

What Causes People to Change Their Opinion about Climate Change?

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After a decade of steady growth in the acceptance of the existence of climate change and its anthropogenic causes, opinions have polarized, with almost one third of Americans, mostly Republicans, denying that the climate is changing or that human activity is responsible. What causes Americans to change their minds on this issue? Using a large panel data set, we examined the impacts of direct experience with weather anomalies, ideology, relative prioritization of environmental conservation in comparison to economic development, and motivated reasoning that adjusts individual opinion to align with others who share one's party identification. A generalized ordered logit model confirmed the importance of political ideology, party identification, and relative concern about environmental conservation and economic development on attitude change. The effect of party identification strengthened with attentiveness to news and public affairs, consistent with the logic of motivated reasoning. Recent experience with hot summers, warm winters, droughts, and natural disasters had only a minimal impact on attitude change. *Key Words: climate change, longitudinal survey, motivated reasoning, opinion change, political ideology.*

对气候变迁的存在及其人为肇因，在近十年来逐渐受到接受之后，观点却出现了两极化，有近三分之一的美国人，其中绝大多数是共和党员，否认气候正在变迁，或是人类活动必须为此负责。是什麼改变了美国人对此议题的态度呢？我们运用大型面板数据集，检视有关气候异常的直接经验、意识形态、环境保育之于经济发展的相对优先性，以及让个人意见与其他支持同一党员者趋近一致的受驱动的论据之影响。广义阶层罗吉特模型，证实了政治意识形态、政党认同以及有关环境保育和经济发展的相对考量之于态度变化的重要性。政党认同的效应，透过对新闻和公共事务的关注而强化，并与受驱动的论据逻辑一致。极端炎热的夏天、暖冬、乾旱与自然灾害的晚近经历，仅对态度变化具有极微小的影响。关键词：气候变迁，纵贯式调查，受驱动的论据，观点改变，政治意识形态。

Tras una década de crecimiento permanente de aceptar la existencia del cambio climático y de sus causas antropogénicas, las opiniones se han polarizado, con casi un tercio de los norteamericanos, principalmente republicanos, que niegan que el clima esté cambiando o que la actividad humana sea la responsable. ¿Qué determina en los norteamericanos el cambio en su modo de pensar al respecto? Con el uso del conjunto de datos de un gran panel, examinamos los impactos de la experiencia directa con las anomalías meteorológicas, la ideología, la relativa priorización de la conservación ambiental en comparación con el desarrollo económico, y el razonamiento motivado que ajusta la opinión individual para sumarse a otros que comparten con uno la identificación partidista. Un modelo logit ordenado y generalizado confirmó la importancia que tienen sobre el cambio de actitud la ideología política, la identificación partidista y la relativa preocupación acerca de la conservación ambiental y del desarrollo económico. El efecto de la identificación partidista fortalecida con la atención a las noticias y los asuntos públicos fue consistente con la lógica del razonamiento motivado. La experiencia reciente con veranos calurosos, inviernos templados, sequías y desastres naturales tuvieron solo un mínimo impacto en el cambio de actitud. *Palabras clave: cambio climático, exploración longitudinal, razonamiento motivado, cambio de opinión, ideología política.*

The United States lags behind much of the world in support for action to mitigate climate change (IPSOS MORI 2014). Almost one third of Americans, primarily Republicans, believe either that climate change is not occurring or that it is not due to human activity (Riffkin 2014; Leiserowitz et al. 2016; Mills, Borick, and Rabe 2016). The Pew Research Center found that 79 percent of liberal Democrats but only 15 percent of conservative Republicans, believed

that as a result of human activity the Earth is warming (Funk and Kennedy 2016).

Beliefs about the existence and causes of global climate change are also related to values concerning the relative importance of job growth as opposed to environmental conservation. As Heath and Gifford (2006, 65–66) noted, “Those who value the free market system over environmental quality tend to believe that global change is not occurring, that the causes of global

climate change are more natural than human caused, and that its consequences will not be negative.”

The process by which individuals develop and change their views about climate change is complex. In this article, we demonstrate that a national sample of Americans changed their opinions between 2010 and 2014 primarily to align better with those who shared their party identification and political ideology. This conforms with the theory of motivated reasoning: Evidence consistent with prior beliefs is viewed as strong and, on politically salient issues, people strive to bring their opinions into conformance with those who share their political identity (Kahan et al. 2012).

Previous studies aggregating cross-sectional surveys across time have identified trends and polarization in overall public opinion but have not been able to track how individuals modify their attitudes over time. The contribution of this article is its analysis of a nationally representative panel of 9,500 respondents who were asked the same question about climate change in 2010 and 2014. These data provide the basis for the first large-sample empirical analysis of individual opinion change on global warming. Using these data, we identified people who maintained the same opinion as opposed to those who changed their opinions, becoming either more concerned or more skeptical about climate change. We then examined the relative importance of political ideology, party identification, relative concern about the environment in comparison with the economy, and recent experience with anomalous weather patterns on stability or shifts in opinion. The empirical analysis supports the theory of motivated reasoning: people tend to align their opinions on climate change to match those of others who share their political party or political ideology.

Findings about Beliefs in Climate Change from Cross-Sectional Studies

Belief in the existence of climate change and its anthropogenic causes has not grown consistently in the United States. Based on a review of 240 articles published between 1980 and 2014, Capstick et al. (2015) showed that acceptance of the existence of climate change grew steadily from the 1980s through the early 1990s but was more erratic in the next decade. More recently, skepticism has grown and opinions have polarized along political party lines (Dunlap and McCright 2008). Studies from the Yale Project on Climate Change reported that although a slowly growing majority of Americans are

worried about global warming, only a minority believe that human action is causing it (Howe and Leiserowitz 2013; Roser-Renouf et al. 2014). Furthermore, those who believe that the climate is not changing have become more certain in their beliefs (Leiserowitz et al. 2015).

A vast literature has examined trends in beliefs about the existence of and causes for climate change and the correlates of these beliefs. The findings of this research form the basis of the hypotheses about the influence of four sets of variables on receptivity to messages about climate change: (1) opinion leaders or membership in a social network, (2) direct experience with weather events that could be linked to global climate change, (3) science education as well as general scientific literacy, and (4) demographic characteristics that precondition receptivity to messages about climate change.

Influence of Opinion Leaders or Membership in a Social Network

Early research suggested that a small number of “opinion leaders” shaped the influence of media on public opinion (Katz and Lazarsfeld 1955; Lazarsfeld, Berelson, and Gaudet 1968). Zaller (1992) added the modification that those who are either less attentive to or less aware of the messages being promulgated by the elite are less likely to accept them. Social networks and interactions can also influence the ways in which people form and change opinions (Watts and Dodds 2007; Moussaïd et al. 2013). People use several perspectives or “frames” to interpret information generally, especially information that has a highly political or emotional edge, and these frames matter more in opinion formation than the facts themselves (Chong and Druckman 2007; Hoffman 2015).

Both the framing of messages about climate change and the current association of the entire subject of climate change with political ideology have an overwhelming impact on acceptance of ideas about climate change (Druckman and Bolsen 2011; Brulle, Carmichael, and Jenkins 2012; Bolsen, Druckman, and Cook 2014a). Kahan (2015a) found that simply providing more accurate scientific information to the general public does not change opinions but instead reinforces prior views: “Those whose cultural commitments predispose them to be concerned about climate change become even more so as their level of science comprehension increases” (12). People selectively seek evidence that supports the position of the group with which they identify and dismiss evidence that contradicts it (van der Linden 2015).

The phenomenon of seeking information that confirms prior beliefs is known as *motivated reasoning* or *confirmation bias* (Nickerson 1998; Kahan 2015b). One exhibits motivated reasoning when one “view[s] evidence consistent with prior opinions as stronger or more effective” (Druckman 2015, 60). When political party shapes motivated reasoning, this phenomenon is labeled partisan motivated reasoning (Bolsen, Druckman, and Cook 2014a, 2014b, 2015) or politically motivated reasoning (Kahan 2015b). In this framing, individuals strive to shape their opinions on politically salient issues to conform with those of their party, reject information and ideas that conflict with party ideology, and become ever more convinced that their party’s position is accurate (Kahan et al. 2012).

Political parties in the United States are sharply divided on climate change and its anthropogenic causes. Whereas the Democratic Party views climate change as an urgent problem, the Republican Party tends to deny or downplay its significance. Whereas the 2016 Democratic Party platform characterizes climate change as “a real and urgent threat” and states that “Democrats share a deep commitment to tackling the climate challenge” (Democratic Party Platform Committee 2016, 27), the Republican Party platform notes that “climate change is far from this nation’s most pressing national security issue” and opposes “any carbon tax” (Republican National Committee 2016, 20). Further, many notable Republican leaders deny that the planet is warming or that human activity is the primary driver of climate change (McCright, Dunlap, and Xiao 2014; Gregoire 2015). This difference between conservative and liberal party positions seems to be unique to the United States (Båtstrand 2015).

Direct Experience with Environmental Hazards or Temperature Variability

Some studies have found that personal experience with storms, floods, drought, or temperature anomalies leads to greater acceptance of the existence of climate change. For example, respondents in the United Kingdom who had experienced flood damage expressed more concern about climate change (Spence et al. 2011). Similarly, Elrick-Barr et al. (2015) studied two coastal communities in Australia that were equally vulnerable to climate hazards and found that it was not proximity to the coast but instead prior experience with the hazard that increased perceived risk. Brody et al. (2008) also found only a weak relationship between proximity to flood-prone areas and risk perception, particularly in comparison with the impact of the

personality variables they used as controls, including “perceived efficacy” and “new ecological values” (88).

Several studies have focused on warmer summer or winter temperatures in affecting perceptions of climate change. Hamilton and Keim (2009) found that in U.S. regions accustomed to winter snow, relatively warm winters were associated with increased concern with climate change. Zaval et al. (2014) and Li, Johnson, and Zaval (2011) found that respondents expressed greater concern about global warming on hot summer days and speculated that people might substitute the current temperature for general trends when thinking about global warming. Similarly, Borick and Rabe (2010, 6) found that respondents identified “warmer temperatures in your area during recent years” as a major influence on their views that “the earth is getting warmer.” In contrast, Egan and Mullin (2012) found that any effect of the daily temperature immediately before or at the time of the survey on opinion about global warming was likely to be temporary.

Three studies found that warmer-than-normal summers and winters had an effect but only in combination with prior beliefs about climate (Hamilton and Stampone 2013; Howe and Leiserowitz 2013; Clayton et al. 2015). In contrast, Deryugina (2013) matched a sample of U.S. adults from the Gallup Environmental Poll for 2003 to 2010 with local weather information and found that short-run temperature fluctuations lasting between one and fourteen days had no effect on beliefs about global warming. Even extreme events such as “Snowmageddon” and Superstorm Sandy did not seem to alter climate change perception (Lehner and Stocker 2015; Saad 2015; Trenberth, Fasullo, and Sheperd 2015). In trying to account for this absence of effect, Mastrandrea, Luers, and Schneider (2006) hypothesized that Americans do not consider climate change to be as important and immediate as other environmental issues. Leiserowitz and Broad (2006) noted that the image that many Americans have of the impacts of global warming, such as melting polar icecaps, are distant from everyday experience: “Most Americans lacked vivid, concrete, and personal-relevant affective images of climate change, which helps explain why climate change remains a relatively low priority national or environmental issue” (55). In addition, many Americans believe that even if climate change does cause disruption, society will either adapt or find a technological solution.

Because of their midlatitude location, Americans might also find it difficult to experience “climate change” directly, and for those who live in areas where summers and winters have sharply different

temperature ranges, the experience of cold in the winter might erase the memory of the previous hot summer (Weber 2010; Howe and Leiserowitz 2013; Van Der Linden 2014). Indeed, a recent survey found that some view climate change as a positive trend, particularly for those Americans who have experienced relatively mild winters between 1974 and 2013 (Egan and Mullin 2016).

Another issue that impedes a direct relationship between experienced weather and belief in climate change is the process that people must undertake to see the linkage. The probability that people connect weather patterns to global climate change is likely to be filtered by prior beliefs or ideology that affects the ways in which they process information. In addition, when people are exposed to weather anomalies but do not suffer serious consequences, they might become more confident that climate change is not occurring or that it is not serious (Brody et al. 2008; Saad 2015)

Science Education and Scientific Literacy

Some have hypothesized that directed science education about human-caused climate change can shift opinion, overcoming ideological resistance. Guy et al. (2014) found such a pattern in Australia, and a 2008 survey in the United States (Borick and Rabe 2010) concluded that the 2007 report of the Intergovernmental Panel on Climate Change and Al Gore's documentary *An Inconvenient Truth* had a major impact on Americans' attitudes on global warming. Presumably in response to both sources of information, U.S. respondents cited images of shrinking glaciers and polar ice as the most important issues affecting their belief in global warming. In contrast, however, the preponderance of survey research in the United States has shown that scientific articles or assessment reports do *not* move public opinion (Zia and Todd 2010; Hamilton 2011; Hart and Nisbet 2011; Brulle, Carmichael, and Jenkins 2012). No matter how vivid the message or how strong the technical background of the audience, other factors are more important in shaping attitudes about climate change.

Demographic Characteristics and Receptivity to Information about Climate Change

Some research suggests that both gender and ethnicity might independently affect ideology or worldview, in turn shaping receptivity to new information on climate change. Surveys have found that women are more concerned than men about climate change,

perhaps due to differences in socialization and therefore the development of key values (McCright and Dunlap 2011). White men tend to be relatively more hierarchical and individualistic and, as a result, show greater skepticism about any kind of risk, including the deleterious effects of global climate change (Finucane et al. 2000; Kahan et al. 2007).

Hypotheses

In sum, cross-sectional surveys have provided overwhelming evidence that ideology, party identification, and attitudes about environmental conservation versus economic development strongly influence beliefs about climate change in the United States. Based on the theory of politically motivated reasoning, we hypothesized that people tend to shift their opinions over time to better match those of opinion leaders they respect and that this effect is even stronger for those who pay more attention to messages from party elites. We also explored the effects of education levels and personal experience with hot summers, warm winters, droughts, and weather-related natural disasters on changing beliefs about climate change.

Data and Methods

The nine cross-sectional surveys that make up the Cooperative Congressional Election Study (CCES) have provided the basis for many scholarly studies (Ansolabehere and Schaffner 2015). The CCES also includes a nationally representative 2010 to 2014 panel, which repeatedly asked 9,500 respondents the same question about climate change. YouGov/Polimetrix administers the "opt-in" Internet-based survey that compensates respondents with rewards or points for every survey they complete (Ansolabehere and Schaffner 2014). Schaffner and Ansolabehere (2015a, 2015b) described the detailed sampling strategy, sample matching algorithm, and theoretical background for the panel study. They noted that YouGov reinterviewed 83 percent of the 2010 panel sample in 2012 and 68 percent of the 2012 respondents in 2014. Although any attrition decreases the representativeness of panel surveys, the overall retention rate of 56 percent compares favorably to the 41 percent retention rates reported in the 2000 to 2004 American National Election Studies. Sample composition did not change markedly between 2010 and 2014; although attrition was somewhat higher for blacks and nonvoters,

attrition rates were generally similar among subgroups (Schaffner and Ansolabehere 2015a, 2015b).

The dependent variable in this analysis was derived by comparing the 2010 and 2014 responses to the following question: “From what you know about global climate change or global warming, which one of the following statements comes closest to your opinion?”

1. Global climate change has been established as a serious problem and immediate action is necessary.
2. There is enough evidence that climate change is taking place and some action should be taken.
3. We don’t know enough about global climate change and more research is necessary before we take any actions.
4. Concern about global climate change is exaggerated and no action is necessary,
5. Global climate change is not occurring and this is not a real issue.”

We coded the 65 percent who gave the same response in both years as 0, the 17 percent who gave a lower numbered answer in 2014 as -1 , and the 18 percent who gave a higher numbered answer in 2014 as $+1$.

We measured all individual-level independent variables in 2010 and experiences with weather anomalies within the period between the two surveys. We used two dummy variables to distinguish Democrats and Republicans from independents, the reference group. To test whether partisan respondents sought partisan information, we tested the interaction between party identification and interest in public affairs as measured on a four-level scale, based on responses to this question: “Some people seem to follow what’s going on in government and public affairs most of the time, whether there’s an election going on or not. Others aren’t that interested. Would you say you follow what’s going on in government and public affairs most of the time, some of the time, only now and then, or hardly at all?”

We coded liberalism on a five-point scale, ranging from 1 (*very conservative*) to 5 (*very liberal*). We measured attitudes about the relative importance of environmental conservation versus economic development based on 2010 responses to the question, “Some people think it is important to protect the environment even if it costs some jobs or otherwise reduces our standard of living. Other people think that protecting the environment is not as important as maintaining jobs and our standard of living. Which is closer to the way you feel, or haven’t you thought much about this?” We coded this variable as 1 for those who said it was much

more important to protect jobs and 5 for those who said it was much more important to protect the environment. To test the “white male” effect, we introduced nine dummy variables for white women, and black, Hispanic, Asian, and “other” men and women.

Because the CCES identifies the respondent’s county of residence, we were able to associate weather-related variables at the county level, using other data sets. To measure warm winters and hot summers, we used the mean January and July temperatures in the county from 2011 to 2014, minus the mean temperatures for the same month from 1950 to 2010 (Menne et al. 2012). Because most of the previous research has weather-related variables for much shorter periods ranging from that day’s temperature (Egan and Mullin 2012) to up to one year (Hamilton and Stampone 2013), we also ran models using only data from the previous year. The effects were similar to those reported. The temperature data came from the Global Historical Climatology Network-Daily at the National Oceanic and Atmospheric Administration. Across the entire sample, the average January temperature from 2011 through 2014 was slightly cooler (0.1°C) than in 1950 through 2010, but the average July temperature was 0.5°C higher than the baseline.

We measured experience with drought using the number of weeks between November 2010 and September 2014 that the county had moderate-to-extreme drought conditions (D1–D4), using data from the U.S. Drought Monitor. Four measures of the severity of eight natural disasters in the county between November 2010 and September 2014 were analyzed: the natural logarithms of total fatalities, injuries, crop damage, and property damage due to coastal flooding, drought, flooding, heat, hurricane or tropical storm, severe storm or thunderstorm, tornado, or winter weather (Hazards and Vulnerability Research Institute 2014).

For the initial analysis, we compared the characteristics of people who did and did not change their opinions on climate change between 2010 and 2014. We tabulated the differences between changers and nonchangers with respect to party identification, ideology, relative importance of environmental conservation, interest in public affairs, race or ethnicity, gender, age, and education. Given the overwhelming impact of political party identification on beliefs about climate change, we then focused on opinion change among respondents who identified with the same political party in 2010 and 2014.

We ran generalized ordered logit models to assess the impact of our independent variables on whether respondents became more skeptical, did not change, or became more concerned about climate change

Table 1. Percentages taking each position on climate change, 2010 and 2014

	2010 (%)	2014 (%)
Global climate change is not occurring	6.2	7.6
Concern is exaggerated; no action is needed	19.5	19.5
More research is needed	20.0	18.4
Enough evidence that climate change is taking place	27.0	24.8
Global climate change is a serious issue; action needed	27.3	29.7
Total	100.0	100.0

Note: Sampling weight applied.

between 2010 and 2014.¹ Because the weather-related variables are measured at the county level, we clustered the standard errors at the same level.² We could not use simple ordered logit analysis because our model violated the proportionality of odds assumption. To ease interpretation, we did not report the coefficients from the Stata `gologit2` command (Williams 2005). Instead, we reported the marginal effects, also called the average partial effects (APEs; Wooldridge 2010).

Opinion Change from 2010 to 2014

Overall, the distribution of opinion on climate change was similar in 2010 and 2014. Changes tended to come at the two extreme ends of the spectrum: increases in those stating that climate change is not occurring or that climate change is a serious issue warranting action, balanced by small decreases in those stating that more research is needed (Table 1).

More than 35 percent of the respondents gave different responses in 2014 than they had in 2010, however. Although one would expect some level of variability in survey responses with a repeated survey over a four-year period of time, this volume of change exceeded the variability noted on other survey items such as opinions on the Affordable Care Act, granting legal status to immigrants, or gun control (Schaffner and Ansolabehere 2015a).

The five responses were condensed into three categories (Table 2). The first category summarized those

who are not concerned with global climate change: the combination of “Global climate change is not occurring and this is not a real issue” and “Concern about global climate change is exaggerated and no action is necessary.” The second category, “We don’t know enough about global climate change and more research is necessary before we take any actions,” remained the middle position. The third category was the combination of those concerned with global climate change: “Global climate change has been established as a serious problem and immediate action is necessary” and “There is enough evidence that climate change is taking place and some action should be taken.” Cross-tabulations and chi-square tests compared the six groups off the diagonal to those in the same rows whose views remained the same between 2010 and 2014 (Table 3).

Among those who said that climate change was not occurring in 2010, those who changed to saying that more research is needed in 2014 were more likely to be Democrats or independents, to be moderate or liberal in ideology, to place equal importance on the economy and the environment, and to show moderate interest in public affairs. The very small percentage who shifted from a belief that climate change is not occurring to the belief that it is occurring were more likely to be female, Democrats, under age fifty, moderate or liberal, and not white males; to have a moderate interest in public affairs; to give equal weight to the economy and environment, and to have started but not completed college.

Table 2. Percentages changing opinions between 2010 and 2014

Climate change (2010)	Climate change (2014)		
	Climate change is not happening or is exaggerated (%)	More study is needed (%)	Climate change is occurring and demands action (%)
Climate change is not happening or is exaggerated	77.4	19.1	3.5
More study is needed	25.2	56.1	18.8
Climate change is occurring and demands action	2.1	6.5	92.4

Note: Sampling weight applied.

Table 3. Characteristics of those whose opinions changed

	2014: Climate change is not happening or is exaggerated	2014: More study is needed	2014: Climate change is occurring and demands action
2010: Climate change is not happening or is exaggerated	N = 532 Conservative to very conservative Economy is more important than the environment Interested in public affairs most of the time Republican	N = 363 Moderate or liberal ideology Economy and environment are of equal importance Moderate interest in public affairs Independent or Democrat	N = 109 Below age 50 Fewer postgraduate, more with "some college" Female Moderate, liberal ideology Economy and environment are of equal importance Democrat Not white male
2010: More study is needed	N = 532 Conservative to very conservative Economy is more important than the environment Interested in public affairs most of the time Republican	N = 281 More in age 40-50 group, fewer over 50 Less frequent for college educated Economy is more important than environment Some interest in public affairs Republican	N = 335 Below age 65 Female Moderate to liberal Environment is somewhat more important than the economy Some interest in public affairs Democrat Non-white
2010: Climate change is occurring and demands action	N = 101 More in age 40-50 group, fewer over 50 Conservative to very conservative Less frequent for college educated Economy is more important than environment Some interest in public affairs Republican	N = 281 Not in California Less well educated Female Conservative to very conservative Economy and environment are equally important or economy is more important Infrequent interest in public affairs Independent or Republican Not white male	

Among those who said that more study was needed in 2010, respondents who shifted to believing that climate change is not happening or is exaggerated were more likely to be conservative or very conservative, to value the economy and jobs over the environment, to be interested in public affairs most of the time, and to be Republican. Those whose opinions shifted in the opposite direction, stating in 2014 that climate change is occurring, were more likely to be under sixty-five, female, non-white, moderate to liberal, and Democrat, and to view the environment as somewhat more important than the economy.

Finally, respondents who said that climate change is occurring in 2010 but said that climate change is not happening or is exaggerated in 2014 were more likely to be between forty and fifty years old, conservative to very conservative, and Republican, to believe that the economy is more important than the environment, and to have some interest in public affairs. The respondents who shifted to calling for more research on whether climate change is occurring by 2014 were less well educated, female, Republican, conservative to very conservative, felt that the economy is equally or slightly more important than the environment, and were infrequently interested in public affairs.

Opinion Change among Republicans, Democrats, and Independents

To test the theory of motivated reasoning, we next focused on how political party affiliation affected the strength and direction of such change. For this

analysis, we restricted the sample to the 85 percent (8,113 respondents) who had not changed their political party affiliation between 2010 and 2014.

Overall, a much smaller proportion of these respondents, 18 percent compared to the 35 percent noted for the full sample, had changed their opinion over the 2010 to 2014 time period. We found the impact of political party on the direction of change overwhelming (Table 4). Democrats were even more likely to attest that climate change is occurring and that this change demands action: The largest percentage of opinion changers were in the category of those who had formerly said more research was needed and now were convinced that climate change was occurring. On the other hand, Republicans were more likely to become more skeptical about climate change: 48.2 percent remained skeptical about climate change throughout the study period, and an additional 11.1 percent who had previously stated that more research was needed reported by 2014 that climate change is not occurring or is exaggerated.

The geographic pattern of opinion change when stratified by political party is complex (Figure 1). Republicans who shifted from asking for more research in 2010 to being convinced that climate change is not occurring tended to be more concentrated in the southeastern part of the United States and in relatively more rural or suburban counties where they are likely to hold local majorities.

A generalized ordered logit analysis permits the identification of the relative importance of the independent variables (Table 5). Each row shows how a one-unit increase in the independent variable changes

Table 4. Attitude change by party identification

	Republican	Independent	Democrat
	Climate change not occurring 2010		
Climate change not occurring 2014	84.7	73.4	48.5
More research in 2014	12.8	17.1	28.2
Climate change occurring in 2014	2.5	9.5	23.3
Sample size	2,017	158	103
	More research needed in 2010		
Climate change not occurring 2014	38.2	20.0	12.4
More research in 2014	50.8	51.0	38.8
Climate change occurring in 2014	10.9	29.0	48.8
Sample size	1,025	145	242
	Climate change occurring 2010		
Climate change not occurring 2014	9.5	2.8	0.6
More research in 2014	22.8	10.4	2.4
Climate change occurring in 2014	67.7	86.7	96.9
Sample size	504	316	3,403

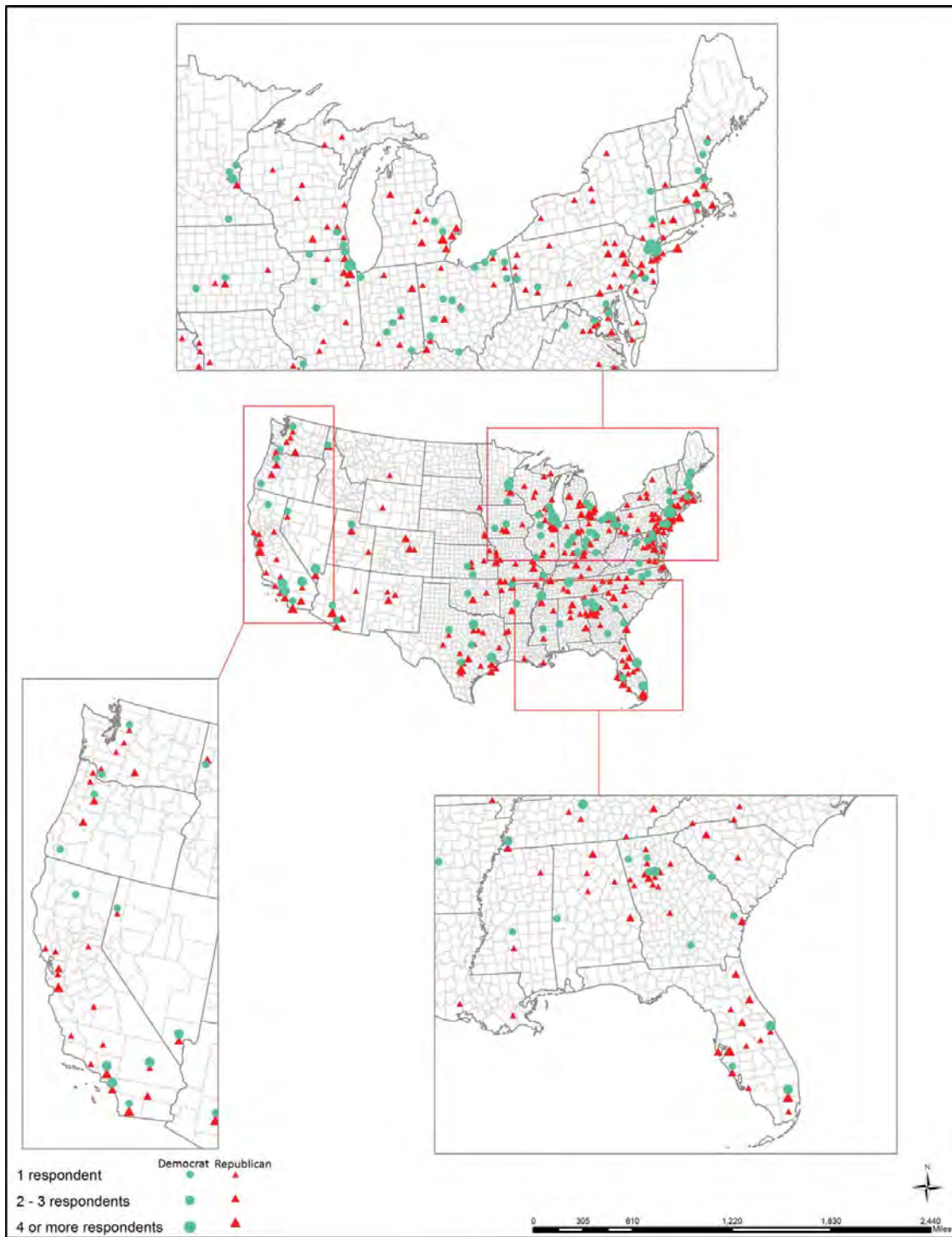


Figure 1. Republicans who changed from more research to skepticism and Democrats who changed from more research to belief. (Color figure available online.)

the average probability of becoming more skeptical about, keeping the same opinion on, or becoming more convinced of global climate change. Within each row, the probability changes sum to zero. Thus, for example, a one-point rise in the relative

importance one placed on the environment relative to jobs in 2010 led to a 4.5 percent drop in one's probability of becoming more skeptical about climate change by 2014. This is offset by a 4.3 percent increase in one's probability of becoming more concerned and a

Table 5. Changes in opinions, 2010–2014: Average partial effects from generalized ordered logit model

	Change in beliefs		
	Became more skeptical	Did not change	Became more concerned
Relative importance of environment and economy (1–5)	–4.5*** (0.4)	0.3* (0.1)	4.3*** (0.3)
Liberalism (1–5)	–5.1*** (0.4)	0.3* (0.1)	4.8*** (0.4)
Republicans who almost never follow public affairs information	–10.7† (5.5)	1.1 (2.0)	9.5* (4.2)
Democrats who almost never follow public affairs information	–2.1 (6.1)	–9.3* (4.3)	11.3* (4.5)
Impact of interest in news and public affairs (1–4) among:			
Republicans	5.7*** (1.2)	–2.5*** (0.6)	–3.2*** (0.7)
Independents	–2.3 (1.5)	0.0 (0.2)	2.3 (1.5)
Democrats	–3.3*** (0.6)	1.5 (1.2)	1.8 (1.2)
Education (1–5)	–1.1** (0.3)	1.2** (0.4)	–0.2 (0.3)
Age	–0.1** (0.0)	0.1* (0.0)	0.0 (0.0)
Weather-related variables			
Average January temperature deviation	–0.9** (0.3)	0.1† (0.0)	0.8** (0.3)
Average July temperature deviation	0.3 (0.4)	–0.0 (0.0)	–0.2 (0.4)
Weeks of drought conditions	0.0 (0.0)	–0.0 (0.0)	–0.0 (0.0)
Log total fatalities	0.4 (0.3)	–0.0 (0.0)	–0.4 (0.3)
Log total injuries	–0.0 (0.2)	0.0 (0.0)	0.0 (0.2)
Log total crop damages	0.0 (0.1)	–0.0 (0.0)	–0.0 (0.0)
Log total property damages	–0.1 (0.1)	0.0 (0.0)	0.1 (0.1)
White male effect?			
White female	–0.8 (0.7)	0.0 (0.0)	0.7 (0.6)
Black female	5.1** (1.7)	–0.3† (0.2)	–4.8** (1.6)
Hispanic female	2.3 (2.2)	–0.1 (0.1)	–2.2 (2.1)
Other female	3.8 (3.6)	–11.3** (3.8)	7.5* (3.1)
Black male	6.4* (2.6)	–7.0* (3.0)	0.6 (2.4)
Hispanic male	5.0* (2.0)	–8.3** (2.6)	3.3 (2.3)
Other male	4.9* (2.0)	–0.3† (0.2)	–4.6* (1.9)
Observations	1,347	5,085	1,442

Note: Standard errors, clustered at the county level, are in parentheses. Respondent's belief of climate change in 2010 is included in the model.

† $p < 0.10$.

* $p < 0.05$.

** $p < 0.01$.

*** $p < 0.001$.

0.3 percent increase in one's probability of not changing one's position. Similarly, respondents who were one level more liberal in 2010 were 4.8 percent more likely to increase their concern about climate change and 5.1 percent less likely to become more skeptical.

Republicans who almost never followed the news about public affairs were 9.5 percent more likely than comparable independents to become more concerned about climate change and 10.7 percent less likely to become more skeptical. Democrats who almost never followed the news were 11.3 percent more likely than comparable independents to increase their concern and insignificantly less likely to increase their skepticism. In other words, low-information Democrats were only 1.8 percent more likely than low-information Republicans to increase their concern and 8.4 percent less likely to become more skeptical.

For those interested in news and public affairs, however, the partisan effects were clear. Following the news did not change the opinion of independents much, but each one-point rise on the four-point news interest scale increased Republicans' probability of becoming more skeptical about climate change by 5.7 percent and decreased their probability of becoming more concerned by 3.2 percent. In contrast, following the news reduced Democrats' chances of becoming more skeptical; each one-point rise on the four-point news interest scale reduced their probability of greater skepticism by 3.3 percent. Thus, each one-point rise in news interest widened the gap between Republicans and Democrats by 9 percent. This is strong evidence for the motivated reasoning hypothesis: Individuals find information to confirm the general ideology of the group to which they belong and shift their beliefs toward the modal belief of their reference group.

We found little evidence that direct experience with warmer weather, droughts, and weather-related natural disasters affected opinions about climate change. Of the weather-related independent variables, only warm winters had a statistically significant impact: a 1° increase in average January temperatures relative to the baseline is associated with a 0.8 percent increase in the probability of rising concern and a 0.9 percent decrease in the probability of greater skepticism (Table 5). The impacts of hot summers, droughts, and natural disasters on change in opinion were not statistically distinguishable from zero.

The impacts of other variables on opinion change were weaker and less consistent. More-educated and older respondents were less likely to become more skeptical about climate change. We found little evidence

for the white male effect. Only "other" females were more likely than comparable white men to increase their concern about climate change between 2010 and 2014. Black women and black, Hispanic, and "other" men were all about 5 percent more likely than comparable white men to increase their skepticism.

Conclusions

Americans are becoming more polarized along partisan lines, and that change tends to bring the individual in line with the modal view of the political or ideological group with which the person identifies. An overwhelming number of Democrats strongly believe that climate change is occurring and that immediate action is required. Independents are also somewhat moving toward this point of view, although in smaller percentages. Republicans, on the other hand, generally remained convinced that climate change is not occurring or that its seriousness is exaggerated, and even those who sought more research on the topic in 2010 tended to become more skeptical of the existence of climate change by 2014. This vast difference in perspective is also reflected in the 2016 political party platforms on climate change. Democrats view climate change as "an urgent threat" and a "defining challenge," whereas the Republican platform pledged to defeat the Clean Power Plan to cut energy-sector greenhouse emissions and rejected the 2015 Paris UN agreement on climate change.

Using repeated surveys on the same individuals over a four-year period, this analysis suggests that the direction of change in opinion is clearly related to respondents' political and environmental ideology, particularly when they pay more attention to public affairs: Those most engaged and interested in public affairs seem to be seeking information that confirms the positions that their political ideology would suggest, resulting in confirmation and strengthening of their opinions over time. This is strong evidence for the theory of motivated reasoning in accounting for the changing opinion of Americans with respect to climate change.

In contrast, direct experience with indicators of climate change had little impact on changes in beliefs and attitudes. Experience with hotter summers, drought, and natural disasters did not have clear impacts on attitude change.

The absence of growth in acceptance of climate change since 1990, the increase in partisan polarization of opinion, and the finding that direct experience with drought or warmer summer temperatures has had little or no impact on belief in the existence of climate change

suggest that the attitudes of Americans are not very susceptible to influences outside of political and economic ideology. Our findings portend that even with news of more summer heat, massive fires, drought, and record-breaking storms, an important portion of the population will not accept evidence of global climate change.

Notes

1. Ordered logistic regression assumes that the independent variables have linear (constant) impacts on the natural logarithms of the odds, rather than on the probabilities, of each belief. Thus, the impact of each independent variable on the probabilities varies across individuals. The APE estimates the probability change for each individual in the data set and then calculates the mean of those changes.
2. We also tested a multilevel mixed-effects ordered logistic regression using the Stata `meologit` command. The `meologit` command has a strength in recognizing that we are measuring the weather-related variables at the county level and the other variables at the individual level but a weakness in not allowing us to relax the parallel odds assumption. Nonetheless, `meologit` did not meaningfully change the findings.

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