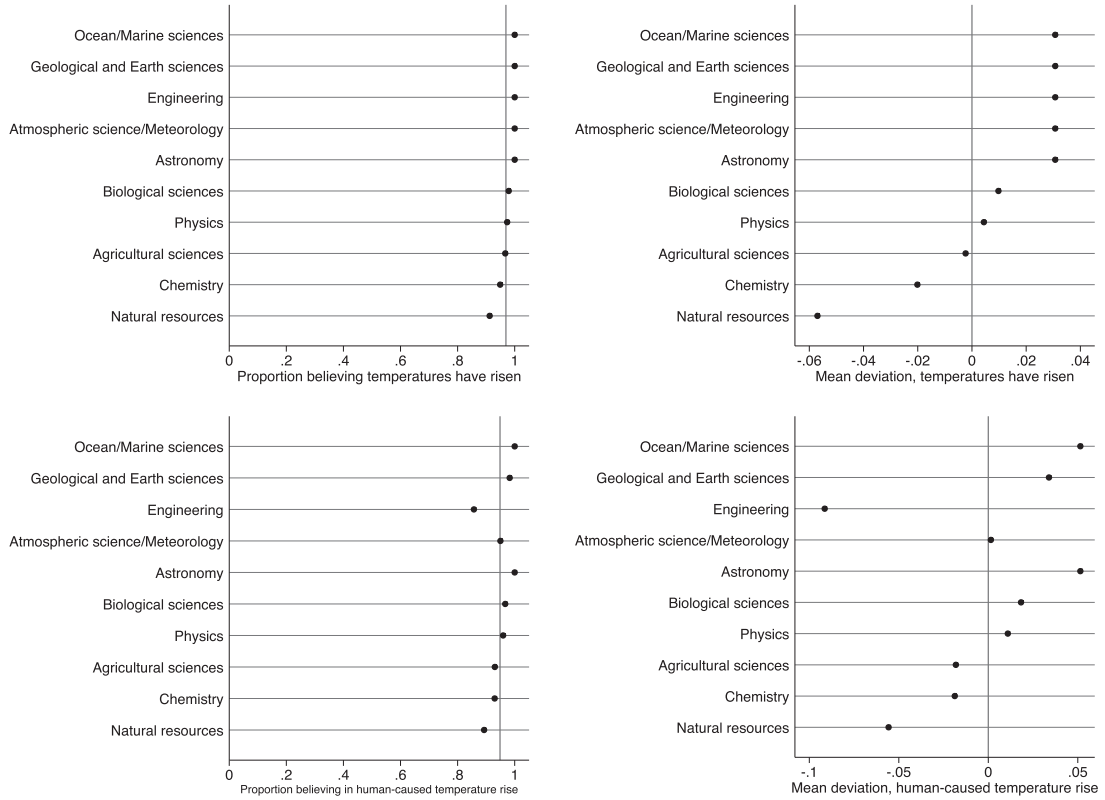

Figure 1. Proportion and mean deviation of scientists in Big 10 universities believing that temperatures have risen and a human cause of rising temperatures, by academic discipline. The vertical line represents the average in the proportion graphs and the 0-point in the mean deviations.

between greenhouse gases, solar activity, climate change, and climate change models, as well (figure 2), indicating that a disagreement about the 'facts' of climate change was at least part of the difference between those who did and did not believe in climate change.

The cognitive and demographic data are presented in figure 3. Those who believed that mean temperatures had risen had significantly higher levels of trust in climate science, were significantly more egalitarian, more communitarian, and more liberal than those who did not believe temperatures had risen. The respondents were divided in cultural values: 35.1% hierarchical individualist, 31.3% egalitarian communitarians, and 33.6% were either egalitarian-individualist or hierarchical-communitarian. A significantly smaller proportion of hierarchical individualists (e.g., those who scored above the median on both the hierarchical and individualism scales, Kahan *et al* 2011) believed in climate change than non-hierarchical individualists (94.3% versus 98.8%; $t = 2.11$, $p = 0.02$). The difference is greater when comparing egalitarian communitarians to hierarchical individualists (leaving out those in the middle): 100% of egalitarian communitarians believed in climate change compared to 94.3% of hierarchical individualists ($t = 2.21$, $p = 0.01$). Cultural values were also significantly associated with certainty that climate change is occurring: hierarchical individualists were significantly less certain when compared to the rest of the sample (mean certainty of 3.14 versus 3.63, $t = 5.43$, $p < 0.001$) and when compared to egalitarian communitarians (3.14 versus 3.65, $t = 4.69$, $p < 0.001$).

Cultural values were associated with belief in human contribution to climate change. Significantly fewer hierarchical individualists believed in climate change than others (90.3% versus 99.4%, $t = 3.72$, $p < 0.001$). Again, the difference was stronger at the cultural value extremes: 100% of egalitarian communitarians believed in a human cause compared to the 90.3% of hierarchical individualists ($t = 2.94$, $p = 0.002$). Compared to other respondents, hierarchical individualists who believed in anthropogenic climate change were significantly less certain of a human contribution to climate change (mean certainty 3.12 for hierarchical individualists versus 3.54 for others, $t = 4.46$, $p < 0.001$). As expected, this difference was even greater when comparing hierarchical individualists to egalitarian communitarians (3.12 versus 3.64, $t = 4.69$, $p < 0.001$). In all, these results affirm prior findings that cultural values are a significant determinant of climate change beliefs (Kahan *et al* 2011), though the effects may be smaller among scientists than the general public.

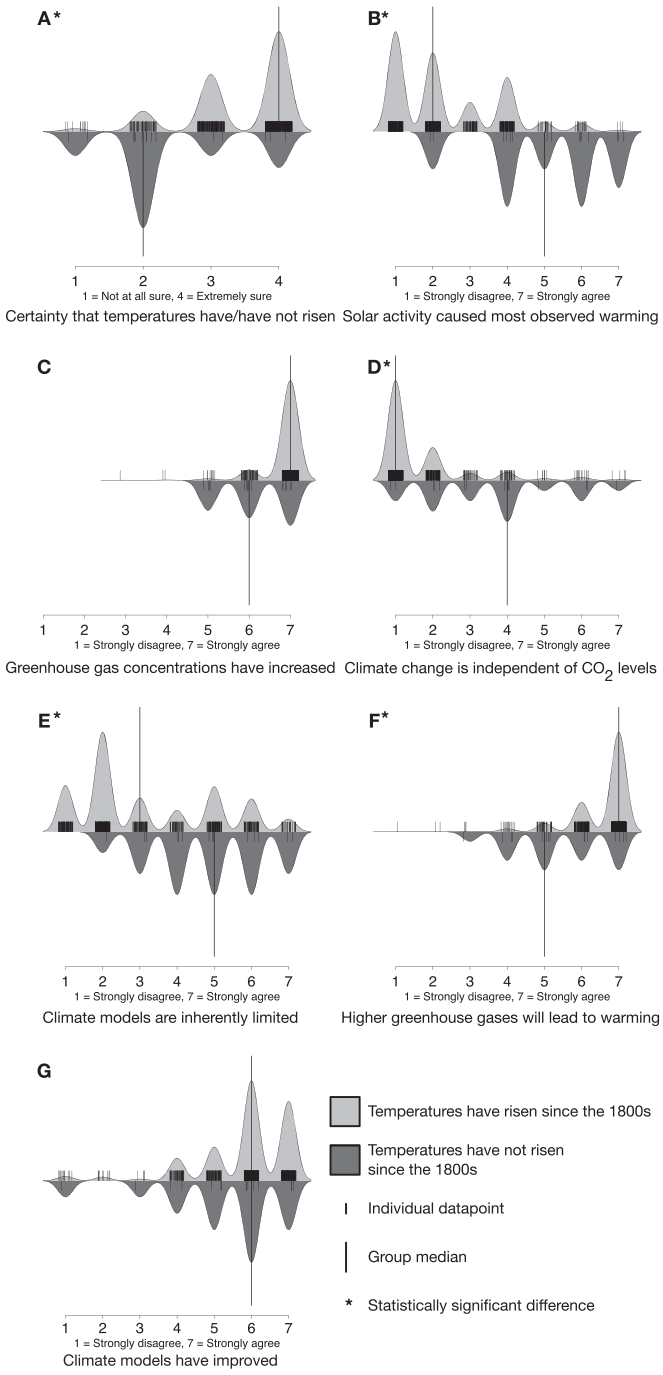

Figure 2. Beliefs about climate change among those who do and do not believe that mean temperatures have risen since the 1850s. The width and shape of the beanplots represent kernel density estimates for the distribution of responses. The thin, vertical black lines represent individual responses, which were jittered to improve clarity. The vertical lines represent the medians. Statistically significant differences include subgraphs A ($t = -05.08, p < 0.001$), B ($t = 9.11, p < 0.001$), C ($t = -6.17, p < 0.001$), D ($t = 6.21, p < 0.001$), E ($t = -1.91, p = 0.03$), and F ($t = -5.31, p < 0.001$).

Respondents generally found climate science to be credible. The average response to 'Climate science is a credible science' was 6.67 out of 7, indicating strong agreement. The average response to 'Compared to my field, climate science is a mature science' was 4.78 out of 7, indicating slight agreement. Respondents also rated the trustworthiness of climate science compared to their field, from 1 ('Much less trustworthy') to 5 ('Much more trustworthy') with a middle point of 3 ('About equally trustworthy'). The average response was 2.69, indicating that respondents thought climate science was slightly less trustworthy than their field. The data, grouped by respondents' disciplines, are presented in figure 4.

As with the general public, the mass media's tendency to give undue weight to climate skepticism (Boykoff and Boykoff 2004, Boykoff 2007) appears to have influenced scientists. Though amount of climate

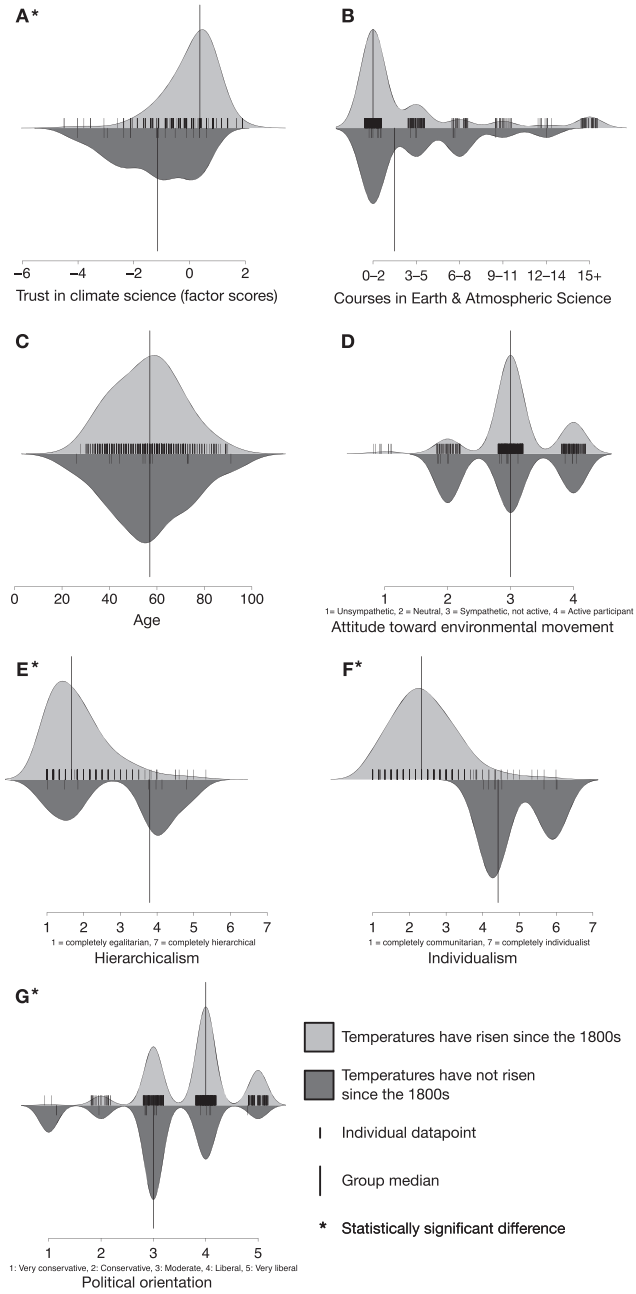

Figure 3. Demographic and cognitive variables among those who do and do not believe that mean temperatures have risen since the 1850s. The width and shape of the beanplots represent kernel density estimates for the distribution of responses. The thin, vertical black lines represent individual responses, which were jittered to improve clarity. The vertical lines represent the medians. Significant differences include subgraphs A ($t = -5.47, p < 0.001$), E ($t = 3.55, p < 0.001$), F ($t = 7.56, p < 0.001$), and G ($t = -3.40, p < 0.001$).

change information received from scientific literature compared to mass media was not significantly correlated with belief in climate change or belief in human contribution, there was a slight, significant correlation between proportion of climate change information received from scientific literature and certainty that climate change was occurring ($r = 0.15$, $p < 0.001$) and a moderate, significant correlation between proportion of climate change information from scientific literature and certainty of a human contribution ($r = 0.23$, $p < 0.001$). In other words, those who received more climate change information from mass media were less certain of the existence of and human contribution to climate change.

The results of the regression models for climate change beliefs and certainty are presented in tables 1 and 2. The only predictor that was significant in all models was trust in climate science: respondents who trusted climate science more were more likely to believe in climate change, were more likely to believe in

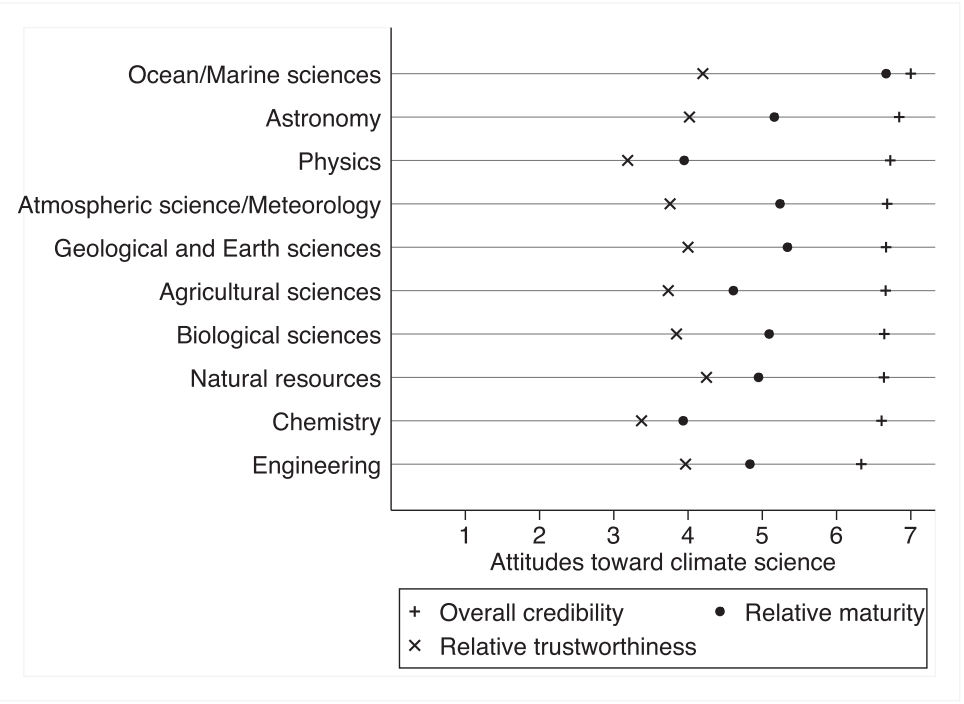

Figure 4. Big 10 scientists' perceptions of climate science as measured by overall credibility of climate science, the maturity of climate science relative to respondents' field, and the trustworthiness of climate science relative to respondents' field. Relative trustworthiness was re-scaled from 5-points to 7-points for this figure.

Table 1. Logistic regressions for belief in climate change and belief in human contribution to climate change among scientists at Big 10 Universities.

	Belief in climate change		Belief in human contribution	
Predictor	Odds ratio	*p*-value	Odds ratio	*p*-value
Trust in climate science	2.95	0.000	5.72	0.000
Proportion of research concerning climate change	0.21	0.007	0.13	0.022
Proportion of climate change information from scientific literature	0.77	0.600	1.15	0.858
Male	0.2	0.037	0.77	0.829
Age	0.96	0.055	0.99	0.893
Liberalism	1.71	0.116	4.56	0.005
Chemistry classes taken	0.78	0.201	1.02	0.951
Physics classes taken	1.31	0.442	2.11	0.232
Earth/Ocean/Atmospheric science classes taken	1.41	0.159	1.3	0.507
Math classes taken	1.23	0.665	0.49	0.314
Biology classes taken	1.46	0.044	1.06	0.835
Engineering classes taken	0.82	0.449	0.79	0.616
Model p	<0.001		<0.001	
Pseudo R^2	0.3457		0.6449	

a human contribution to climate change, and were more certain in these beliefs. These results suggest that, when it comes to climate change, scientists are people, too: prior research shows that trust in scientists mediates climate change perceptions (Hmielowski *et al* 2014). Political values and sources of media influence climate change beliefs in several of the models, though the effect is attenuated compared to the general public (McCright and Dunlap 2011).

4. Conclusions

Though public awareness of the scientific consensus on climate change may be insufficient to spur large-scale adaptive or mitigative measures (Kellstedt *et al* 2008), prior work has suggested that it may be necessary. For example, public support for climate policies is affected by incorrect perceptions that the existence of anthropogenic climate change is

Table 2. Regression predicting certainty that climate change is occurring and that humans are contributing to climate change among scientists at Big 10 universities.

	Certainty of climate change		Certainty of human contribution	
Predictor	Beta	*p*-value	Beta	*p*-value
Trust in climate change	0.39	0.000	0.31	0.000
Proportion of research concerning climate change	0.09	0.050	0.05	0.352
Proportion of climate change information from scientific literature	0.11	0.013	0.21	0.000
Male	−0.05	0.215	0.06	0.150
Age	0.03	0.450	0.04	0.368
Liberalism	0.22	0.000	0.24	0.000
Chemistry classes taken	0.01	0.873	0.07	0.095
Physics classes taken	0.17	0.005	0.07	0.265
Earth/Ocean/Atmospheric science classes taken	−0.05	0.277	−0.10	0.026
Math classes taken	−0.05	0.386	0.02	0.715
Biology classes taken	−0.01	0.746	0.01	0.873
Engineering classes taken	−0.04	0.402	−0.06	0.206
p	<0.001		<0.001	
*Adjusted r*2	0.2583		0.2256	

scientifically controversial (Ding *et al* 2011, Aklin and Urpelainen 2014). Prior work has established that there is consensus among climate scientists that anthropogenic climate change exists (Doran and Zimmerman 2009, Anderegg *et al* 2010, Cook *et al* 2013). Our findings expand beyond these works to show that there is a general consensus among biophysical scientists across the United States that (1) climate change is occurring, (2) humans are contributing to it, and (3) climate science is a trustworthy, mature, and credible discipline. Scientists who continue to claim otherwise are operating outside of the consensus, not just of climate scientists, but also of scientists as a whole.

However, the fact that cultural values and political ideology appeared to influence the scientists' beliefs underscores the difficulty of climate change as a public issue. There is a temptation to think of those who don't believe in climate change as uninformed or irrational. However, studies are increasingly showing that knowledge and rationality are just one piece of the complicated climate puzzle. Values and identity matter, among the general public (e.g., Kahan *et al* 2011) and, as this research shows, among putatively rational scientists. It is becoming increasingly apparent that effective climate change outreach, communication, and policy must account not just for the 'facts' of climate change, but for the 'feel' of it, as well.

Acknowledgments

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Appendix. Survey questions and results

Q1 Which of the following best describes your primary field of study:

1.	Agricultural Sciences	18.8%
2.	Astronomy	4.85%
3.	Atmospheric Science and Meteorology	3.08%
4.	Biological Sciences	28.34%
5.	Chemistry	8.81%
6.	Engineering	1.03%
7.	Geological and Earth Sciences	9.10%
8.	Natural Resources	8.81%
9.	Ocean/Marine Sciences	0.59%
10.	Physics	11.31%
11.	Other (please specify) _____	5.29% (**recoded based on Q2 for analysis**)

Q2 What is your specific field of study? (Open-ended).

Q3 When compared with pre-1800's levels, do you think that mean global temperatures have generally risen, fallen, or remained relatively constant?.

1.	Risen	93.48%
2.	Remained relatively constant	2.22%
3.	Fallen	0.74%
4.	No opinion/don't know	3.56%

Q4 Do you think human activity is a significant contributing factor in changing mean global temperatures? (Question displayed only if respondent thinks temperatures have risen).

1.	Yes	96.66%
2.	No	3.34%
3.	Not Sure	0%

Q5 How sure are you that mean global temperatures have risen compared to pre-1800s levels? (Question displayed only if respondent thinks temperatures have risen).

1.	Extremely sure	55.98%
2.	Very sure	31.26%
3.	Somewhat sure	11.16%
4.	Not at all sure	1.59%

Q10 How sure are you that mean global temperatures have remained constant compared to pre-1800s levels? (Question displayed only if respondent thinks temperatures have remained constant).

1.	Extremely sure	7.14%
2.	Very sure	14.29%
3.	Somewhat sure	64.29%
4.	Not at all sure	14.29%

Q11 How sure are you that mean global temperatures have fallen compared to pre-1800s levels? (Question displayed only if respondent thinks temperatures have fallen).

1.	Extremely sure	66.67%
2.	Very sure	0%
3.	Somewhat sure	0%
4.	Not at all sure	33.33%

Q12 How sure are you that human activity is a significant contributing factor in changing mean global temperatures? (Question displayed only if respondent thinks human activity is a contributing factor).

1.	Extremely sure	53.23%
2.	Very sure	35.32%
3.	Somewhat sure	10.45%
4.	Not at all sure	1.00%

Q13 How sure are you that human activity is not a significant contributing factor in changing mean global temperatures? (Question displayed only if respondent thinks human activity is not a contributing factor).

1.	Extremely sure	33.33%
2.	Very sure	27.78%
3.	Somewhat sure	38.89%
4.	Not at all sure	0%

Q18 Climate science is a credible science.

1.	Strongly agree	78.79%
2.	Moderately agree	15.30%
3.	Slightly agree	3.03%
4.	Undecided	1.06%
5.	Slightly disagree	0.61%
6.	Moderately disagree	0.91%
7.	Strongly disagree	0.30%

Q19 Compared to my field, climate science is a mature science.

1.	Strongly agree	17.10%
2.	Moderately agree	33.74%
3.	Slightly agree	12.67%
4.	Undecided	8.09%
5.	Slightly disagree	11.15%
6.	Moderately disagree	10.38%
7.	Strongly disagree	6.87%

Q20 Compared to my field, climate science is.

1.	Much less trustworthy	8.62%
2.	Slightly less trustworthy	21.85%
3.	About equally trustworthy	62.92%
4.	Slightly more trustworthy	4.15%
5.	Much more trustworthy	2.46%

Q25 Which of the following statements comes closest to describing your research?

1.	The majority of my research concerns climate change or the impacts of climate change	5.50%
2.	Some of my research concerns climate change or the impacts of climate change	42.45%
3.	None of my research concerns climate change or the impacts of climate change	52.04%

Q26 Where do you get your information about climate change?

1.	Mostly from popular media	14.88%
2.	Mostly from scientific literature	32.82%
3.	About equally from popular media and scientific literature	52.30%

Q27 Please indicate how strongly you agree or disagree with the following statements about climate change:

	Strongly agree (%)	Moderately agree (%)	Slightly agree (%)	Undecided (%)	Slightly disagree (%)	Moderately disagree (%)	Strongly disagree (%)
Atmospheric concentrations of greenhouse gases have increased sharply since the Industrial Revolution.	86.55	10.36	2.16	0.77	0.15	0	0
Variation in solar activity is responsible for the majority of the observed warming in the past century.	0.93	3.88	3.88	20.00	10.39	26.98	33.95
Higher emissions of greenhouse gases will lead to greater atmospheric warming.	68.32	20.56	6.65	3.25	0.62	0.46	0.15
Climate predictions are largely inaccurate because of the inherent limitations of computer climate models.	4.81	11.49	15.68	8.39	11.34	32.45	15.84
Climate models have improved in their ability to predict surface temperature patterns.	31.53	40.80	13.60	9.74	0.93	1.39	2.01
Climate change is independent of atmospheric carbon dioxide levels.	0.93	2.17	1.70	6.50	5.57	21.21	61.92

Q28 People in our society often disagree about how far to let individuals go in making decisions for themselves. How strongly do you agree or disagree with each of these statements?

	Strongly agree	Moderately agree	Slightly agree	Slightly disagree	Moderately disagree	Strongly disagree
The government interferes far too much in our everyday lives.	2.95	6.56	13.77	16.07	33.44	27.21
Sometimes the government needs to make laws to keep people from hurting themselves.	2.97	1.32	1.32	12.87	37.95	43.56
It's not the government's business to try and protect people from themselves.	2.97	4.29	8.58	16.50	3993	27.72
The government should stop telling people how to live their lives.	3.06	8.50	15.99	19.73	33.33	19.39
The government should do more to advance society's goals, even if that means limiting the freedom and choices of the individuals.	6.40	6.40	10.77	29.63	32.32	14.48
Government should put limits on the choices individuals can make so they don't get in the way of what's good for society.	7.51	8.87	9.22	28.67	32.08	13.65

Q29 People in our society often disagree about issues of equality and discrimination. How strongly do you agree or disagree with each of these statements? (Omitted for half the respondents).

	Strongly agree	Moderately agree	Slightly agree	Slightly disagree	Moderately disagree	Strongly disagree
We have gone too far in pushing equal rights in this country.	2.09	2.44	6.27	9.06	24.74	55.40
Our society would be better off if the distribution of wealth was more equal.	4.47	3.09	2.75	16.84	27.84	45.02
We need to dramatically reduce inequalities between the rich and the poor, whites and people of color, and men and women.	3.77	2.74	7.53	16.44	25.34	44.18
Discrimination against minorities is still a very serious problem in our society.	1.03	2.41	2.41	15.46	41.58	37.11
It seems like blacks, women, homosexuals, and other groups don't want equal rights, they just want special rights just for them.	0.34	2.41	5.86	8.62	22.07	60.69
Society as a whole has become too soft and feminine.	1.05	2.10	8.39	7.34	15.03	66.08

Q30 Thinking about the environmental movement, do you think of yourself as:

1.	An active participant in the environmental movement	21.55%
2.	Sympathetic towards the environmental movement, but not active	65.61%
3.	Neutral	11.25%
4.	Unsympathetic towards the environmental movement	1.58%

Q31 In general, would you describe your political views as….

1.	Very conservative	0.63%
2.	Conservative	4.60%
3.	Moderate	29.84%
4.	Liberal	47.46%
5.	Very liberal	17.46%

Q32 What is your gender?

1.	Male	78.31%
2.	Female	21.69%

Q33 In what year were you born?
Mean age 56.38, SD 13.83

Q34 What is your ethnicity?

1.	African-American	0.48%
2.	American Indian	0.16%
3.	Asian/Asian-American/Pacific Islander	3.68%
4.	Hispanic/Latino	0.96%
5.	White/Caucasian	89.12%
6.	Multi-racial	0.80%
7.	Other	0.64%
8.	Prefer not to answer	4.16%

Q35 During your undergraduate and graduate education, how many courses did you take in chemistry?

1.	0–2	18.96%
2.	3–5	39.18%
3.	6–8	19.91%
4.	9–11	7.27%
5.	12–14	5.06%
6.	15+	8.06%
7.	Don't know/can't remember	1.58%

Q36 During your undergraduate and graduate education, how many courses did you take in physics?

1.	0–2	36.87%
2.	3–5	32.75%
3.	6–8	8.23%
4.	9–11	5.54%
5.	12–14	4.75%
6.	15+	10.44%
7.	Don't know/can't remember	1.42%

Q37 During your undergraduate and graduate education, how many courses did you take in earth, ocean, or atmospheric science?

1.	0–2	64.43%
2.	3–5	15.47%
3.	6–8	5.74%
4.	9–11	4.31%
5.	12–14	2.07%
6.	15+	6.86%
7.		1.12%

(Continued.)

	Don't know/can't remember	

Q38 During your undergraduate and graduate education, how many courses did you take in math?

1.	0–2	8.40%
2.	3–5	42.63%
3.	6–8	25.83%
4.	9–11	12.84%
5.	12–14	5.23%
6.	15+	3.96%
7.	Don't know/can't remember	1.11%

Q39 During your undergraduate and graduate education, how many courses did you take in biology?

1.	0–2	28.89%
2.	3–5	11.59%
3.	6–8	10.32%
4.	9–11	10.48%
5.	12–14	9.52%
6.	15+	27.30%
7.	Don't know/can't remember	1.90%

Q40 During your undergraduate and graduate education, how many courses did you take in engineering?

1.	0–2	79.58%
2.	3–5	10.86%
3.	6–8	2.92%
4.	9–11	2.11%
5.	12–14	0.97%
6.	15+	2.43%
7.	Don't know/can't remember	1.13%

References

Aklin M and Urpelainen J 2014 Perceptions of scientific dissent undermine public support for environmental policy *Environ. Sci. Policy* **38** 173–7

Anderegg W R L, Prall J W, Harold J and Schneider S H 2010 Expert credibility in climate change *Proc. Natl Acad. Sci. USA* **107** 12107–9

Antilla L 2005 Climate of skepticism: US newspaper coverage of the science of climate change *Glob. Environ. Change* **15** 338–52

Boden T A, Marland G and Andres R J 2013 *Global, Regional, and National Fossil-Fuel CO_2 Emissions* (Oak Ridge, TN: Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory U.S. Department of Energy) (doi:10.3334/CDIAC/00001_V2013)

Boykoff M T 2007 Flogging a dead norm? newspaper coverage of anthropogenic climate change in the United States and United Kingdom from 2003 to 2006 *Area* **39** 470–81

Boykoff M T and Boykoff J M 2004 Balance as bias: global warming and the US prestige press *Glob. Environ. Change* **14** 125–36

Carlton J S and Jacobson S K 2013 Climate change and coastal environmental risk perceptions in Florida *J. Environ. Manage.* **130** 32–9

Carlton J S and Jacobson S K 2015 Using expert and nonexpert models of climate change to enhance communication *Environ. Commun.* at press (doi:10.1080/17524032.2015.1016544)

Cook J, Nuccitelli D, Green S A, Richardson M, Winkler B, Painting R, Way R, Jacobs P and Skuce A 2013 Quantifying the consensus on anthropogenic global warming in the scientific literature *Environ. Res. Lett.* **8** 024024

Dillman D A, Smyth J D and Christian L M 2008 *Internet, Mail, and Mixed-Mode Surveys: The Tailored Design Method* (New York: Wiley)

Ding D, Maibach E, Zhao X, Roser-Renouf C and Leiserowitz A 2011 Support for climate policy and societal action are linked to perceptions about scientific agreement *Nat. Clim. Change* **1** 462–6

Doran P T and Zimmerman M K 2009 Examining the scientific consensus on climate change *Eos* **90** 22–3

Dotson D M, Jacobson S K, Kaid L L and Carlton J S 2012 Media coverage of climate change in Chile: a content analysis of conservative and liberal papers *Environ. Commun.* **6** 64–81

Gifford R 2011 The dragons of inaction: psychological barriers that limit climate change mitigation and adaptation *Am. Psychol.* **66** 290–302

Hart P S and Nisbet E C 2012 Boomerang effects in science communication: how motivated reasoning and identity cues amplify opinion polarization about climate mitigation policies *Commun. Res.* **39** 701–23

Heberlein T A 2012 *Navigating Environmental Attitudes* (Oxford: Oxford University Press)

Hmielowski J D, Feldman L, Myers T A, Leiserowitz A and Maibach E 2014 An attack on science? media use, trust in scientists, and perceptions of global warming *Publ. Unders. Sci* **23** 866–83

Jacques P J, Dunlap R E and Freeman M 2008 The organization of denial: conservative think tanks and environmental skepticism *Environ. Politics* **17** 349–85

Kahan D M, Braman D, Slovic P, Gastil J and Cohen G 2008 Cultural cognition of the risks and benefits of nanotechnology *Nat. Nanotechnology* **4** 87–90

Kahan D M, Peters E, Wittlin M, Slovic P, Ouellette L L and Braman D 2012 The polarizing impact of science literacy and numeracy on perceived climate change risks *Nat. Clim. Change* **2** 732–5

Kahan D M, Jenkins-Smith H and Braman D 2011 Cultural cognition of scientific consensus *J. Risk Res.* **14** 147–74

Kellstedt P M, Zahran S and Vedlitz A 2008 Personal efficacy, the information environment, and attitudes toward global warming and climate change in the United States *Risk Anal.* **28** 113–26

Kendall-Zimmerman M R 2008 The consensus on the consensus: an opinion survey of earth scientists on the global climate change *MS Thesis* University of Illinois at Chicago

Lahsen M 2008 Experiences of modernity in the greenhouse: a cultural analysis of a physicist 'trio' supporting the backlash against global warming *Glob. Environ Change* **18** 204–19

Leiserowitz A, Feinberg G, Howe P and Rosenthal S A 2013 Climate change in the Coloradan mind: July 2013. (Yale Project on Climate Change (http://environment.yale.edu/climate-communication/files/Climate-Change-in-the-Coloradan-Mind.pdf)

Leiserowitz A, Maibach E and Roser-Renouf C 2010 *Climate Change in the American Mind: Americans' Global Warming Beliefs and Attitudes in January 2010* Yale Project on Climate Change (http://e360.yale.edu/images/digest/AmericansGlobalWarmingBeliefs2010.pdf)

McCright A M and Dunlap R E 2003 Defeating kyoto: the conservative movement's impact on US climate change policy *Soc. Problems* **50** 348–73

McCright A M and Dunlap R E 2011 Cool dudes: the denial of climate change among conservative white males in the United States *Glob. Environ. Change* **21** 1163–72

Oreskes N 2004 The scientific consensus on climate change *Science* **306** 1686

Prokopy L S *et al* 2013 Agricultural advisors: a receptive audience for weather and climate information? *Weath. Clim. Soc.* **5** 162–7

Stenhouse N *et al* 2014 Meteorologists' views about global warming: a survey of american meteorological society professional members *Bull. Am. Meteorol. Soc.* **95** 1029–40

Trumbo C 1996 Constructing climate change: claims and frames in US news coverage of an environmental issue *Publ. Unders. Sci.* **5** 269–83

Weber E U and Stern P C 2011 Public understanding of climate change in the United States *Am. Psychol.* **66**