



Citizens', Scientists' and Policy Advisors' Beliefs about Global Warming

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Abstract

Few political debates have attracted as much attention as the ones surrounding global warming. Extant work has identified numerous factors that shape citizens' beliefs on this issue, yet few studies compare the views of the public with other key actors in the policymaking process. The researchers draw on data from simultaneous and parallel surveys of (1) the U.S. public, (2) scientists who actively publish research on energy technologies in the U.S. and (3) Congressional policy advisors. They find that beliefs about global warming diverge markedly in comparing the views of the public, scientists, and policy advisors. Scientists and policy advisors are more likely than the public to express a belief in the existence and anthropogenic nature of global warming; however, similar to the public, policy advisors – and to a lesser degree scientists - are ideologically polarized over global warming.

Global warming is among the most complex and challenging problems facing humanity. Yet, in spite of a consensus among climate scientists about the reality of human induced global warming (Melillo et al. 2014), numerous studies find that segments of the public express doubt about whether this phenomenon is occurring and, if it is, whether this is the result of humans' actions (anthropogenic) or the result of natural causes (Bruelle et al. 2012; Hamilton 2011; Jones 2011; McCright and Dunlap 2011; Mildenerger and Leiserowitz 2013). It has also become apparent that "educating" the public about the "facts" associated with global warming rarely leads individuals to update their beliefs in a corrective fashion. This stems from the politicization of science that creates uncertainty about whether one can trust scientific evidence invoked in the context of political arguments (Bolsen, Druckman, and Cook 2014a).¹ It consequently has led to diminishing trust in science among some citizens (Akerlof et al. 2012; Gauchat 2012; Hmielowski et al. n.d.; Lewandowsky et al. 2013).

Extant work has identified a number of factors that shape citizens' beliefs about global warming (Borick and Rabe 2010; Nisbet and Myers 2007; Nisbet 2009; Schuldt, Konrath, and Schwartz 2011), yet no studies that we have been able to find compare the views of the public with other key actors in the policymaking process. Currently most research on the drivers of beliefs about global warming relies on either individual level cross-sectional analyses or state and national level time-series analyses of samples. No studies to date have assessed the degree to which scientists and policy advisors differ from the public in their beliefs about global warming and how the politicization of climate science shapes fundamental beliefs about global warming among these three distinct groups.

To address these issues, we draw on data from three simultaneous and parallel surveys of (1) the U.S. public, (2) scientists who work at universities in the U.S. and who actively publish

research on energy technologies and (3) Congressional policy advisors. These three surveys enable us to pinpoint areas of agreement and disagreement regarding beliefs about anthropogenic global warming among these critical actors in the policymaking process. We also test the degree to which fundamental beliefs about climate science are associated with political ideology (Hamilton 2011; Hmielowski et al. n.d.; Zia and Todd 2010), party identification (Dunlap and McCright 2008; Hart and Nisbet 2012; Weber and Stern 2011), values (Dietz 2013; Jones 2011; Kahan et al. 2012), and the interaction of factual knowledge with ideology and party identification (Hayes 2001; Malka, Krosnick, and Langer 2009; McCright 2010).

We find that beliefs about the existence of anthropogenic global warming diverge markedly in comparing the views of the public, scientists, and policy advisors. Compared to the public, scientists and policy advisors are more likely to express a belief in the existence of anthropogenic global warming. When it comes to ideological polarization, however, the public and policy advisors look the same whereas scientists differ, looking less polarized. The results highlight challenges that the politicization of science presents to achieving a consensus necessary for meaningful policy action.

Drivers of Beliefs about Anthropogenic Global Warming

“A central departure point for any examination of public opinion on the issue of global warming involves measurement of the public’s belief that global warming is actually occurring... as the issue has evolved over the past two decades, there has been significant debate in the public forum regarding the reality of global warming...” (Borick and Rabe 2010, 781).

In recent testimony to Congress on the issue of global warming, Professor Jon Krosnick (2013) provided an overview of beliefs labeled *the fundamentals* with respect to aspects of global

warming attitudes: (1) the belief that global warming is happening and (2) that the observed warming trend is the result of humans' actions. Any meaningful collective action when it comes to global warming requires coherence in the attitudes and beliefs among the key actors involved: policy advisors who create the laws, scientists who generate technologies, and the public who determines what laws and technologies survive the political and economic marketplace. For example, policymakers rarely take action without public support and technologies that scientists believe are helpful will not survive in the marketplace without being endorsed by policy advisors and the public – i.e., there needs to be some agreement between these key actors for technologies and policies designed to combat global warming to take effect (Druckman 2013).

Although clear scientific consensus exists that anthropogenic global warming occurs, the percentage of the U.S. public who reported a belief in its existence declined between 2008 and 2011 at a rate of about 5% per year (Krosnick and MacInnis 2012; Mildenberger and Leiserowitz 2013). Approximately two-thirds of Americans now believe that global warming is happening (63%) based on the results from a survey of a representative sample of the U.S. public in late November and early December 2013 (Leiserowitz et al. 2014).ⁱⁱ Higher levels of education and knowledge tend to correlate with greater concern about anthropogenic global warming; however, the effect of knowledge depends on one's ideology and party identification in the U.S. (Malka et al. 2009; Hamilton 2011). As McCright and Dunlap (2011, 161) have pointed out, "Citizens' political orientations may lead them to perceive this politically contentious issue quite differently." An abundance of survey data clearly shows that partisan and ideological divisions have emerged in recent years in the U.S. on the issue of global warming with liberals and Democrats more likely to accept the scientific consensus on this issue relative to conservatives and Republicans (McCright and Dunlap 2011; Mildenberger and Leiserowitz 2013; Schuldt,

Konrath, and Schwarz 2008). Skepticism about whether anthropogenic global warming is happening is more common among Republicans with 57% seeing “no solid evidence” compared to 17% of Democrats based on the results from a survey conducted in 2009 (Schuldt et al. 2008).ⁱⁱⁱ This leads us to offer the following prediction.

Individuals who identify as liberal or Democrat will be more likely – and individuals who identify as conservative or Republican will be less likely – to believe that (a) global warming is happening and (b) humans are responsible for it among each of the three distinct samples we study (Hypothesis 1).

Individuals’ values also play a key role in shaping beliefs about global warming. Values refer to concepts or beliefs about desirable end states or behaviors that transcend specific situations, guide evaluations, and are ordered in their relative importance (Davidov, Schmidt, and Schwartz 2008; Dietz 2013, 14081). Values play a central role in determining attitudes and behaviors toward environmental issues (Douglas and Wildavsky 1982; Stern, Dietz, and Guagnano 1995). One prominent set of values associated with beliefs about global warming stems from cultural cognition theory (Kahan et al. 2012). It posits that individuals form perceptions of societal risks that cohere with values characteristic of groups with which they identify (Kahan et al. 2011). According to Kahan et al. (2012, 732), individuals “who subscribe to a ‘hierarchical, individualistic’ worldview... tend to be skeptical of environmental risks [because] widespread acceptance of such risks would license restrictions on commerce and industry, forms of behavior that Hierarchical Individualists value... persons who hold an ‘egalitarian, communitarian’ worldview tend to be morally suspicious of commerce and industry, to which they attribute social inequity. They therefore find it congenial to believe those forms of behaviors are dangerous and worthy of restriction.” We expect that these values will not only

shape citizens' beliefs about global warming but also the beliefs of scientists and policy advisors. Kahan et al. (2012) find that individuals with the highest levels of numeracy and scientific literacy were the ones among whom cultural polarization on climate change was the greatest. *Individuals who possess Hierarchical / Individualist values will be less likely – relative to those who possess Egalitarian / Communitarian values – to believe that (a) global warming is happening and (b) humans are responsible for it among each of the three distinct groups we study (Hypothesis 2).*

Politicization and Ideological Polarization

The politicization of climate science refers to a concerted effort that began in the 1990s to challenge the legitimacy of the scientific consensus emerging on this issue by organized interests within both the fossil fuel industry and conservative think tanks allied with business interests (Weber and Stern 2011). This has resulted in declining levels of trust toward scientists among conservatives and ideological polarization on this issue (Gauchat 2012). In the past, research on public understanding of science emphasized the relationship between scientific literacy – i.e., knowledge of scientific facts – and support for science and scientists (Gauchat 2012, 169). However, factual knowledge and education do not always predict attitudes about global warming. A number of studies show that the marginal effect of an increase in education or knowledge depends on one's partisanship and ideology (Hamilton 2011; Malka et al. 2009; Mildemberger and Leiserowitz 2013). This is likely because knowledgeable partisans and ideologues are more likely to engage in motivated reasoning when expressing their beliefs about global warming (Hart and Nisbet 2012; Taber and Lodge 2006).

Motivated reasoning refers to one's goal in the process of forming a belief or opinion (Kunda 1999; Taber and Lodge 2006).^{iv} Individuals can either pursue a *directional goal* - in

which an evaluation or opinion expressed in a given context serves to bolster existing beliefs or identities - or an *accuracy goal* - in which one's underlying motivation is to form and hold a correct or accurate belief. When people engage in directional reasoning they tend to give more weight to evidence that is consistent with existing views, dismiss information that is inconsistent with existing views, and view evidence and arguments as stronger when they are consistent with one's beliefs (e.g., see Druckman, Peterson, and Slothuus 2013; Kunda 1990; 1999). Past work demonstrates that the tendency to engage in motivated reasoning gets stronger as individuals become more knowledgeable and sophisticated (e.g., see Malka et al. 2009; Taber and Lodge 2006). Therefore, we expect higher levels of knowledge to lead to greater polarization among ideologues and partisans across the three distinct groups we study due to a greater propensity to engage in motivated reasoning.^v

Partisanship and ideology will interact with knowledge such that liberals / Democrats who possess higher levels of knowledge will be more likely – and conservatives / Republicans who possess higher levels of knowledge will be less likely - to believe that (a) global warming is happening and (b) humans are responsible for it among each of the three distinct groups we study (Hypothesis 3).^{vi}

A number of other individual and contextual factors are associated with beliefs about global warming in the U.S. We do not offer explicit hypotheses regarding these additional factors given that they largely serve as controls in the analyses below. Nonetheless, the literature shows that disbelief in anthropogenic global warming is more common among whites and males (McCright and Dunlap 2011; McCright 2010). Individuals who have higher levels of trust in science (Gauchat 2012), who experience extreme local weather (Egan and Mullin 2012; Hamilton and Stampone 2013; Hansen, Sato, and Ruedy 2012), who have higher levels of

political awareness (Boykoff 2007; Feldman et al. 2011; Zhao et al. 2011), and who possess positive perceptions of scientists (Giddens 2009; Leiserowitz et al. 2012; Oreskes and Conway 2010) are more likely to believe in anthropogenic global warming. Thus, we account for these additional factors in the analyses reported below.

Surveys

As mentioned, existing work in the U.S. that focuses on beliefs about global warming: (1) has not simultaneously explored the attitudes of three key groups in the policymaking process (i.e., the public, scientists, policy advisors); (2) has not isolated the key factors driving opinions *across* these groups; and, (3) has not explored the impact of the politicization of climate science on knowledgeable partisans and ideologues. We draw on data from three simultaneous and parallel surveys conducted in August 2010 on samples of (1) the U.S. public, (2) scientists who actively publish research on energy technologies in the U.S., and (3) a first-of-its-kind survey of Congressional policy advisors to address these questions.

Public Sample

We contracted with a survey research company (Bovitz Inc.) to conduct a web-based survey of a representative sample of 1,600 citizens in the U.S. The sample comes from a panel of respondents who have opted to complete online surveys. The panel was originally developed based on a random-digit-dial (RDD) telephone survey, where to enter the panel a respondent needed to have access to the Internet.^{vii} The panel has continued to grow based on ongoing RDD recruiting and referrals. From the panel, which has approximately one million members, a given sample is drawn using a matching algorithm (based on likely response rates) to ensure that those screened to qualify for the survey constitute a sample that demographically represents the United States.

Scientist Sample

We conducted a simultaneous and parallel survey of scientists who publish research in areas related to energy technologies at universities located in the U.S. to assess their beliefs about global warming. We focused on the population of scientists who work on energy technology and conduct potentially influential research. We identified our population based on a search of the Web of Science's *Science Citation Database* to locate those who had *published* articles on energy technology between January 1, 2006, and October 17, 2009.^{viii} We drew a random sample of 1,800 articles that met our search criteria over this period. We then identified the contact / lead author to ensure that the person was actively involved in a sustained research program. We removed scientists located outside the U.S. as well as authors whose work had been cited less than five times. We recorded the contact information for each lead author and attempted to contact each person to invite them to participate in a survey about energy-related issues in the U.S. We sent a \$5 Starbucks gift card to each scientist invited to participate in the survey that they could keep regardless of whether or not they completed it. We contacted a total of 827 scientists after removing emails and letters that were returned to sender. A total of 280 scientists completed the survey for a response rate of 34%. This is an exceptionally high response rate in comparison to similar types of surveys previously conducted on elite samples (Berkman and Plutzer 2011).^{ix}

Policy Advisors

Our third survey focused on policy advisors who may affect U.S. energy policy. We initially defined our population of interest as legislative directors who work for members of Congress (N=535); however, concerns about a low response rate prompted us to collect additional data that focused on lower-level staff members within each member of Congress' office including communication directors and legislative assistants (see Plutzer, Maney, and

O'Connor 1998).^x We collected the names of up to three staff members from each office using the *Congressional Staff Directory*. As with our sample of scientists, we removed from the sample individuals whom we could not contact because of letters and emails that were returned to sender. We mailed a letter to each member of Congress' office in advance of the survey that provided information about its purpose and provided a \$5 Starbucks gift card that they could keep regardless of whether or not they completed the survey. In addition, staff members who completed the survey were offered a completion code that they could enter to receive \$20 as compensation for their time. We contacted a total of 984 individuals. A total of 55 policy advisors completed the survey for a response rate of 5.56%. Although this is a disappointingly low response rate, of the 55 policy advisors who completed our survey, there is a good mix of variation in party identification and ideological self-placement – 49% identify as a Democrat, 35% identify as a Republican, and 16% identify as an Independent; 38% identify as a Liberal and 35% as a Conservative. The total number of policy advisors we completed interviews with was comparable to other samples that have attempted to interview this population (Plutzer, Maney, and O'Conner 1998).

Measures

Our primary dependent variables include two questions that measure: (1) belief about whether global warming is happening (where 1=definitely is not happening, 4 = not sure, and 7=definitely is happening), and (2), if it is happening, whether the trend is a result of natural changes or humans' actions (1-7 scale, where 1=definitely naturally induced, 4 = not sure, and 7=definitely human induced). The exact wording for each measure is included in the Appendix.

We also included measures of the previously discussed demographic and political characteristics posited to be associated with beliefs about anthropogenic global warming.^{xi} This

included measures of cultural cognition theory's worldview variables – hierarchical (as opposed to egalitarianism) and individualism (as opposed to communitarianism) – measured on 7-point scales with higher values indicating hierarchical tendencies or individualism.^{xii} We measured energy, science, and political knowledge and created a global measure of *knowledge* based on the number of correct responses across these items (see Table A-1 in the Appendix for a list of the individual items and responses). Finally, we included standard measures that asked for respondents' gender (1=male, 2=female), ethnicity^{xiii}, education^{xiv}, age^{xv}, media exposure^{xvi}, trust in government^{xvii}, trust in science^{xviii}, local weather experience^{xix}, ideology^{xx}, and party identification^{xxi}.

Results

We begin, in Figure 1, by presenting the percentage in each sample that believe global warming is happening and that it is human induced as opposed to a result of natural changes. The majority of respondents in all three samples say they believe global warming is happening. However, there are striking differences in the beliefs about global warming in comparing responses across the three samples.^{xxii} Not surprisingly, scientists working at universities in the U.S. and who publish research in energy-related areas are far more likely than policy advisors or members of the public to say that global warming is happening (89% of scientists; 64% of the public; and, 71% of policy advisors). The strong endorsement of global warming among our sample of scientists comports with data recently released from a panel evaluating levels of scientific consensus regarding climate change among climate scientists for the *American Association for the Advancement of Science* (AAAS), which reports that 97% of climate scientists believe in anthropogenic global warming (AAAS 2014). The slightly lower percent of energy scientists who endorse global warming in our sample – compared to climate scientists'

views - is likely due to the fact that the scientists in our sample are not climate scientists but rather scholars working on energy-related research at universities in the U.S. The percentage of the public in our sample who believe global warming is happening is nearly identical to what other surveys of the U.S. public recently report (Leiserowitz et al. 2014). Similarly, the energy scientists who completed our survey overwhelmingly attribute the rise in Earth's temperature to humans' actions (81% of those who believe it is happening). Policy advisors were largely in agreement with scientists that global warming is a result of human actions (70% of those who believe it is happening). The U.S. public was more divided on this issue with 57% of those who believe global warming is happening seeing it as human induced. Thus, the data suggests that the views of these critical actors in the policymaking process diverge markedly about the fundamentals related to global warming. We next proceed to test the aforementioned hypotheses about the effect of party identification and ideology, values, and the politicization of climate science on beliefs about whether global warming is happening and if it is human induced. In particular, we want to learn the extent to which the same factors or different ones shape the responses of the public, energy scientists, and policy advisors.

Insert Figure 1. Citizens', Scientists, and Policy Advisors' Beliefs about Global Warming

In Table 1, we report the results from a series of ordered probit models that estimate factors that increase or decrease the likelihood of expressing a belief that global warming is happening among members of the U.S. public, energy scientists, and policy advisors for members of Congress. The first model for each sample (Model 1) allows a test of hypothesis 1 about the impact of party identification and political ideology on the likelihood that one expresses a belief that global warming is happening. In strong support of hypothesis 1, and in line with the results of numerous recent surveys (Brulle et al. 2012; Malka et al. 2009; McCright

and Dunlap 2011; Hamilton 2011), we find that party identification and political ideology play a powerful role in determining individuals' beliefs about global warming. Among members of the public, Democrats are significantly more likely to express a belief that global warming is happening (72% predicted probability of expressing a belief global warming is happening), while Republicans are significantly less likely to express this view (57% predicted probability of expressing a belief global warming is happening).^{xxiii} Similarly, among members of the public, liberals are significantly more likely than conservatives to believe global warming is happening (73% versus 60% predicted probability of expressing a belief that global warming is happening, respectively). This result is true not only for members of the public but also for policy advisors and scientists where ideology significantly plays a role in determining these groups' views (but not party identification for scientists and policy advisors) (McCright and Dunlap 2011). The predicted probability of a liberal scientist expressing a belief that global warming is happening is 94%, whereas the probability that a conservative scientist expresses a similar view is 84%. The same pattern is observed among the sample of policy advisors; however, the sample is too small to accurately estimate changes in predicted probabilities among this group. Nonetheless, ideology clearly plays a central role in driving beliefs about whether global warming is happening among all three of our samples.

Insert Table 1. Determinants of Belief Global Warming is Happening

We also find strong support for hypothesis 2 regarding the role that values play in shaping individuals' beliefs about whether global warming is happening. Cultural cognition theory posits that the values of hierarchy (as opposed to egalitarianism) and individualism (as opposed to communitarianism) reduce the likelihood that an individual will express a belief in global warming because it would lead to unwanted restrictions on businesses and individuals

(Kahan et al. 2011; Kahan et al. 2012). As predicted, hierarchical individualists are significantly less likely to accept the scientific consensus that global warming is happening relative to egalitarian communitarians (52% versus 85% predicted probability of expressing a belief that global warming is happening, respectively). Values not only shape the public's views but also shape the views of scientists and policy advisors in the expected direction. The predicted probability of expressing a belief that global warming is happening for a scientist who values hierarchy and individualism is 81%; the probability of expressing a similar belief for a scientist who values egalitarianism and communitarianism is 97%. Thus, in line with a growing literature, we find that values play a central role in shaping views about the fundamentals of global warming (Dietz 2013; Kahan et al. 2012; Weber and Stern 2011).^{xxiv}

We report the results from a second model (Model 2, Table 1) for each sample to test hypothesis 3 about the politicization of climate science and ideological and partisan polarization on this issue rooted in the theory of motivated reasoning (Kunda 1990; Taber and Lodge 2006). We test this hypothesis by creating dichotomous measures for individuals who identified as a Democrat or Republican, and as a liberal or conservative, and interacting these variables with a measure of knowledge based on the number of correct responses to factual questions about politics, energy, and science (see Table A-1). The results are striking and offer strong support for hypothesis 3. Members of the public who identify as Republican and as conservative and who are relatively *more knowledgeable* about politics, energy and science are significantly *less likely* to say that global warming is happening relative to less knowledgeable conservatives. Among scientists and policy advisors, we do not find significant effects when party identification is interacted with knowledge; however, the coefficients for conservative and Republican are all signed in the expected negative direction and knowledgeable, conservative scientists are

significantly less likely to believe global warming is happening ($p = .06$, one-tailed test). Taken together, the results presented in Table 1 clearly demonstrate that the politicization of climate science has resulted in a partisan and ideological divide among members of the public, and to a lesser extent among scientists and policy advisors, over whether global warming is actually occurring, and this divide gets significantly wider as individuals become more knowledgeable about politics, energy, and science.

The results reported in Table 1 also show that minorities are significantly more likely than whites to express a belief in global warming among members of the public and policy advisors, but race does not play a role in determining the views of scientists. Among members of the public, people who perceive that they experience extreme local weather are significantly more likely to express a belief that global warming is happening - and this is true both for members of the public and for policy advisors (but not for scientists). Finally, media use, trust in government, and trust in science are associated with acceptance of the scientific consensus that global warming is happening among members of the public. Interestingly, among members of the public (see Model 1, Table 1, public sample), education, knowledge, gender, and age appear to have no impact on the beliefs about whether global warming is happening; however, female scientists (see Model 1, Table 1, scientist sample), minority policy advisors, and older policy advisors (see Model 1, Table 1, policy advisors sample) are significantly more likely to express a belief that global warming is happening.

In Table 2, we report the results from a second series of ordered probit models that estimate factors that increase or decrease the likelihood of expressing a belief that global warming is happening due to humans' actions as opposed to natural changes among members of the U.S. public, energy scientists, and policy advisors. In support of hypothesis 1, we find that

members of the public who identify as liberal or as a Democrat are significantly more likely (64% predicted probability) – and conservatives are significantly less likely (50% predicted probability) – to express a belief that global warming is occurring as a result of humans’ actions. Similarly, the predicted probability of a liberal scientist expressing a belief that global warming is human induced is 92%, whereas for a conservative scientist the predicted probability drops significantly to 63%. Thus, ideology and partisanship also play a central role in shaping each sample’s views that the warming trend is due to anthropogenic forces.

Insert Table 2. Determinants of Belief Global Warming is Anthropogenic

We again find strong support for hypothesis 2. Individuals who subscribe to a hierarchical and individualistic worldviews are significantly less likely to view global warming as happening due to humans’ actions. This is consistent with cultural cognition’s thesis that the acceptance that global warming is happening threatens these individuals’ worldviews by leading to inevitable efforts to regulate businesses and place constraints on individuals’ freedoms (Kahan et al. 2011). These values not only shape the U.S. public’s views but also influence the way that scientists and policy advisors form opinions about the issue of global warming. In short, people who value individualism and hierarchy are less likely to believe in anthropogenic global warming compared to those who value egalitarianism and communitarianism.

To test hypothesis 3, we once again interact measures of party identification and ideology with our knowledge measure. The results, presented in Table 2 (Model 2), offer strong support for the ideological polarization thesis rooted in the theory of motivated reasoning (see Gauchat 2012). Among members of the public, knowledgeable conservatives are significantly more likely than conservatives who lack factual knowledge about politics, energy, and science to express a belief that global warming is happening because of natural changes (as opposed to

humans' actions). There is less support for hypothesis 3 in looking at the effects of knowledge interacted with party identification and ideology among our sample of scientists and policy advisors. Although most of the coefficients are signed in the expected direction for scientists and policy advisors, they are not statistically significant.

In order to better illustrate the magnitude of the impact of knowledge among ideological subgroups within the public, we plot, in Figure 2, the predicted probability of expressing a belief that global warming is happening and human induced among liberals and conservatives as knowledge increases from its minimum to its maximum value, holding all other covariates at their means.^{xxv} The predicted value for the belief global warming is happening on a seven-point scale among the *least* knowledgeable conservative in the public sample is 5.32 (where 1 = definitely not happening and 7 = definitely happening); however, the predicted value for the *most* knowledgeable conservative on this question drops to 3.72. In contrast, there is a marginal increase in the belief global warming is happening among liberals in moving from the least (4.98) to most knowledgeable (5.25) in the sample. Policy advisors also display a tendency to engage in motivated reasoning on this issue to a greater extent as their levels of knowledge increase. The least knowledgeable conservative policy advisor's predicted score for the belief global warming is happening is a remarkably high 6.61 but drops significantly to 5.35 for the most knowledgeable conservative policy advisor. The reverse pattern – i.e., significant knowledge increases – is not detected for liberal policy advisors likely due to ceiling effects in terms of support for the scientific consensus (e.g., the predicted score for the *least* knowledgeable liberal in the policymaker sample is 6.87). The predicted value that the belief global warming is happening among the least knowledgeable conservative scientist is 5.49 and this increases to 5.70 for the most knowledgeable conservative scientist. The predicted increase

for a liberal scientist in moving from the least to most knowledgeable is a modest 6.09 to 6.30 on the seven-point scale.

The right side of Figure 2 plots predicted values for the least and most knowledgeable liberals and conservatives in our public sample on whether global warming is human induced. The results follow the same pattern as the slope of the lines on the left hand side of Figure 2. Low knowledge liberals and conservatives do not possess significantly different views about the fundamental cause of global warming, however, as conservatives become more knowledgeable they become less likely to accept the scientific consensus regarding human induced global warming. Conversely, knowledge marginally (but not significantly, see Table 2) increases the likelihood that liberals express a view that is consistent with the scientific consensus. These relationships are not apparent among the most and least knowledgeable conservative and liberal scientists and policy advisors; however, conservative scientists who believe global warming is happening are significantly more likely to report that it is the result of natural changes to earth as opposed to human induced (see Table 2, Model 1, scientist sample).

Insert Figure 2. Predicted Values for Beliefs about Global warming for Liberals and Conservatives among the Public

Although we did not offer explicit hypotheses about the impact of the control variables in Table 2, we find that females, minorities, individuals with greater factual knowledge, and those who experience extreme local weather are significantly more likely to see global warming as happening as a result of humans' actions; however, the relationships are weaker or non-existent in many cases among scientists and policy advisors.

Conclusion

Three sets of findings emerge from our analyses. First, we find significant differences in comparing the views of the public, scientists, and policy advisors on the issue of global warming and its fundamental cause. Similar to the results of recent surveys of nationally representative samples of the U.S. public, we find that 64% of the public believes that global warming is happening (Leiserowitz et al. 2014). This compares to nearly 90% of the energy scientists in our sample who express this belief, and 71% of the policy advisors who completed our survey. Moreover, significant differences were observed in evaluating the belief that global warming is human-caused across samples. Although the majority of the public (57%) sees global warming as caused by human action, widespread misperceptions of the scientific consensus still persist on this issue. Nearly one in five energy scientists (19%), and about one in three policy advisors (30%), in our sample express doubt or uncertainty about whether global warming is human induced (see Figure 1).

Second, we find strong support for the argument based on cultural cognition that hierarchical and individualistic values determine people's beliefs about the fundamentals of global warming (Kahan et al. 2012). Scientists and policy advisors also appear to form beliefs about global warming that are consistent with their underlying values.

Third, we demonstrate that the propensity to engage in motivated reasoning related to global warming increases as individuals become more knowledgeable about politics, energy, and science. Among the public and policy advisors, Democrats and liberals are more likely to accept the scientific consensus regarding the reality of global warming, while conservatives and Republicans are significantly less likely to express a belief that is consistent with the scientific consensus on this issue. Unfortunately, the tendency to engage in motivated reasoning on this

issue becomes more pronounced as individuals become more knowledgeable (Kahan et al. 2012; McCright and Dunlap 2011; Malka et al. 2009), at least among members of the public.

The divisions we pinpoint across the public, energy scientists, and policy advisors – all key actors in the policymaking process - highlight major challenges to meaningful policy action to address the problem of global warming. They raise questions about the long-term implications of the politicization of science given the tendency for individuals to engage in motivated reasoning – the process whereby they form an attitude that is consistent with their partisan and ideological identities rather than the goal of holding an accurate opinion. Conservatives have become increasingly distrustful of science due to the rise of a “new right” skeptical of organized science and the intellectual establishment. As Gauchat (2012) argues, “The relationship between public trust in science and political orientations also poses larger questions about the unevenness of the cultural authority of science and the potential for deep sociocultural divisions in the public sphere (168).”

Understanding the opinions of key groups in the policymaking process including the public, scientists, and policy advisors is a crucial first step if political science is to contribute to developing responses to the vexing problem of global warming (McCright and Dunlap 2011; Javeline Forthcoming). In moving forward, it is important to consider what, if anything, can be done to communicate climate science more effectively in order to create greater consensus necessary for meaningful policy action. Unfortunately, the problem is deeper than informing the public about the correct facts in the “debate” over global warming. Weber and Stern (2011, 323) explain that the problem in understanding global warming is not one of “illiteracy” – in comparison to the rest of the world the U.S. public has average levels of knowledge – but rather that some individuals’ “mental models” of the world conflict with consensus scientific

understanding. In such cases, science communicators may find it difficult to motivate citizens to accurately process information in a way necessary to form a belief that is congruent with a consensus of scientists (Lupia 2013; Pidgeon and Fischhoff 2011). Science can play an important role in informing citizens about what they should believe about how the world works, but it cannot tell us what people should care about: as Dietz (2013, 14085) has pointed out, “Science has no privilege with regard to values. However, continuing research on how values influence and are influenced by decision-making processes can help us hone better processes for identifying and coping with the diversity of values engaged around complex societal decisions.”

Given that citizens tend to conform their beliefs to their peers, “communicators should endeavor to create a deliberative climate in which accepting the best available science does not threaten any group’s values” (Kahan et al. 2012, 734). Thus, there is a need to find more effective frames and ways to counter the politicization of science so that citizens are open to new information that may lead to support for scientific adaptations that would benefit society (Bolsen, Druckman, and Cook 2014a; Emanuel 2013; Nisbet 2009; Stern 2011). One promising avenue for overcoming opinion formation biases rooted in partisan motivated reasoning is to find ways to motivate citizens to form accurate beliefs when there is a clear scientific consensus surrounding a given issue (Bolsen, Druckman, and Cook 2014b). Future research must find additional ways to counter the politicization of science if we hope to combat the challenging and complex problems we collectively face.

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Supplemental Appendix

Dependent Measures

Global warming refers to the idea that the world’s average temperature has been increasing over the past 150 years and may be increasing more in the future. What do you think? Do you think that global warming is happening?

<u>definitely is NOT happening</u>	<u>very likely is NOT happening</u>	<u>probably is NOT happening</u>	<u>not sure</u>	<u>probably is happening</u>	<u>very likely is happening</u>	<u>definitely is happening</u>
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If global warming is happening, to what extent do you think it is caused by human activities, as opposed to natural changes in the environment? (If you are “extremely sure global warming is not happening,” you can leave this answer blank.)

<u>definitely human induced</u>	<u>very likely human induced</u>	<u>probably human induced</u>	<u>neither human nor naturally induced</u>	<u>probably naturally induced</u>	<u>very likely naturally induced</u>	<u>definitely naturally induced</u>
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Endnotes

ⁱ McCright and Dunlap (2011, 181) explain that they use “the terms ‘politicized’ and ‘politicization’ to refer to how the science underlying policy decisions is increasingly the object of promotion and attack by advocates and opponents of regulatory policies... [and] means that the defense and denial of scientific findings that have implications for regulatory policy increasingly align with existing political divisions between those who oppose regulations on economic markets and those who see regulations as necessary to protect the public good” (also see Bolsen, Druckman, and Cook 2014a)

ⁱⁱ Leiserowitz et al. (2014) divide the American public into six subgroups of citizens representing different levels of concern about global warming: alarmed (16%), concerned (27%), cautious (23%), disengaged (5%), doubtful (12%), and dismissive (15%). Thus, although a strong majority of Americans believe that global warming is happening a large minority of citizens holds beliefs that run counter to the scientific consensus on this issue.

ⁱⁱⁱ Schuldt et al. (2008) also find divisions in beliefs about whether global warming is happening based on if the observed warming trend is labeled “climate change” versus “global warming.” Specifically, conservatives and Republicans are significantly less likely to say that “global warming” is happening compared to “climate change.” This is not the case for liberals or Democrats who appear to be unaffected by the question’s wording. We use global warming throughout the paper, as opposed to climate change, given that our specific survey item asked about beliefs about “global warming”.

^{iv} Note that motivated reasoning encompasses a range of distinct goals, including defending prior opinions, impression motivation, and behavioral motivation (see Kunda 1999), but here we follow political science work to date in focusing on directional and accuracy goals.

^v Note that we are unable to distinguish between partisan motivated reasoning and simple cue-taking in which individuals follow whatever cues are most accessible in the opinion formation context as a way to avoid effortful cognition – i.e., as a heuristic – in terms of identifying the underlying process driving any observed effects from interacting knowledge with partisanship and ideology. Several recent studies provide clear evidence using response latency data that motivated reasoning is an effortful process and does not involve following cues as a means of avoiding effortful cognition (see Bolsen, Druckman, and Cook 2014b; Petersen et al. 2013). Thus, although we ground Hypothesis 3 in the literature on motivated reasoning, we have no way to rule out an alternative process driving this effect stemming from elite cue-theory (Zaller 1992).

^{vi} Weber and Stern (2011) argue that scientists differ in their reasoning about global warming relative to non-scientists. Specifically, scientists are less likely to rely on weather extremes and ideology (Rothman and Lichter 1987) in forming their beliefs about global warming. On the

other hand, other work that focuses on how scientists, journalists, and federal government policy advisors form perceptions of risk toward emergent technologies finds that political ideology can play a key role in shaping attitudes about the risks associated with new technologies (Plutzer, Maney, and O’Conner 1998).

^{vii} In this sense, it is a non-probability sample in the same way as those taken by firms such as YouGov are non-probability samples.

^{viii} We considered starting in 2001, because this marked the beginning of a new era of concerns about the energy supply in the U.S. (see Bolsen 2011). However, we opted to start in 2006 for the practical reason of maximizing the likelihood that the authors’ contact information remains accurate. Please contact the authors for additional details on the sampling procedure.

^{ix} There is not an abundance of survey data from samples of scientists in the U.S. in recent years to make a comparison for our response rate; however, it is comparable to Berkman and Plutzer (2011)’s response rate from a survey of U.S. high school biology teachers conducted in May 2007 that focused on the issue of evolution. Response rates for surveys of elite samples have declined precipitously in recent years. Berkman and Plutzer (2011) note that Gallup’s *Phi Delta Kappa Survey of Teachers* produced response rates of 42% in 1986, 26% in 1996, and 18% in 1999 using a methodology in which surveys were mailed and postcards were sent as a reminder.

^x Ideally, we would have liked for the population to include members of Congress; however, members of Congress only rarely, if ever, take part in surveys on policy issues. We received numerous emails from staff members telling us that it was against their office policy to participate in surveys. This accounts for the low response rate we report for the sample of policy advisors. We used an approach that mirrors that employed by Plutzer et al. 1998 in contacting scientists, journalists, and policy advisors in which all subjects initially received a letter

explaining the general topic of our survey, its length, and the procedures to guarantee confidentiality. The initial letter included a URL link to complete the survey, and we followed the letter up a week or two later with an email reminder and link to the survey. Plutzer et al.'s policymaker sample included 40 policy advisors and 70 senior staff members serving in the 102nd and 103rd Congress. They achieved a remarkable response rate of 64% for policy advisors, 84% for scientists (116 in total), and 75% for journalists (119 in total) from telephone surveys conducted in 1992.

^{xi} Table A-1 in the Appendix reports the demographic and political characteristics of each sample and the distribution of responses for all measures that are included in the statistical analyses.

^{xii} Kahan et al. (2011) use multiple items for each construct; due to space limitations we used only one item for each (as suggested to us in a personal communication from Kahan). (See Table A-1 for the wording for each item.)

^{xiii} We asked respondents to identify their ethnicity and classified African Americans, Asian Americans, Hispanics, and Others as minorities.

^{xiv} Respondents reported their highest level of completed education (see Table A-1).

^{xv} Respondents reported their age as following one of seven ranges (See Table A-1).

^{xvi} We asked respondents how often they read the newspaper, watch television news, or get information online with higher scores indicating greater media use.

^{xvii} Respondents reported their trust in government on a four-point scale with higher scores indicating greater trust (see Table A-1).

^{xviii} Respondents reported the degree to which they believe science can overcome almost any problem on a five point scale from not at all to a great deal (see Table A-1).

^{xix} Respondents reported their perception of how extreme the local weather is where they live relative to the rest of the U.S. (see Table A-1).

^{xx} Ideology was measured on a standard seven-point scale with higher values associated with being more conservative. In the statistical analyses below, we collapsed the scale into a dichotomous measure in which liberals = 1 and 0=otherwise.

^{xxi} Party identification was measured on a standard seven-point scale with higher values associated with Republicans. In the statistical analyses reported below, we created a dichotomous measure for Democrats and Republicans.

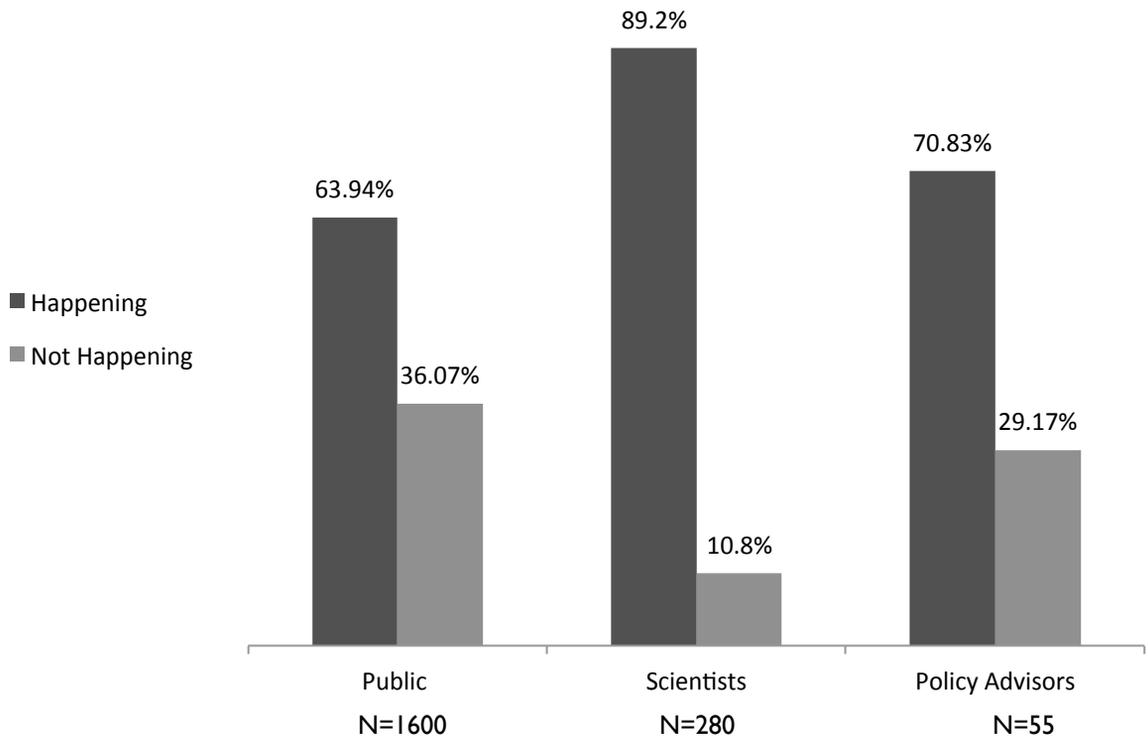
^{xxii} Figure 1 collapses the seven-point measure for each dependent variable into a dichotomous measure for clarity of presentation. Respondents at the mid-point on each scale were lumped in with “not happening” and “natural changes” columns in each table, respectively. For the full distribution of responses on each measure see Table A-1.

^{xxiii} We used *Clarify* to estimate the predicted values reported here and below (Tomz, Wittenberg, and King 2003). In all cases, we hold all other covariates at their mean values.

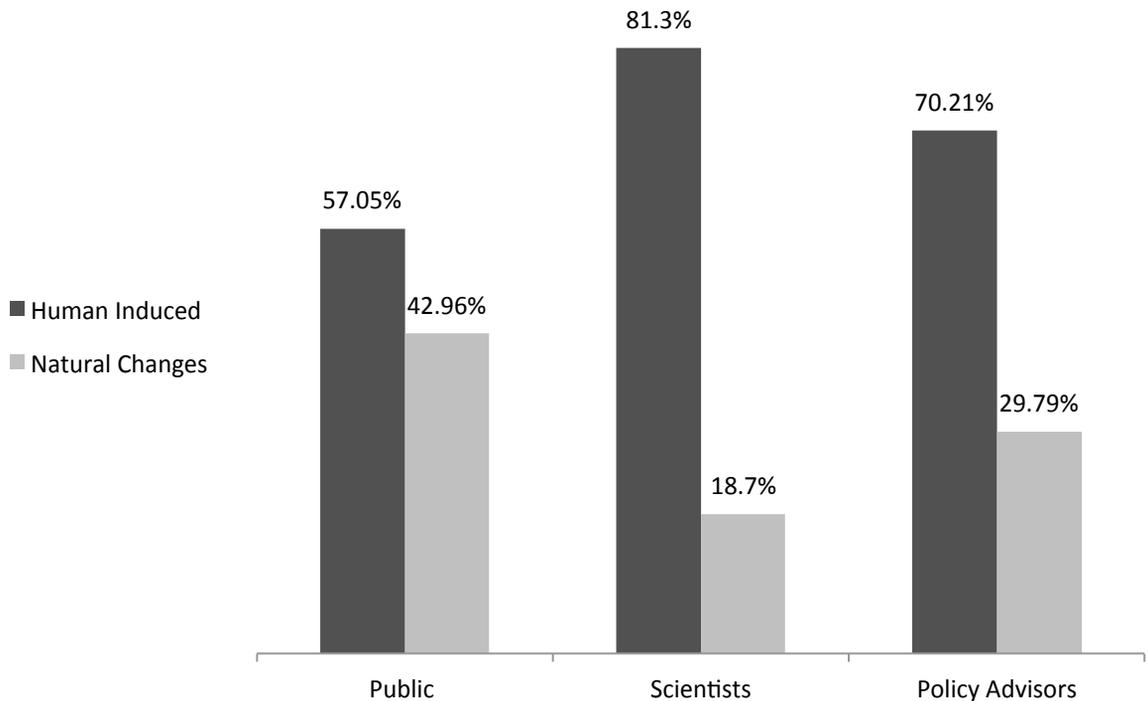
^{xxiv} Kahan et al. (2012)’s results show that individuals with higher levels of numeracy and scientific literacy who possess hierarchical / individualist versus egalitarian / communitarian values are more likely to express divergent views on whether global warming is happening; however, we do not interact knowledge with distinct values given that there is no justification rooted in cultural cognition theory for doing so.

^{xxv} For purposes of presentational clarity, Figure 2 does not include predicted probabilities for conservative and liberal scientists and policy advisors with different levels of knowledge. The results from these analyses, however, are reported in the main text.

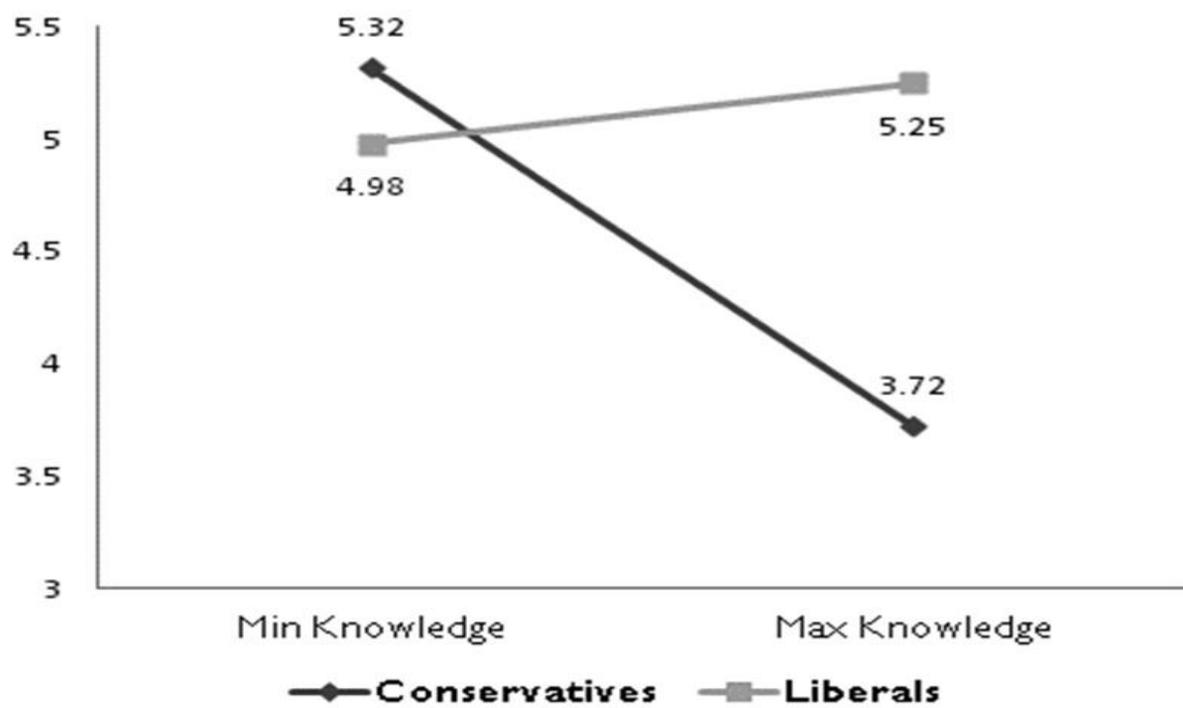
Believe Global Warming is Happening



Believe Global Warming is Anthropogenic



Global Warming is Happening



Global Warming is Anthropogenic

