Does Global Warming Increase Public Concern About Climate Change?

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Abstract

There is no consensus about whether exposure to a changing climate influences public concern about climate change. In this paper, we examine the link between climate change and public opinion using a comprehensive index of the mass public's latent concern about climate change in each state from 1999-2017. The index aggregates data from over 400,000 survey respondents in 170 polls. These new estimates of state-level climate concern enable us to exploit geographic variation in locally experienced climate changes over an extended time period. We show that climate concern peaked in 2000 and again in 2017. At the national level, trends in public opinion clearly mirror trends in temperature. Moreover, climate concern is modestly responsive to changes in state-level temperatures. Overall, our results suggest that continued increases in temperature are likely to cause public concern about climate change to grow in the future. But a warming climate, on its own, is unlikely to yield a consensus in the mass public about the threat posed by climate change.

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Is the public's concern about climate change increasing as the planet warms? Understanding the link between experience with climate change and climate concern is important, since belief in climate change tends to be correlated with support for policies to address it (Egan and Mullin, 2017). But identifying this link poses measurement challenges because the extent of warming varies considerably across the United States (Kaufmann, 2016). Thus, assessing the relationship between climate change and climate concern demands a research design that both accounts for variation in Americans' exposure to climate change across geography and time and allows us to account for other factors, such as changes in the national economy, that might influence public opinion.

In this paper, we develop a new index of the mass public's concern about climate change in each state from 1999-2017. This comprehensive index enables us to identify the effect of exposure to climate change with a new level of robustness. It is also the first to show trends in climate concern at the state level, which is the level of opinion aggregation that matters most to state elected officials and members of Congress. Using these data and exploiting geographic variation in exposure to climate change, we show that higher temperatures lead to greater state-level concern about climate change. But a warming climate, on its own, is unlikely to yield a consensus in the mass public on climate change.

Background

Scholars have not definitively determined whether changes in the climate influence public opinion. This lack of consensus stems in part from inconsistencies in the extent to which scholars account for variation in exposure to climate change. A number of national or regional-level studies find inconsistent (Donner and McDaniels, 2013) or non-existent (Carmichael and Brulle, 2017; Marquart-Pyatt et al., 2014) links between temperature trends and public opinion. However, these studies assume that individuals hundreds or thousands of miles apart experience climate change in the same way. Several studies examine the asso-

ciation between subnational temperature and opinion over a short time frame and generally find short-lived but significant effects (e.g., Konisky, Hughes, and Kaylor, 2016; Egan and Mullin, 2012; Kaufmann, 2016; Palm, Lewis, and Feng, 2017; Scruggs and Benegal, 2012, but see Mildenberger and Leiserowitz, 2017). A strength of these studies is that they assess reactions to climate change at the level at which people actually experience it. However, these studies are capturing the effect of "attribute substitution": the use of weather anomalies as a biased heuristic for a changing climate (Egan and Mullin, 2014). Thus, it is not clear what they imply about the link between annual temperature trends and public opinion. Only a few studies have examined the effect of state or local variation in climate change over a longer time scale (Deryugina, 2013; Shao et al., 2014). Tantalizingly, these studies find a modest link between annual changes in temperature and public opinion. But they use small survey samples and sometimes find inconsistent effects across polls.

One of the main challenges to identifying the relationship between climate change and climate concern is measuring subnational public opinion over an extended time period. Many previous studies focus on a long-running series of questions about climate change on Gallup's Social Series (e.g., Figure 1, panel a) (McCright and Dunlap, 2011; Marquart-Pyatt et al., 2014; Deryugina, 2013; Donner and McDaniels, 2013; Carmichael and Brulle, 2017). Despite its ubiquity in the literature, Figure 1 shows there are downsides of focusing exclusively on the Gallup series: the sample sizes are too small to produce state-level estimates, and the questions offer incomplete time coverage. Focusing on the Gallup surveys also leaves out dozens of other questions about climate change that have been asked on surveys.

Research Design

To address these limitations, we assembled a dataset of all publicly available survey data on climate change from 1999-2017. The dataset includes approximately 400,000 survey respondents from 170 individual polls. It includes questions about belief that climate change

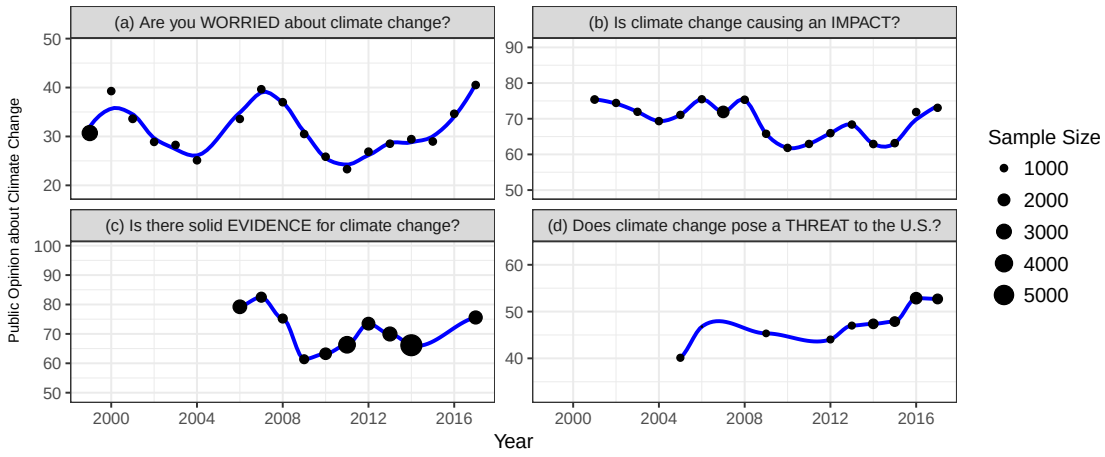

Figure 1: Trends in Public Opinion on Individual Climate Poll Questions

is occurring and/or caused by human activities, concern about global warming, and support for prioritizing policies to address climate change. Figure 1 shows a sample of these questions, and a full list is provided in Supplementary Appendix A. Figure 1 indicates that trends in public opinion are highly correlated across survey questions.

To summarize this comprehensive dataset of public opinion on climate change, we use a group-level item response theory (IRT) model to generate an aggregate index of latent concern about climate change in each state/year between 1999 and 2017 (Caughey and Warshaw, 2015).[1] No previous study has described trends in public opinion about climate at the state level, where they arguably matter most for legislators who respond to state, rather than national, constituencies. The long time frame from 1999 to 2017 provides sufficient statistical power to detect small effects of climate change on public opinion. It also ensures that any findings are generalizable beyond a particular snapshot in time. Our extended time period also enables us to examine whether the effect of temperature on public opinion is decreasing as the public grows more polarized.

We conduct a battery of analyses to examine whether changes in the climate of each state influence public opinion. First, we examine the effect of temperature on public opinion

[1]See Supplementary Appendices A and B for details about the model. In Appendix C, we provide evidence that concern about climate change can be reduced to a single dimension. We also validate our estimates by comparing them to the best available measures of state-level climate opinion (Howe et al., 2015).

based on variation in the annual average of monthly average temperatures in each state. Next, we examine five indicators of extreme events in each state that are linked to trends in precipitation: storms, short- and long-term drought severity, precipitation, and wildfires. We standardize each extreme-events measure for comparability across indicators, and we lag all climate measures by one year to ensure that public opinion is measured post-treatment.

To isolate the effect on climate concern of citizens' exposure to climate change at the state-level from other time-varying confounders and to test the persistence of the effect, we estimate a series of increasingly nuanced time series, cross-sectional (TSCS) models.[2] We first use a model with both state and year fixed effects. The year fixed effects account for national-level shocks, such as recessions or the debut of *An Inconvenient Truth*,[3] while the state fixed effects control for variation in baseline climate conditions as well as the political culture of each state (McCright and Dunlap, 2011; Marquart-Pyatt et al., 2014; Shao et al., 2014). Next, we add linear time trends within each state (Angrist and Pischke, 2014). This allows us to account for smooth changes in state characteristics over time (such as ideology or economic conditions) that might influence public attitudes about climate change. Finally, we use a model with a lagged dependent variable to capture other, time-varying omitted variables and to determine whether the effect of temperature persists over time (Beck and Katz, 2011; De Boef and Keele, 2008). We adjust our analyses to account for measurement error in our estimates of climate concern using a technique known as the "method of composition" or "propagated uncertainty" (Treier and Jackman, 2008).[4]

Results

Figure 2 shows trends in public opinion (upper panel) and temperature (lower panel) at the national level from 1999-2017. When our index is at 0, approximately 59% of the public

[2]See Supplementary Appendix D for more details.

[3]It is worth noting, however, that the year fixed effects also net out any changes in temperature or other climate indicators that are correlated across states.

[4]The main consequence is to increase the uncertainty in our estimates of the effect of temperature on climate concern. In Supplementary Appendix F, we show regressions that are unadjusted for measurement error.

worries a 'great deal or fair amount' about climate change in Gallup's annual polls.[5] In addition, a one standard-deviation change in our latent scale is roughly equivalent to a 7% change in the number of people that worry about climate change. Overall, the upper panel of Figure 2 confirms the trends observed on individual survey questions (see Figure 1). Public concern about climate change reached its maximum in about 2000, dipped over the next few years, and then rebounded between 2005 and 2008. Concern then slumped again around 2009, remained low until 2015, and ticked up in 2016 and 2017.

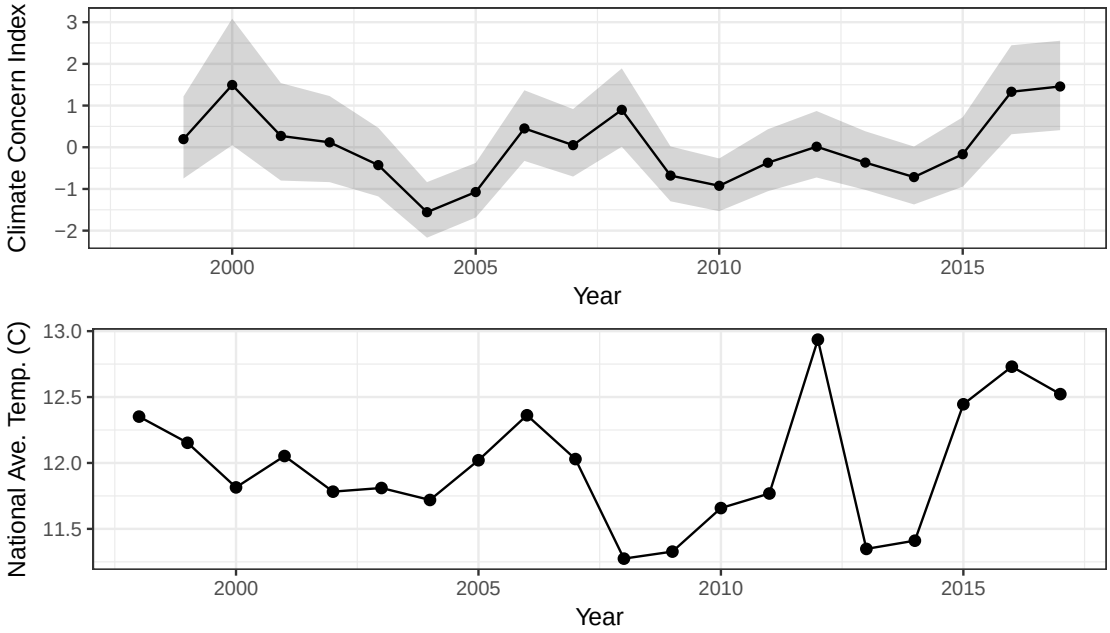

Figure 2: Trends in Climate Concern and Temperature at the National Level: This graph shows trends in our index of climate concern and annual average temperatures at the national level. The figure shows 90% credible intervals around the estimates.

Figure 2 shows that trends in public opinion clearly mirror trends in temperature. A one-degree Celsius change in temperature at the national-level is associated with a 1.04 standard-deviation change in opinion in the next year.[6] While this association is large and implies a strong relationship between climate change and opinion, it could be confounded by any number of omitted variables. Moreover, there is high variation in locally experienced warming trends (Kaufmann, 2016).

[5]See Supplementary Figure C2.
[6]See Supplementary Appendix E.

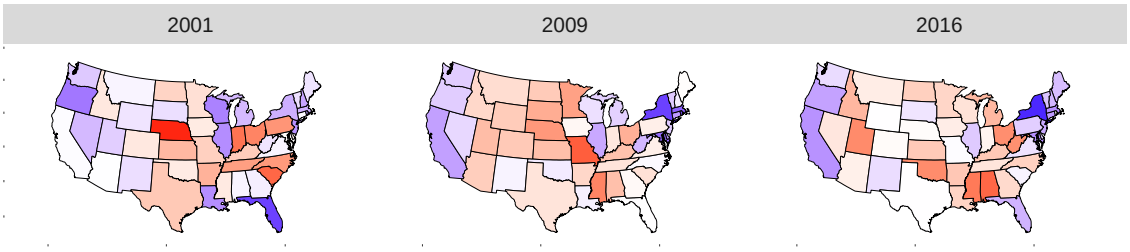

Figure 3: Average state climate concern, 2001–2016. Deep red represents states with low concern about climate change, while deep blue represents states with high concern. The estimates have been standardized within each year to accentuate cross-sectional variation.

To address these limitations, we next examine the public's climate concern at the state level. Figure 3 shows how state-level concern about climate change has changed over the past 15 years. The figure conforms with prior research showing that the alignment between public opinion on climate change and partisanship has increased over the past two decades (e.g., McCright and Dunlap, 2011). Overall, states that tend to elect Republicans have generally become more skeptical about the existence of climate change, whereas Democratic states have become more likely to believe in anthropogenic climate change.

Table 1: Effect of State-Level Temperature on Public Opinion (1999-2017)

	Climate Concern		
	(1)	(2)	(3)
Average Monthly High Temperature$_{t-1}$ (°C)	0.157**	0.116*	0.145**
	(0.068)	(0.069)	(0.071)
Lagged Climate Concern			0.107
			(0.069)
State Fixed Effects	X	X	X
Year Fixed Effects	X	X	X
State-specific time trend		X	
Lagged outcome Variable			X
Observations	931	931	882
R^2	0.583	0.659	0.603
Note:			*p<0.1; **p<0.05

What is the effect of changes in climate at the state level on public concern about climate

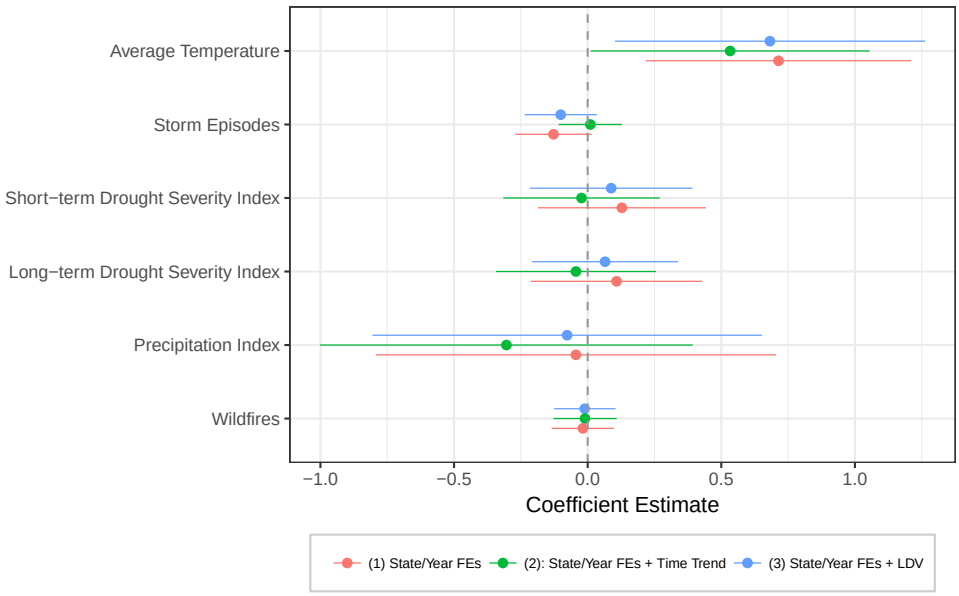

Figure 4: The effect of a one standard-deviation change in various climatic indicators on public opinion. The indicators are measured at the state level and refer, from top to bottom, to the annual average of monthly average temperature in degrees Celsius, the duration of storm events, annual average of monthly short-term drought, annual average of monthly long-term drought, reduction from median annual precipitation, and the (logged) acres that experienced wildfires.

change? We find that changes in annual-average temperatures have a small but robust effect on climate concern. Across specifications, a one-degree Celsius increase in temperature in a state relative to the nation leads to an increase of 0.12 - 0.16 standard deviations in the state-level climate-concern index in the following year (Table 1). This effect implies that a one-degree Celsius increase in temperature causes an increase of about 1% in the number of people in a state that worry a 'great deal or fair amount' about climate change.[7] Moreover, this effect persists even in the face of growing polarization on climate change.[8] The last column includes a lagged dependent variable (LDV), which enables us to assess the long-term effects of increases in temperature on public opinion. It shows that the effect of a single year's temperature on climate concern decays over time. For example, 2015's temperature has about one tenth the effect on climate concern in 2017 as temperature in 2016.

[7]See Supplementary Figure C2.
[8]See Supplementary Appendix G.

Finally, we examine the effect on public opinion of an array of standardized indicators of extreme events in each state that are linked to trends in precipitation. None of the climate-extremes indicators have a robust, significant effect on public opinion (Figure 4). Since we assess responses to extreme events that occurred in the previous year, our results leave open the possibility that these indicators can affect public opinion on a scale of weeks or months (Konisky, Hughes, and Kaylor, 2016). They do not appear to have a persistent effect on public opinion at the state level though. Elements of the media environment might explain this distinction. Perhaps local news coverage has been more apt to link temperature trends, as opposed to precipitation-related climate indicators, to climate change.

Conclusion

There is no consensus in the literature about whether exposure to a changing climate influences the mass public's concern about climate change. To resolve this debate, we present the first estimates of trends in both national and state-level climate concern across nearly two decades. These estimates enable us to assess the relationship between indicators of a changing climate and public opinion with a new level of rigor. They also open new opportunities for robust research into the causes and consequences of climate concern at the state level.

We find a large association between changes in temperature and the public's climate concern at the national level. Of course, this national-level relationship is subject to an array of potential confounders. Turning to the state-level, we use an array of TSCS models to show that public opinion clearly responds to changes in annual temperature. We find a continuing effect of temperature on climate concern in recent years, despite increasing polarization on climate change. However, the relatively small size of the effect of changes in state-level temperature on public opinion indicates that a warming climate, on its own, is unlikely to yield a consensus about the threat posed by climate change.

References

Angrist, Joshua D, and Jörn-Steffen Pischke. 2014. *Mastering 'metrics: The path from cause to effect*. Princeton University Press.

Beck, Nathaniel, and Jonathan N Katz. 2011. "Modeling Dynamics in Time-Series-Cross-section Political Economy Data." *Annual Review of Political Science* 14: 331–352.

Carmichael, Jason T, and Robert J Brulle. 2017. "Elite cues, media coverage, and public concern: An integrated path analysis of public opinion on climate change, 2001–2013." *Environmental Politics* 26(2): 232–252.

Caughey, Devin, and Christopher Warshaw. 2015. "Dynamic estimation of latent opinion using a hierarchical group-level IRT model." *Political Analysis* 23: 197–211.

De Boef, Suzanna, and Luke Keele. 2008. "Taking Time Seriously." *American Journal of Political Science* 52(1): 184–200.

Deryugina, Tatyana. 2013. "How do people update? The effects of local weather fluctuations on beliefs about global warming." *Climatic change* 118(2): 397–416.

Donner, Simon D, and Jeremy McDaniels. 2013. "The influence of national temperature fluctuations on opinions about climate change in the US since 1990." *Climatic change* 118(3-4): 537–550.

Egan, Patrick J, and Megan Mullin. 2012. "Turning personal experience into political attitudes: The effect of local weather on Americans' perceptions about global warming." *The Journal of Politics* 74(03): 796–809.

Egan, Patrick J, and Megan Mullin. 2014. "Psychology: Local weather and climate concern." *Nature Climate Change* 4(2): 89–90.

Egan, Patrick J, and Megan Mullin. 2017. "Climate Change: US Public Opinion." *Annual Review of Political Science* 20: 209–227.

Howe, Peter D, Matto Mildenberger, Jennifer R Marlon, and Anthony Leiserowitz. 2015. "Geographic variation in opinions on climate change at state and local scales in the USA." *Nature Climate Change* 5(6): 596–603.

Kaufmann, Robert K, et al. 2016. "Spatial heterogeneity of climate change as an experiential basis for skepticism." *Proceedings of the National Academy of Sciences* p. 201607032.

Konisky, David M, Llewelyn Hughes, and Charles H Kaylor. 2016. "Extreme weather events and climate change concern." *Climatic Change* 134(4): 533–547.

Marquart-Pyatt, Sandra T, Aaron M McCright, Thomas Dietz, and Riley E Dunlap. 2014. "Politics eclipses climate extremes for climate change perceptions." *Global Environmental Change* 29: 246–257.

McCright, Aaron M, and Riley E Dunlap. 2011. "The politicization of climate change and polarization in the American public's views of global warming, 2001–2010." *The Sociological Quarterly* 52(2): 155–194.

Palm, Risa, Gregory B. Lewis, and Bo Feng. 2017. "What Causes People to Change Their Opinion about Climate Change?" *Annals of the American Association of Geographers* 107(4): 883–896.

Scruggs, Lyle, and Salil Benegal. 2012. "Declining public concern about climate change: Can we blame the great recession?" *Global Environmental Change* 22(2): 505–515.

Shao, Wanyun, Barry D Keim, James C Garand, and Lawrence C Hamilton. 2014. "Weather, climate, and the economy: Explaining risk perceptions of global warming, 2001–10." *Weather, Climate, and Society* 6(1): 119–134.

Treier, Shawn, and Simon Jackman. 2008. "Democracy as a Latent Variable." *American Journal of Political Science* 52(1): 201–217.

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Supplementary Appendix A: Extended Data, Figures, and Legends

Table 1: Illustrative Question Categories

Category	Question
Belief	Do you believe that climate change is happening or will happen?
Worry	Do you worry about climate change?
Scientific Consensus	Do scientists agree that climate change is happening and humans are contributing to it?
Evidence	Is there solid evidence that climate change is happening?
Causes	Is climate change caused by human activities?
Policy	Should the government take policy action to address climate change?
Impacts	Is climate change causing a serious impact, or will it in the future?

Table 2: Survey Questions

Question Category	Years	Question	Sources
Belief	2006	Will climate change get worse next year?	Associated Press 2006
Belief	1999; 2010	Will climate change happen in the future?	Pew 1999a, 2010a
Belief	2006; 2007; 2008; 2012; 2016	Has climate change been happening over the past 100 years?	ABC News, Stanford University, and Time Magazine 2006, ABC News, Stanford University, and The Washington Post 2007, ABC News, Discovery Channel, Stanford University 2008, American National Election Studies 2012, 2016
Belief	2011	Has climate change been happening over the past 100 years? (different prelude)	Cooperative Campaign Analysis Project 2011
Causes	2012; 2016	Is climate change caused by human activities; or a combination of human and natural causes? (Question assumes it's happening)	American National Election Studies 2012, 2016
Causes	2005; 2007	Is the burning of fossil fuels one of the causes of climate change?	ABC News, The Washington Post 2005, CBS, The New York Times 2007
Causes	2001	Will increased CO2 lead to an increase in global temperatures?	Harris Interactive 2001
Causes	2013	Are record temperatures are due to the burning of fossil fuels or random weather variation?	National Journal 2013
Causes	2010; 2011	Is the earth's atmosphere too large for human activity to affect the climate?	National Surveys on Energy and Environment 2010a, 2011a
Causes	2001; 2003; 2006; 2007; 2008; 2010; 2011; 2012; 2013; 2014; 2015; 2016; 2017	Is climate change due more to human activities or natural forces?	Gallup 2001, 2003, 2006, 2007a, 2008, 2010a, 2011, 2012, 2013, 2014, 2015, 2016, 2017
Causes	2009; 2010; 2011; 2012; 2013; 2014; 2015; 2016; 2017	Has the earth been getting warmer over the past 4 decades due to human causes?	National Surveys on Energy and Environment 2009, 2010a,b, 2011a,b, 2012a,b, 2013a,b, 2014a,b, 2015, 2016a,b, 2017
Causes	2005; 2006	Is climate change caused by human activities? (asked of subpopulation of people who have heard about climate change)	Pew 2005a, 2006a
Causes	2012	Do you agree that climate change is caused by human activities? (asked of subpopulation)	Public Religion Research Institute 2012
Causes	2006; 2007; 2008; 2009; 2010; 2011; 2012; 2013; 2014; 2017	Is climate change happening and caused by human activities? (Includes subsetting question asking if climate change is happening)	Pew 2006b,c, 2007, 2008a, 2009a, 2010b, 2011a,b, 2012a, 2013a,b, 2014a, 2006d, 2017a
Causes	2007; 2008; 2009; 2010; 2011; 2013; 2014	Is climate change happening and caused by human activities? (includes option for climate change not happening; but no subsetting question)	Opinion Research Corporation, CNN 2007, Opinion Research Corporation and CNN 2008, 2009, Public Agenda Foundation 2009, Pew 2009b, Virginia Commonwealth University 2010, Opinion Research Corporation and CNN 2011, 2013, 2014

Survey Questions 2 Continued from previous page

Question Category	Years	Question	Sources
Causes	2011; 2012; 2013; 2014; 2015; 2017	Is climate change happening and caused by human activities? (includes option for climate change not happening; but no subsetting question; and option for both human and natural causes)	CBS and The New York Times 2011, CBS, 60 Minutes, and Vanity Fair 2012a,b, CBS 2013, CBS, 60 Minutes, and Vanity Fair 2013a,b, Social Science Research Solutions, CBS, and The New York Times 2014, Social Science Research Solutions, CBS 2014, CBS 2015, 2017
Causes	2009; 2010; 2011; 2012	Is global warming the result of natural causes?	National Surveys on Energy and Environment 2009, 2010a,b, 2011a,b, 2012b
Evidence	2003; 2007; 2008; 2016	Is there sufficient evidence to justify policy action on climate change?	MIT Energy Study 2003, 2007, 2008, Cooperative Congressional Election Study 2016
Evidence	2006; 2007; 2008; 2009; 2010; 2011; 2012; 2013; 2014; 2017	Is there solid evidence the climate is changing?	Pew 2006b,c, 2007, 2008a, 2009a, 2010b, 2011a,b, Public Religion Research Institute 2011a, Pew 2012a, Public Religion Research Institute 2012, Pew 2013a,b, 2014a, 2017a, Public Religion Research Institute 2014
Evidence	2009; 2010; 2011; 2012; 2013; 2014; 2015; 2016; 2017	Is there solid evidence for global warming over the past four decades?	National Surveys on Energy and Environment 2009, 2010a,b, 2011a,b, 2012a,b, 2013a,b, 2014a,b, 2015, 2016a,b, 2017
Evidence	2006; 2009	Is there sufficient evidence to justify policy action?	Hart and McInturff Research Companies, NBC News, and the Wall Street Journal 2006, Hart and McInturff Research Companies, NBC, and The Wall Street Journal 2009a,b
Evidence	2017	Is there sufficient evidence to justify policy action? (with prelude)	Cooperative Congressional Election Study 2017
Evidence	2009; 2010; 2011; 2012; 2013	Is there insufficient evidence for climate change?	National Surveys on Energy and Environment 2009, 2010a,b, 2011a,b, 2012a,b, 2013a
Evidence	2009; 2010; 2011; 2012; 2013	Do scientists overstate the evidence for climate change?	National Surveys on Energy and Environment 2009, 2010a,b, 2011a,b, 2012a,b, 2013a
Impacts	2005; 2008; 2011; 2012	Is climate change making natural disasters more severe?	Gallup 2005a, ABC News, Discovery Channel, Stanford University 2008, Princeton Survey Research Associates, Newsweek 2008, Public Religion Research Institute 2011b, Princeton Survey Research Associates, National Journal 2012, Public Religion Research Institute 2012
Impacts	2005; 2008	Did climate change contribute to specific recent disasters	Pew 2005b, ABC News, Discovery Channel, Stanford University 2008
Impacts	2006	Does climate change threaten the environment?	ABC News, Stanford University, and Time Magazine 2006
Impacts	2006	Is climate change a threat to you personally?	ABC News, Stanford University, and Time Magazine 2006
Impacts	2005; 2006; 2009; 2012; 2013; 2014; 2015; 2016; 2017	Is climate change a threat to the U.S.?	Taylor Nelson Sofres 2005, 2006, Pew 2009c, 2012b, 2013c, 2014b, 2015a, 2016, 2017b
Impacts	2002; 2006; 2008; 2012; 2014; 2015; 2016; 2004; 2010; 2017	Is climate change a threat to the vital interests of the US?	Harris Interactive, Chicago Council on Foreign Affairs 2002, Chicago Council on Foreign Relations 2006, Program on International Policy Attitudes, Search for Common Ground 2006, Chicago Council on Global Affairs 2008, 2012, Knowledge Networks, The Chicago Council on Global Affairs 2014, Chicago Council on Global Affairs 2015, 2016, Chicago Council on Foreign Relations 2004, Chicago Council on Global Affairs 2010, 2017
Impacts	2006	Is climate change a threat to the U.S.? (4 answer choices)	Taylor Nelson Sofres 2006
Impacts	2002	Is climate change a threat to quality of life in the U.S.?	Princeton Survey Research Associates, Kaiser Family Foundation 2002

Survey Questions 2 Continued from previous page

Question Category	Years	Question	Sources
Impacts	2014; 2015; 2016	Has global warming influenced the weather on earth?	National Surveys on Energy and Environment 2014b, 2015, 2016a
Impacts: seriousness	2001; 2004; 2006; 2007; 2008; 2009; 2010; 2011; 2012; 2013; 2014	Is climate change a very; fairly; or somewhat serious problem; or not a problem?	Harris Interactive, Time Magazine, and CNN 2001, National Annenberg Election Study 2004, Pew 2006c, 2007, 2008a, 2009b,d,a, 2010b, 2011b, 2012a, 2013a, ABC 2014, Pew 2006d, 2008b
Impacts: seriousness	2007; 2009	How serious is climate change; and should it be a high priority for government leaders?	CBS, The New York Times 2007, CBS and The New York Times 2009
Impacts: seriousness	2015	Is climate change a serious problem facing this country?	ABC 2015
Impacts: seriousness	2007	How serious will climate change and its consequences be?	Gallup 2007b
Impacts: seriousness	2008; 2009	Is climate change a very; fairly; or somewhat serious problem; or not a problem? (Asked of subset)	ABC News, Discovery Channel, Stanford University 2008, ABC and The Washington Post 2009
Impacts: seriousness	2011	Is climate change a very; somewhat; or not very serious problem?	Cooperative Campaign Analysis Project 2011
Impacts: seriousness	2010	Is climate change a very; fairly; or somewhat serious problem; or not a problem?	Virginia Commonwealth University 2010
Impacts: time	2001; 2002; 2003; 2004; 2005; 2006; 2007; 2008; 2009; 2010; 2011; 2012; 2013; 2014; 2015; 2016; 2017	Are climate change impacts happening now or will they happen soon?	Gallup 2001, 2002, 2003, 2004, 2005b, 2006, 2007b,a, 2008, 2009, 2010a, 2011, 2012, 2013, 2014, 2015, 2016, 2017
Impacts: time	2006; 2007	Will climate change become a more serious problem in the future?	ABC News, Stanford University, and Time Magazine 2006, ABC News, Stanford University, and The Washington Post 2007
Impacts: time	2003	Will climate change become a more serious problem in the future? (asked of subset)	CBS 2003
Impacts: time	2006; 2007	Is climate change causing serious impacts now?	CBS, The New York Times 2006a, CBS 2007a
Impacts: time	2003; 2006	Is climate change causing serious impacts now? (asked of subset)	CBS 2003, CBS, The New York Times 2006b
Impacts: time	2006	Is climate change causing serious impacts now? (follow-up question; but asked of full set)	ABC News, Stanford University, and Time Magazine 2006
Impacts: time	2001; 2007; 2009; 2010; 2011; 2012; 2013; 2014; 2015	Is climate change causing serious impacts now or will it in the future?	CBS 2001, CBS, The New York Times 2007, CBS and The New York Times 2007, CBS 2007b, 2009, CBS and The New York Times 2010, CBS, 60 Minutes, and Vanity Fair 2010, CBS 2010, CBS, 60 Minutes, and Vanity Fair 2011, CBS, The New York Times, 60 Minutes, and Vanity Fair 2012, CBS 2013, CBS, 60 Minutes, and Vanity Fair 2013b, Social Science Research Solutions, CBS 2014, CBS 2015
Impacts: time	2007	Will climate change be a threat in the next 10 years?	Taylor Nelson Sofres 2007
Impacts: time	2005; 2007; 2008	Is climate change a threat to future generations?	ABC News, The Washington Post 2005, Princeton Survey Research Associates International 2007, ABC News, Discovery Channel, Stanford University 2008
Impacts: time	2010	How serious is the threat of climate change to future generations?	Gallup 2010b,c

Survey Questions 2 Continued from previous page

Question Category	Years	Question	Sources
Impacts: time	2006	How serious is the threat of climate change to quality of life?	ABC News, Stanford University, and Time Magazine 2006, CBS, The New York Times 2006a
Impacts: time	2005; 2008; 2014	Does climate change pose a threat to you in your lifetime	ABC News, The Washington Post 2005, ABC News, Discovery Channel, Stanford University 2008, Opinion Research Corporation and CNN 2014
Impacts: time	2001; 2002; 2006; 2008; 2009; 2010; 2012; 2013; 2014; 2015; 2016; 2017	Does climate change pose a threat to you in your lifetime	Gallup 2001, 2002, 2006, 2008, 2009, 2010a, 2012, 2013, 2014, 2015, 2016, 2017
Impacts: time	2007	Is climate change a threat now or in the short term?	Opinion Research Corporation, CNN 2007
Policy	2015	Should Congress take action on climate change?	Pew 2015b
Policy	2004; 2005; 2008; 2009; 2011; 2012; 2013; 2014; 2016; 2010	Should climate change be an important foreign policy priority?	Pew 2004, 2005c, Chicago Council on Global Affairs 2008, Pew 2008c, 2009c, 2011c, Chicago Council on Global Affairs 2012, Pew 2013d, Knowledge Networks, The Chicago Council on Global Affairs 2014, Chicago Council on Global Affairs 2016, 2010
Policy	2006; 2007; 2012; 2015	How much more should the government do to address climate change?	ABC News, Stanford University, and Time Magazine 2006, ABC News, Stanford University, and The Washington Post 2007, Public Religion Research Institute 2012, ABC 2015
Policy	2001; 2006; 2007	Should the government take action on climate change right away?	CBS 2001, CBS, The New York Times 2006a, 2007
Policy	2007; 2010; 2006	Should the government take action on climate change right away? (asked of subset)	Pew 2007, 2010b, 2006d
Policy	2015; 2016	In light of controversy; should we take action on climate change?	Chicago Council on Global Affairs 2015, 2016
Scientific Consensus	2006; 2007; 2008; 2009; 2015	Do scientists agree with each other about climate change?	ABC News, Stanford University, and Time Magazine 2006, ABC News, Stanford University, and The Washington Post 2007, ABC News, Discovery Channel, Stanford University 2008, ABC, The Washington Post 2009, ABC 2015
Scientific Consensus	2007; 2009; 2010; 2011; 2012; 2013; 2006; 2014	Do scientists agree that humans are causing climate change?	Princeton Survey Research Associates International 2007, Pew 2009b, 2010b, Public Religion Research Institute 2011a, Pew 2012a, 2013b, 2006d, Public Religion Research Institute 2014
Scientific Consensus	2010	Is there consensus among scientists about the evidence for global warming?	Virginia Commonwealth University 2010
Scientific Consensus	2004; 2005; 2007; 2010	Do scientists agree that climate change is happening?	Knowledge Networks 2004, 2005, Princeton Survey Research Associates International 2007, Knowledge Networks 2010
Scientific Consensus	2001; 2006; 2008; 2010; 2011; 2012; 2013; 2014; 2015; 2016; 2017	Just your impression; do scientists agree that climate change is happening?	Gallup 2001, 2006, 2008, 2010a, 2011, 2012, 2013, 2014, 2015, 2016, 2017
Scientific Consensus	2006; 2007; 2008	Do scientists agree climate is changing or is not changing? (asked of subset that believe scientists agree with each other about climate change)	ABC News, Stanford University, and Time Magazine 2006, ABC News, Stanford University, and The Washington Post 2007, ABC News, Discovery Channel, Stanford University 2008
Scientific Consensus	2011; 2012	Do scientists agree climate change is an urgent problem and merits policy action?	Knowledge Networks 2011, Chicago Council on Global Affairs 2012
Scientific Consensus	2008	Do scientists agree with each other about how much of a threat climate change poses?	ABC News, Discovery Channel, Stanford University 2008

Survey Questions 2 Continued from previous page

Question Category	Years	Question	Sources
Worry	2007	How concerned are you about global warming? (4 response options)	ABC, The Washington Post 2007
Worry	2009; 2010; 2011; 2012; 2013; 2014; 2016; 2017; 2015	How concerned are you about global warming? (5 response options)	National Surveys on Energy and Environment 2009, 2010b, 2011b, 2012b, 2013b, Social Science Research Solutions, CBS 2014, National Surveys on Energy and Environment 2016b, 2017, Pew 2015c
Worry	2015	Is climate change a critical issue to you?	Public Religion Research Institute 2015
Worry	2002; 2006; 2007	How important is global warming to you? (5 answer choices)	MIT Energy Study 2002, ABC News, Stanford University, and Time Magazine 2006, ABC News, Stanford University, and The Washington Post 2007
Worry	2006	How important is global warming to you? (4 answer choices)	Pew 2006c
Worry	1999; 2000; 2001; 2002; 2003; 2004; 2006; 2007; 2008; 2009; 2010; 2011; 2012; 2013; 2014; 2015; 2016; 2017	How much do you worry about climate change? (part of battery; 4 answer choices)	Gallup 1999a,b, Pew 1999b, Gallup 2000, 2001, 2002, 2003, 2004, 2006, 2007a, 2008, 2009, 2010a, 2011, 2012, 2013, 2014, 2015, 2016, 2017
Worry	2015	How much do you worry about climate change?	CBS 2015
Worry	2016	How worried are you about global warming?	Cooperative Congressional Election Study 2016
Worry	2009	How much do you worry about climate change? (part of battery; 3 answer choices)	Public Agenda Foundation 2009

Supplementary Appendix B: Model of State-Level Climate Concern

Public Opinion Data. In this study, we focus on the effect of changes in temperature and extreme events on public opinion about climate change at the state level. To build the most comprehensive sample to date of survey data about climate change, we collected all publicly available survey questions about climate change asked between 1999 and 2017. The dataset includes approximately 400,000 survey respondents from 170 individual polls on climate change. We obtained many of these surveys from the Roper Center for Public Opinion Research (e.g., polls from ABC News/Washington Post, CBS News/New York Times, Pew, etc). We also obtained surveys from the Cooperative Congressional Election Study, the General Social Survey, the American National Election Study, the National Surveys on Energy and the Environment, and the Gallup Poll Social Series (GPSS).

A challenge is that the survey questions on climate change differ in their content, wording, and response categories. For example, one question series asks in a single question whether climate change is occurring and whether human activities are causing it. Another series includes an initial question about the existence of climate change, coupled with a follow-up question about its causes. Only the subset of individuals who answered that climate change is occurring answered the follow-up question. Overall, our dataset includes 83 discrete question series in the seven categories shown in Supplementary Table 1. Supplementary Table 2 includes a paraphrase of each question series and the sources from which we include responses for each series.

Statistical Model for Index of Climate Opinion. To summarize all of this survey data on climate change, we use a hierarchical group-level IRT model, which estimates latent public opinion in population subgroups such as states (Caughey and Warshaw, 2015). We build on prior work that has used multilevel modeling to measure state-level public opinion about

the environment (Fowler, 2016; Eun Kim and Urpelainen, 2018). But our model allows us to combine multiple survey questions into an aggregate index of the public's climate concern. In reducing our data to a single dimension, we follow prior studies that have used factor analysis (Zahran et al., 2006) or Stimson's mood algorithm (Carmichael and Brulle, 2017) to aggregate various measures into a single measure of public opinion about climate change. Averaging multiple survey questions on global warming substantially reduces measurement error in our estimates of the public's concern about climate change.

The model adopts the general framework of item-response theory (IRT), which is commonly used to measure individuals' views about political issues by pooling their responses to several survey questions about the issue of interest. In an IRT model, individuals' question responses are jointly determined by their score on some unobserved trait–in our case, their level of belief in and worry about climate change as an anthropogenic phenomenon–and by the characteristics of the particular question. The relationship between responses to question q and the unobserved trait θ_i is governed by the question's threshold K_q, which captures the base level of support for the question, and its dispersion σ_q, which represents question-specific measurement error. The item parameters K_q and σ_q are held constant over time in order to bridge the model longitudinally. We recoded our survey variables as binary variables such that affirmative responses indicate belief in or worry about anthropogenic climate change and its impacts.

Under this model, respondent i's probability of selecting the affirmative response to question q is

$$\pi_{iq} = \Phi\left(\frac{\theta_i - K_q}{\sigma_q}\right), \tag{1}$$

where the normal CDF Φ maps $(\theta_i - K_q)/\sigma_q$ to the (0,1) interval. The model assumes that, the stronger someone's level of belief in climate change (higher values of θ_i), the higher their probability of answering q affirmatively. The strength of the relationship is inversely proportional to σ_q, and the threshold for an affirmative response is governed by K_q. By estimating the relationship of each question to the latent trait in this way, the model overcomes the

lack of a single, valid time-varying measure of belief in climate change.

Since most surveys include only one or a few questions about climate change, each respondent usually only answers one question. This prevents us from using an IRT model to estimate individuals' belief. We can infer the distribution of θ_i though. We model θ_i in group g as distributed normally around the group mean $\bar{\theta}_g$, and marginalize over the distribution of θ_i. Assuming that θ_i is normally distributed within subpopulation groups and given the normal ogive IRT model, the probability that a randomly sampled member of group g answers item q affirmatively is

$$\pi_{gq} = \Phi\left(\frac{\bar{\theta}_g - K_q}{\sqrt{\sigma_\theta^2 + \sigma_q^2}}\right), \tag{2}$$

where $\bar{\theta}_g$ is the mean of θ_i in group g, and σ_θ is the within-group standard deviation of θ_i. In this way, rather than modeling the individual responses y_{iq}, we model $s_{gq} = \sum_i^{n_{gq}} y_{i[g]q}$, the total number of affirmative answers to item q out of the n_{gq} responses of subjects in group g. Also, we adjust the raw values of s_{gq} and n_{gq} to account for survey weights and for respondents who answer multiple questions (Caughey and Warshaw, 2015). To create state-level survey weights, we raked the survey data to match interpolated targets for gender, age, education level, and the percentage black in each state public, based on microdata from the U.S. Census (Ruggles et al., 2010).

We use the dgo package in R to estimate group-level distributions and yearly group means of climate concern θ_{gq}, for each state-year (Dunham, Caughey, and Warshaw, 2017).[1] These estimates are subject to uncertainty, which we are also able to estimate at the state level using the distribution of state estimates across simulation iterations. We standardize our

[1]We will also provide estimates on our websites of state-level climate concern in each year based on a more complicated multi-level regression and post-stratification (MRP) model. Unlike the model in our main paper, this model will use state-level predictors to reduce the error for our estimates of climate concern (Park, Gelman, and Bajumi, 2004). This is likely to particularly improve the accuracy of the estimates for smaller states such as Wyoming and Vermont. However, we do not do so here because we do not want to "shrink" away the treatment effect of temperature on public opinion. Our approach in this respect is driven by Lewis and Linzer (2005)'s finding that measurement error in an *outcome* variable (as in our study) does not lead to biased regression estimates. In contrast, biased estimates of a *treatment* variable could lead to severe attenuation of estimated treatment effects in a regression.

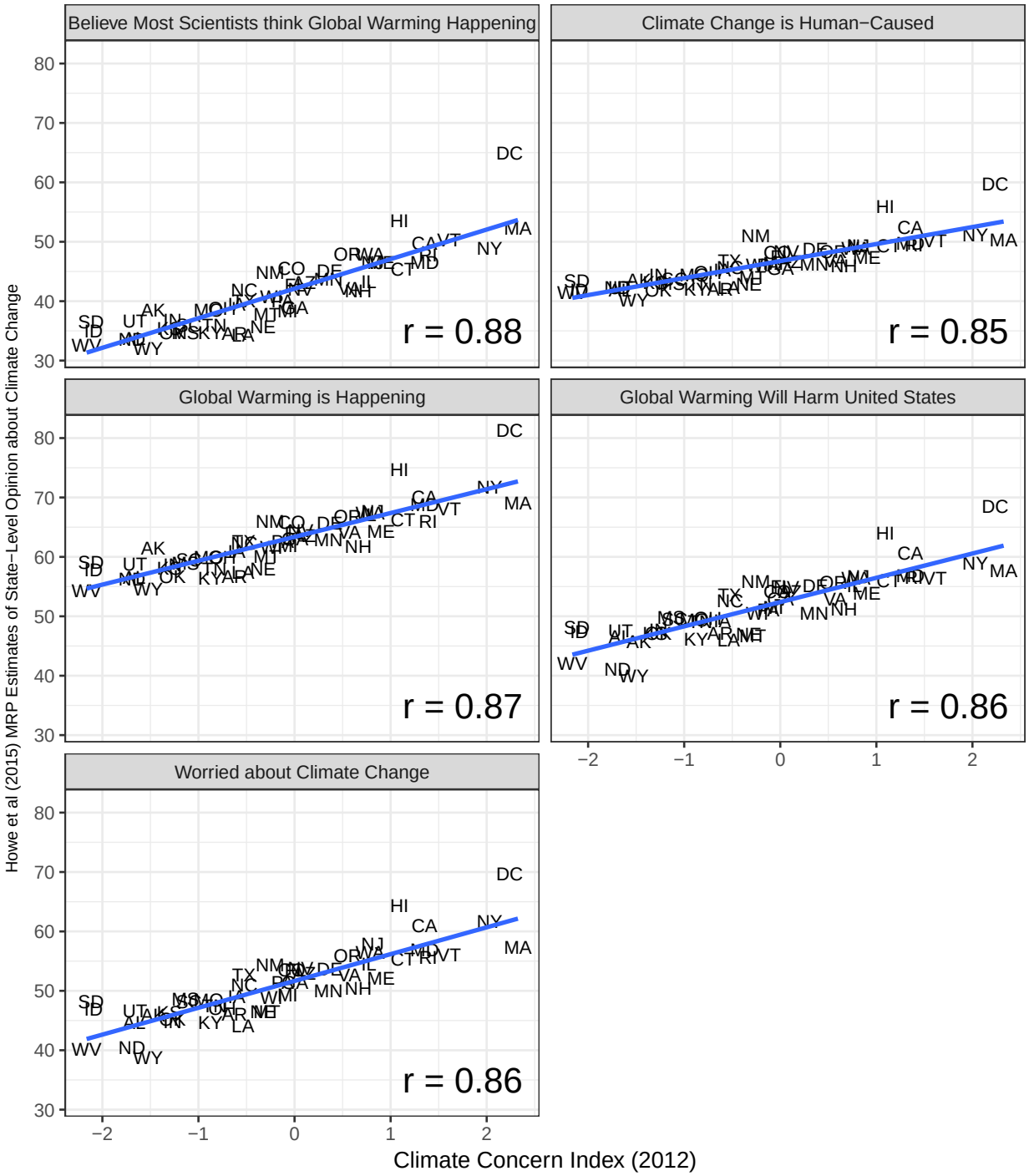
index of climate concern to be mean 0 with standard deviation of 1 at the state level.

Supplementary Appendix C: Validation of State-Level Climate Concern

To formally validate the state-level index of climate opinion, we compare it to the best-available published measures of state-level public opinion about climate change (Howe et al., 2015). These estimates use a Bayesian multi-level regression and post-stratification (MRP) model, using proprietary survey data from the Yale Program on Climate Change Communication. Supplementary Figure C1 shows the relationship between our index and these cross-sectional estimates of public opinion on five individual survey questions about climate change. Overall, we find that our index in 2012 has a correlation of between 0.85 and 0.88 with the five different state-level measures of belief in and concern about climate change that Howe et al. (2015) present. The high correlation with each of the individual climate questions modeled by Howe et al. (2015) suggests that latent climate concern is unidimensional. Unlike the estimates from Howe et al. (2015), which are available for just one year, our index of state-level opinion about climate change is available in each year from 1999-2017.

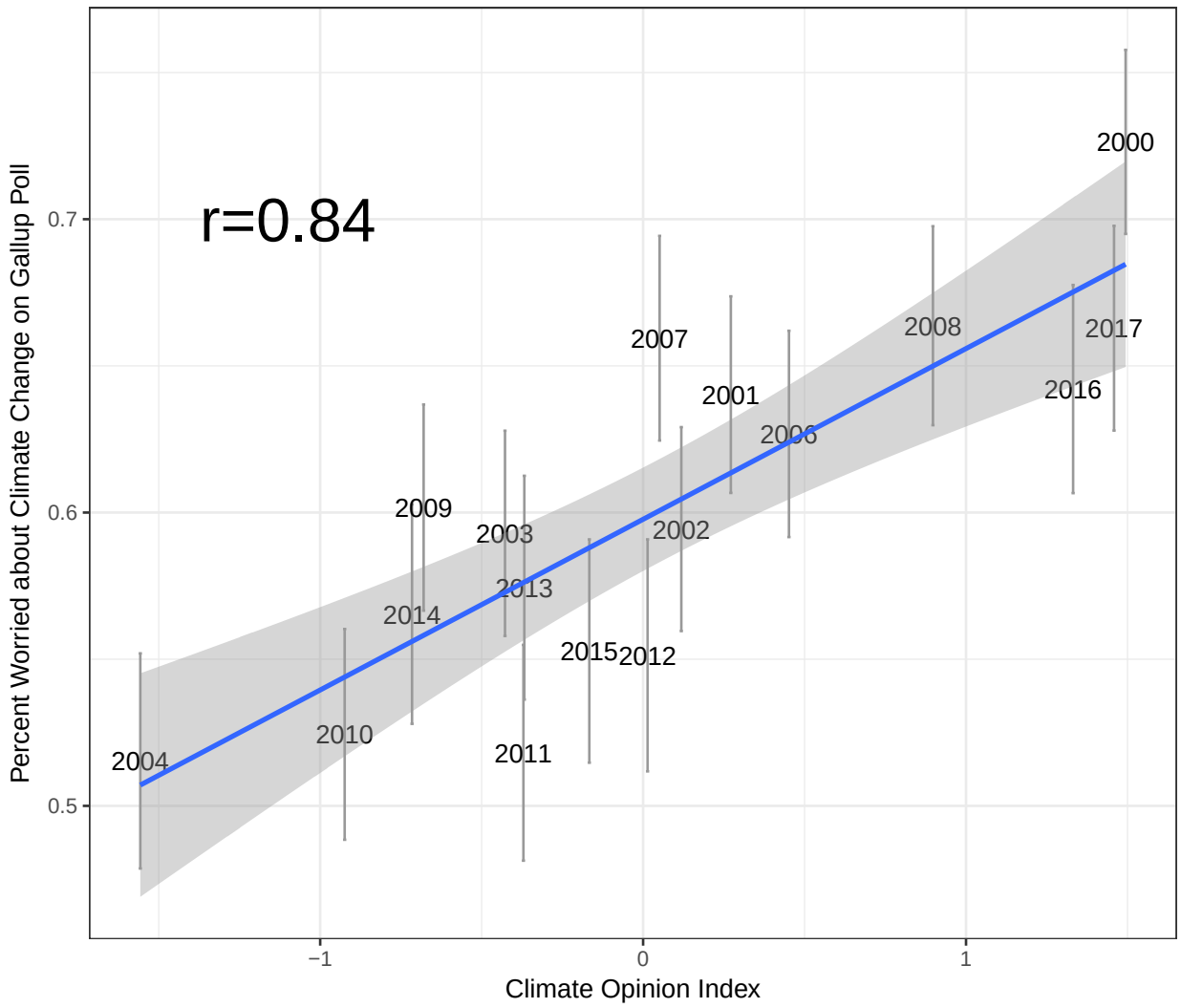
In order to validate the national trends in our estimates, we also compare the relationship between our climate concern index and the percentage of people worried about climate change on Gallup's annual polls (Figure C2). The correlation between these annual measures is 0.84.

Figure C1: Relationship between our climate concern index and the estimates of climate opinion in Howe et al (2015)



This figure shows that there is a very high correlation between our index of climate concern in 2012 and Howe et al's (2015) cross-sectional estimates of public opinion on five individual survey questions about climate change.

Figure C2: Relationship between our climate concern index and Gallup's annual polls on climate concern



This figure shows the relationship between our climate concern index and the percentage of people worried about climate change on Gallup's annual polls. The correlation between the annual measures is 0.84. The figure shows 95% confidence intervals to account for sampling error.

Supplementary Appendix D: Modeling the Effect of Temperature on Public Opinion

In order to examine the link between changes in state-level climate indicators and our index of public opinion about climate change in each state, we use six different indicators of climate change:

- the annual average of monthly average temperatures in each state (Vose et al., 2014)
- an indicator of the duration of storm events in each state, which previous scholars have used as a proxy for changes in extreme events due to climate change (Konisky, Hughes, and Kaylor, 2016). This measure is based on a count of severe weather episodes, as recorded in the National Centers for Environmental Information's (NCEI, housed within NOAA) Storm Events Database (National Centers for Environmental Information, 2015). The NCEI records occurrences of 48 types of severe weather events that are sufficiently intense to cause fatalities, injuries, serious property damage, or business disruptions; are unusual enough to attract media attention; or are otherwise meteorologically significant. To capture the severity of the episodes, we weight each episode by its duration in days. To account for natural variation between states in the likelihood of experiencing severe weather, we standardize each state's annual weighted count by the standard deviation of the state's annual counts across the time period covered by our analysis. We use the natural logarithm of this variable in our analysis.
- an indicator of short-term drought severity in each state (Palmer Drought Severity Index)(Vose et al., 2014)
- an indicator of long-term drought severity (The Palmer Drought Severity and Hydrological Drought Index). This index range from -6 to +6, with zero indicating normal conditions. We have coded the variables such that values between 4 and 6 indicate extreme dry conditions (Vose et al., 2014).

- a standardized precipitation index for each state. The Standardized Precipitation Index measures the probability of experiencing a given amount of precipitation in inches, transformed into an index. The measure ranges from -3 to +3, where 0 is the median. We have coded the variable such that +3 reflects a very extreme dry spell (Vose et al., 2014).

- the natural log of the number of acres in each state that experienced wildfires (National Interagency Fire Center, 2017).

The temperature, precipitation, and drought data were all obtained from the National Oceanic and Atmospheric Administration's Global Historical Climatology Network. The wildfire data is from the National Interagency Fire Center. We lag each measure of climate change by one year to ensure that public opinion is measured post-treatment.

We use three basic time series, cross-sectional (TSCS) modeling strategies to identify the causal effect of changes in state-level temperature on public opinion. We first use a model with both state and year fixed effects (Equation 3). This allows us to control for both state and national-level confounders in order to isolate the causal effects of state variation in climate change. Crucially, the state fixed effects account for time-invariant omitted variables in each state, such as the general ideology or culture. This is important since political party and ideology have been found to be important predictors of public belief in anthropogenic climate change (McCright and Dunlap, 2011; Borick and Rabe, 2010; Marquart-Pyatt et al., 2014; Shao et al., 2014; Deryugina, 2013). The year fixed effects account for unobserved factors that may influence climate concern across the nation, such as the debut of *An Inconvenient Truth* in 2006.

We use the equation:

$$y_{st} = \beta_1 T_{st-1} + \alpha_s + \xi_t + \epsilon_{st}, \tag{3}$$

where s and t index the states and years in our dataset, respectively. y_{st} is latent state-level

concern about anthropogenic climate change, T_{st-1} is an indicator of climate change in the previous year, β_1 is the effect of temperature, α is a vector of state fixed effects, ξ is a vector of year fixed effects, and ϵ is an error term.

Next, in Equation 4 we add linear time trends within each state (Angrist and Pischke, 2014). This allows us to account for smooth changes in state characteristics over time (such as ideological or economic changes) that might influence public attitudes about climate change.

$$y_{st} = \beta_1 T_{st-1} + \alpha_s + \alpha_s * time + \xi_t + \epsilon_{st}, \tag{4}$$

Finally, in Equation 5, we use a specification with a lagged dependent variable (LDV) to capture other, time-varying omitted variables in each state and to determine whether the effect of temperature is persistent over time (Beck and Katz, 2011). The lagged dependent variable can be interpreted as a measure of the persistence of the effect of temperature on climate concern. This persistence can be estimated by dividing β_1 by 1-β_2 in Equation 5. Our results indicate that $\beta_2 = 0.11$ (Main text, Table 1). This means that climate concern quickly adjusts to a value that is more strongly explained by last year's temperature than by the years preceding it. For example, 2015's temperature has about one tenth the effect on climate concern in 2017 as it has in 2016. Still, the effect cumulates over time such that the total long-term effect is about 1.1 times the size of the short-run effect (De Boef and Keele, 2008, 186).

$$y_{st} = \beta_1 T_{st-1} + \beta_2 y_{st-1} + \alpha_s + \xi_t + \epsilon_{st}, \tag{5}$$

Finally, it is important to note that the within-state variation in temperature change used to estimate these effects (Mummolo and Peterson, 2018) is small. After accounting for nationally shared shifts and between-state variation in baseline temperature, the standard deviation of the temperature variable is 0.53 degrees celsius. This is a fraction of expected changes in global temperature, even under the best of circumstances in which we achieve

the Paris Climate Accord's goal of limiting temperature rise to 2 degrees Celsius. Thus, while our study shows that the public responds to changing temperatures, predicting the magnitude of the change that would be associated with future climate change is beyond the scope of the analysis.

Supplementary Appendix E: Association between National-Average Temperature and Public Opinion

Table E1: Association between National-Average Temperature and Public Opinion

	Dependent variable (standardized):
	Climate Concern
National Average Temperature (°C)	1.044*
	(0.458)
Constant	−12.236
	(6.872)
Observations	19
R^2	0.328
Adjusted R^2	0.244
Note:	*p<0.1; **p<0.05

Supplementary Appendix F: Non-Measurement Error Adjusted Results

Table F1: Effect of State-Level Temperature on Public Opinion (non-measurement error adjusted

	Climate Concern		
	(1)	(2)	(3)
Average Monthly High Temperature$_{t-1}$ (°C)	0.156***	0.118***	0.116**
	(0.043)	(0.041)	(0.045)
Lagged Climate Concern			0.332***
			(0.057)
State Fixed Effects	X	X	X
Year Fixed Effects	X	X	X
State-specific time trend		X	
Lagged outcome Variable			X
Observations	931	931	882
R^2	0.756	0.839	0.792
Adjusted R^2	0.738	0.816	0.775
Note:			*p<0.1; **p<0.05

Supplementary Appendix G: Results by Time Period

To test the persistence of the effect over time, we split the time frame into 5-year increments and examine results for models 1 and 2 in each period. The results, reported in Table F1, indicate that the effect has persisted into the present, even in the face of growing polarization on climate change.

Table F1: Effect of State-Level Temperature on Public Opinion for Split Time Series (measurement error adjusted)

	Dependent variable (standardized):		
	Climate Concern		
	1999-2004	2005-2010	2011-2017
Average Monthly High Temperature$_{t-1}$ (°C)	0.010	0.204	0.125
	(0.080)	(0.131)	(0.107)
State Fixed Effects	X	X	X
Year Fixed Effects	X	X	X
Observations	294	294	343
R^2	0.713	0.667	0.645
Adjusted R^2	0.648	0.591	0.577
Note:			*p<0.1; **p<0.05; ***p<0.01

Table F2: Effect of State-Level Temperature on Public Opinion for Split Time Series (non-measurement error adjusted)

	Dependent variable (standardized):		
	Climate Concern		
	1999-2004	2005-2010	2011-2017
Average Monthly High Temperature$_{t-1}$ (°C)	0.014	0.203***	0.131**
	(0.022)	(0.069)	(0.061)
State Fixed Effects	X	X	X
Year Fixed Effects	X	X	X
Observations	294	294	343
R^2	0.936	0.816	0.827
Adjusted R^2	0.921	0.774	0.793
Note:			*p<0.1; **p<0.05; ***p<0.01

References

Angrist, Joshua D, and Jörn-Steffen Pischke. 2014. *Mastering 'metrics: The path from cause to effect*. Princeton University Press.

Beck, Nathaniel, and Jonathan N Katz. 2011. "Modeling Dynamics in Time-Series-Cross-section Political Economy Data." *Annual Review of Political Science* 14: 331–352.

Borick, Christopher P, and Barry G Rabe. 2010. "A reason to believe: examining the factors that determine individual views on global warming." *Social Science Quarterly* 91(3): 777–800.

Carmichael, Jason T, and Robert J Brulle. 2017. "Elite cues, media coverage, and public concern: An integrated path analysis of public opinion on climate change, 2001–2013." *Environmental Politics* 26(2): 232–252.

Caughey, Devin, and Christopher Warshaw. 2015. "Dynamic estimation of latent opinion using a hierarchical group-level IRT model." *Political Analysis* 23: 197–211.

De Boef, Suzanna, and Luke Keele. 2008. "Taking Time Seriously." *American Journal of Political Science* 52(1): 184–200.

Deryugina, Tatyana. 2013. "How do people update? The effects of local weather fluctuations on beliefs about global warming." *Climatic change* 118(2): 397–416.

Dunham, James, Devin Caughey, and Christopher Warshaw. 2017. "dgo: Dynamic Estimation of Group-level Opinion.".

Eun Kim, Sung, and Johannes Urpelainen. 2018. "Environmental public opinion in US states, 1973–2012." *Environmental Politics* 27(1): 89–114.

Fowler, Luke. 2016. "The states of public opinion on the environment." *Environmental Politics* 25(2): 315–337.

Howe, Peter D, Matto Mildenberger, Jennifer R Marlon, and Anthony Leiserowitz. 2015. "Geographic variation in opinions on climate change at state and local scales in the USA." *Nature Climate Change* 5(6): 596–603.

Konisky, David M, Llewelyn Hughes, and Charles H Kaylor. 2016. "Extreme weather events and climate change concern." *Climatic Change* 134(4): 533–547.

Lewis, Jeffrey B, and Drew A Linzer. 2005. "Estimating regression models in which the dependent variable is based on estimates." *Political analysis* 13(4): 345–364.

Marquart-Pyatt, Sandra T, Aaron M McCright, Thomas Dietz, and Riley E Dunlap. 2014. "Politics eclipses climate extremes for climate change perceptions." *Global Environmental Change* 29: 246–257.

McCright, Aaron M, and Riley E Dunlap. 2011. "The politicization of climate change and polarization in the American public's views of global warming, 2001–2010." *The Sociological Quarterly* 52(2): 155–194.

Mummolo, Jonathan, and Erik Peterson. 2018. "Improving the Interpretation of Fixed Effects Regression Results." *Political Science Research and Methods* pp. 1–7.

National Centers for Environmental Information. 2015. "Storm Events Database.".

National Interagency Fire Center. 2017. "Historical Year-End Fire Statistics by State.".

Park, David K., Andrew Gelman, and Joseph Bajumi. 2004. "Bayesian multilevel estimation with poststratification: State-level estimates from national polls." *Political Analysis* 12(4): 375–385.

Ruggles, Steven, J. Trent Alexander, Katie Genadek, Ronald Goeken, Matthew B. Schroeder, and Matthew Sobek. 2010. "Integrated Public Use Microdata Series: Version 5.0 [Machine-readable database]." Minneapolis: University of Minnesota.

Shao, Wanyun, Barry D Keim, James C Garand, and Lawrence C Hamilton. 2014. "Weather, climate, and the economy: Explaining risk perceptions of global warming, 2001–10." *Weather, Climate, and Society* 6(1): 119–134.

Vose, Russell S, Scott Applequist, Mike Squires, Imke Durre, Matthew J Menne, Claude N Williams Jr, Chris Fenimore, Karin Gleason, and Derek Arndt. 2014. "Improved historical temperature and precipitation time series for US climate divisions." *Journal of Applied Meteorology and Climatology* 53(5): 1232–1251.

Zahran, Sammy, Samuel D Brody, Himanshu Grover, and Arnold Vedlitz. 2006. "Climate change vulnerability and policy support." *Society and Natural Resources* 19(9): 771–789.