Disaster Experience Mitigates the Partisan Divide on Climate Change: Evidence from Texas*

Ted Hsuan Yun Chen[1] Christoper J. Fariss[2] Hwayong Shin[3] Xu Xu[4]

April 2, 2024

Abstract

Despite the abundance of real world events and scientific information linking the worsening extreme weather to climate change, public attitudes toward climate issues in the United States remain highly divided along partisan lines. We compare the effect of different stimuli linking extreme weather events to climate change – personal experiences and scientific information – in reducing the partisan gap. A two-wave survey corresponding to multiple extreme weather events in Texas, including a natural experiment with power outage data from the 2021 North American Winter Storms, shows that personal experiences with extreme weather reduce the partisan divide in climate beliefs and polices. Scientific information attributing extreme weather events to climate change, however, had no effect in closing the partisan gap. These findings suggest that extreme climate events and disaster experiences force vividly tangible information about the proximity and severity of climate change on exposed individuals, prompting belief-updating and preference-shifting toward pro-climate policies.

Keywords: climate change beliefs, environmental disasters, natural experiment, disaster experiences, pro-environmental policy attitudes

*Corresponding author: Ted Hsuan Yun Chen (ted.hsuanyun.chen@gmail.com). All authors are listed in alphabetical order. The project has been reviewed and approved by the University of Michigan Institutional Review Board (HUM00187639). Funding for this study comes from the National Science Foundation (grant no. 1760644). We thank the following individuals for help at various points in this project: Boyoon Lee, Paul McLachlan, Brendan Nyhan, Wesley Wehde, and participants at the 2022 APSA Conference.

[1]Department of Environmental Science and Policy, George Mason University

[2]Department of Political Science, University of Michigan

[3]Rockefeller Center for Public Policy and the Social Sciences, Dartmouth College

[4]Department of Politics, Princeton University

1 Introduction

Climate change-induced extreme weather events, such as wild fires in the western United States and hurricanes along the Gulf Coast and Eastern Seaboard, occur with increasing frequency, visibility, and consequence [7, 22]. Experience with these extreme climate events and disasters present vividly tangible stimuli about the proximity, severity, and costliness of climate change. Scientific information attributing extreme weather and its consequences to anthropogenic climate change has also become more abundant through both academic research [28] and public science channels [16]. Yet, individual beliefs and policy preferences about climate change in the U.S. remain deeply polarized along partisan lines [19, 9]. This is in spite of the fact that climate-skeptic individuals, who tend to be Republican, are increasingly exposed to ever-growing amounts of experiential and informational stimuli about climate change. This cause of partisan division is of particular importance because it is associated with gridlock on climate policy-making [13].

Can extreme weather experiences and scientific information attributing extreme weather to climate change reduce this partisan gap? Both these *experiential stimuli* (personal experiences with extreme weather) and *informational stimuli* (scientific information attributing these events to climate change) are seen to be key drivers of individuals associating climate change with negative outcomes [27, 29]. However, despite numerous studies investigating how these two stimuli shape climate attitudes, conclusive findings about either factor have yet to be established. Empirical evidence about the experiential stimuli (personal experience [14, 26, 24, 15]) and the informational stimuli (scientific information on attribution [25]) are mixed between exhibiting positive or null effects. Moreover, scientific information even led to backfire effects among specific politically-relevant subgroups (i.e. Republicans [31, 11] and climate skeptics [8, 4]). Recent studies have begun to examine how the relationship between personal experiences and pro-climate attitudes differs across political groups [5, 13, 30, 21]. Notably, Constantino et al. [5] and Zanocco et al. [30] find evidence that negative personal experience with extreme weather decreased the partisan gap on climate attitudes, as Republicans tended to shift closer to Democrats' positions. Conversely, Hazlett and Mildenberger [13] show that Republican-dominated areas in California were unresponsive to wildfire exposure when voting on climate-policy ballots, which effectively increases the partisan gap.

Critically, existing research does not directly compare the impacts of extreme weather experiences and scientific information, two different types of stimuli prompting individuals to link climate change to negative outcomes, on the same individuals. The lack of within-sample comparisons leaves notable gaps in our understanding of climate attitudes. First, given sample heterogeneity across studies, it is difficult to contextualize findings about different stimuli (i.e. experiential and informational) against one another. Second, personal experiences with extreme weather and scientific information on attribution is likely to conditionally impact or moderate climate attitudes [18], which cannot be examined unless we explicitly model the interaction effect on a sample of individuals.

In this paper, we fill these gaps by comparing the effects of personal experiences and scientific information in influencing the climate attitudes of partisan individuals. We achieve this through several research designs that we conducted as part of two-wave survey (2020 and 2021) fielded in Texas, U.S., a state that has experienced both major hurricanes and extreme winter storms in recent years. Our surveys draw directly on personal experiences, a preregistered experiment (see Supplementary Information S5), and a natural experiment, each measuring exposure of our survey respondents to the link between climate change and extreme weather. We explored both personal experiences about hardship directly experienced from climate disasters and scientific information explicitly highlighting the link. We started with the general expectation that both experiential and informational stimuli will effect pro-climate attitudinal change, then examined how the heterogeneous effects for both stimuli across partisan groups can lead to a reduction in the partisan gap on a set of climate attitudes ranging from belief in anthropogenic climate change to support for various pro-climate policies.

As previewed in the introduction of our research design above, results come from three sets of analyses – survey, quasi-experimental, and experimental – that systematically explore how Democrats' and Republicans' beliefs about climate change and support for pro-climate policies vary by their personal experiences and exposure to scientific information. We find that Republicans update their beliefs about anthropogenic climate change and climate policy when they personally experience extreme weather events while Democrats generally update their beliefs very little because their existing beliefs are already strongly pro-climate. The observed mechanism that experiences drive pro-climate attitudes, however, also holds for Democrats for outcomes not subject to a ceiling effect (i.e. their willingness to share pro-climate messages on social media). In terms of scientific information, experimentally provided scientific attribution linking climate change and extreme weather events had no measurable impact on climate change attitudes for both partisan groups, even when moderated by existing personal experiences.

Beyond being the first study, to our knowledge, that systematically compares the effects of different types of stimuli across a fixed set of individuals from distinct partisan groups, our study makes a number of additional contributions. First, we explicitly study the potential for an interactive effect between the two kinds of stimuli, for which we found none. Second, focusing on Texas afforded a number of benefits (see Methods section 4.1), most notably being able to study individuals' experiences with both expected (i.e. hurricanes) and unexpected (i.e. winter storms) extreme weather events. Here, our findings are highly robust across both contexts. Third, because of the timing of our surveys and the collection of real-world data, we were able to measure personal experience in different ways. Specifically, we measure both perceived personal experience and objective geographic exposure (i.e. being in an afflicted location at the time of an extreme weather event). Perceived personal experience captures important psychological realities [24], but it is hard to identify the causal effect of perception. On the other hand, while geographic exposure – as an externally validated measure of the state of the world – facilitates identified causal estimates, they do not perfectly map onto experience as a construct [24] and are prone to measurement imprecision [1]. Given the shortcomings of any singular measurement approach, we opted to examine both. The results we present about the effects of personal experience are weakly robust to both measurement approaches.

Although climate attitudes are widely viewed as inflexible, especially for Republicans, we show that individuals do update their attitudes when experiencing extreme weather events. By directly comparing experiential and informational stimuli about climate change and extreme weather events, we clarify that personal experiences are more effective than information on scientific attribution in effecting pro-climate attitudes.

2 Results

2.1 Personal Experience with Extreme Weather Events

We conducted a two-wave survey among Texas residents who identified themselves as either Democrat or Republican. (Methods section 4.1 discusses our choice to use Texas as a case.) The first wave took place in fall 2020, three years after Hurricane Harvey($n = 1375$). The second wave took place in summer–fall 2021, a few months after North American winter storms Uri and Viola, with a subset of the same individuals from Wave 1 ($n = 305$). Table 1 summarizes the climate attitudes and policy preferences we examined, which includes, for example, belief in anthropogenic climate change, support for climate-related infrastructure improvement, and willingness to share pro-climate messages on social media. Beyond these main climate attitudes, we also examined additional outcomes in Supplementary Information S1. (Methods section 4.2 describes our survey methodology and our questionnaire is included in Supplementary Information S4.)

Table 1: Measures of pro-climate attitudes.

Concepts	Survey Measures	Wave
Belief in Anthropogenic Climate Change	Pro-climate Belief*	Both
Support for Climate Change Mitigation	Federal Carbon Emissions Tax	Both
	Climate Change Mitigation Spending	Both
Support for Disaster Resilience Policy	Disaster Relief Spending	Both
	Infrastructure Improvement (Flood Barrier)*	1
	Infrastructure Improvement (Power Grid)*	2
Social Media Activism	Social Media Like	1
	Social Media Retweet	1

*Additive scale measures (see Supplementary Information S4)

2.1.1 Perceived Personal Experiences with Extreme Weather

To measure perceived personal experience with Hurricane Harvey, which caused severe damage in southeast Texas in August 2017, we asked participants in the first wave of our survey whether they were personally harmed by Hurricane Harvey on three dimensions, personal health, financial situation, and property damage. In the second wave, we similarly measured perceived personal experience with the 2021 winter storms with a set of fourteen questions about whether they experienced different negative events during the winter storms, including perceived danger, injury, and property damage (adapted from [12]). For both waves, we summed responses from the different questions then rescaled them to the unit interval to obtain our measure of perceived personal experience. (Methods section 4.3 provides additional information on our perceived personal experience measures.)

To test whether perceived personal experiences with extreme weather promote pro-climate attitudes, we fit linear models that examine how various climate attitudes are associated with our measure. Further, to examine how partisan identity moderates the relationship between perceived personal experience and climate attitudes, we included an interaction term between partisanship and experience in the models. We also included a set of individual-level control variables in all models: ideology, age, gender, education, and indicators for Hispanic and Black identification.

We find a large difference between Republicans and Democrats (Figure 1). In general, among Republicans, perceived personal experience with both Hurricane Harvey (Wave 1) and the 2021 winter storms (Wave 2) are positively and statistically significantly associated with pro-climate attitudes. Specifically, with the single exception of beliefs about anthropogenic

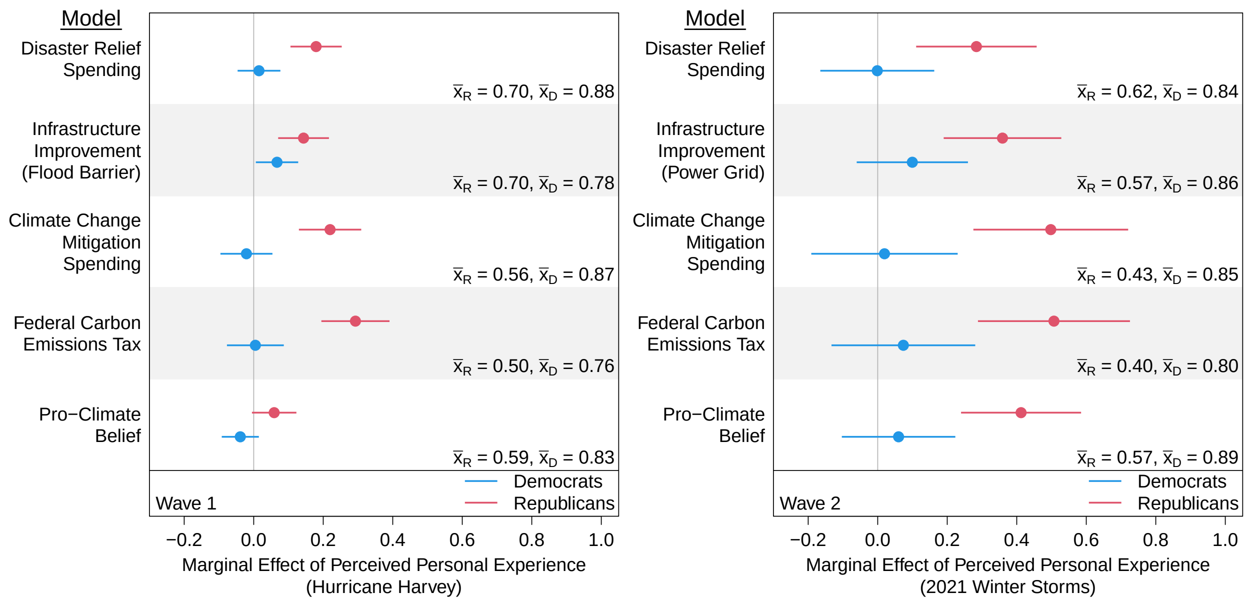

Figure 1: Relationships between perceived personal experience and climate attitudes (point estimates and 95% CIs), for Wave 1 survey respondents (left) and for Wave 2 survey respondents (right). $\bar{x}_R$ and $\bar{x}_D$ refer to, respectively, the sample mean of the outcome variable for the Republican and Democrat groups.

climate change in Wave 1, responses indicating more experience with disaster damages is predictive of greater support for both climate change mitigation and disaster resilience policies. (We show in Supplementary Information S2 that subsetting the Wave 1 analysis to only respondents retained in Wave 2 yields similar results. We also discuss evidence that alleviates concerns about selection bias for Wave 2 results.)

In contrast, among Democrats, there is no statistically discernible relationship between perceived personal experience and our outcomes. While this discrepancy may appear counterintuitive, additional tests show that the null finding among Democrats can be attributed to a ceiling effect [10, 30], whereby many Democrats already possess high levels of pro-climate beliefs and therefore cannot increase their support. (See Democrat group means $\bar{x}_D$ in Figure 1.) In anticipation of this potential ceiling effect, we included in Wave 1 two items on willingness to share pro-climate information on social media, which tends to have a low baseline tendency among both partisan groups. We asked respondents how likely they are to retweet and to 'like' on Twitter a pro-climate mitigation report, both of which are costly public acts of engagement.

As expected, because the baseline tendency to engage in social media activism is generally low, we do not observe the ceiling effect for Democrats. Instead, we find a positive relationship between perceived personal experiences and social media activism for both partisan groups. For Republicans, the marginal effect of perceived personal experience on retweeting is 0.39 (95%CI= $[0.28, 0.51]$) and on 'liking' is 0.26 (95%CI $= [0.15, 0.37]$). For Democrats, the marginal effect on retweeting is 0.21 (95%CI= $[0.11, 0.30]$) and on 'liking' is 0.21 (95%CI = $[0.12, 0.30]$). This finding suggests that the mechanism underlying the relationship between personal experience and pro-climate attitudes is similar across partisan lines.

2.1.2 Natural Experiment of Geographic Exposure to the 2021 Winter Storms

In February 2021, three months after we fielded our first survey, two overlapping winter storms (Uri and Viola) struck various parts of North America, including Texas. The timing of this event, occurring right before our Wave 2 survey, allows us to implement a convincing pretest-posttest design with geographic exposure to the winter storms as the treatment in a natural experiment.

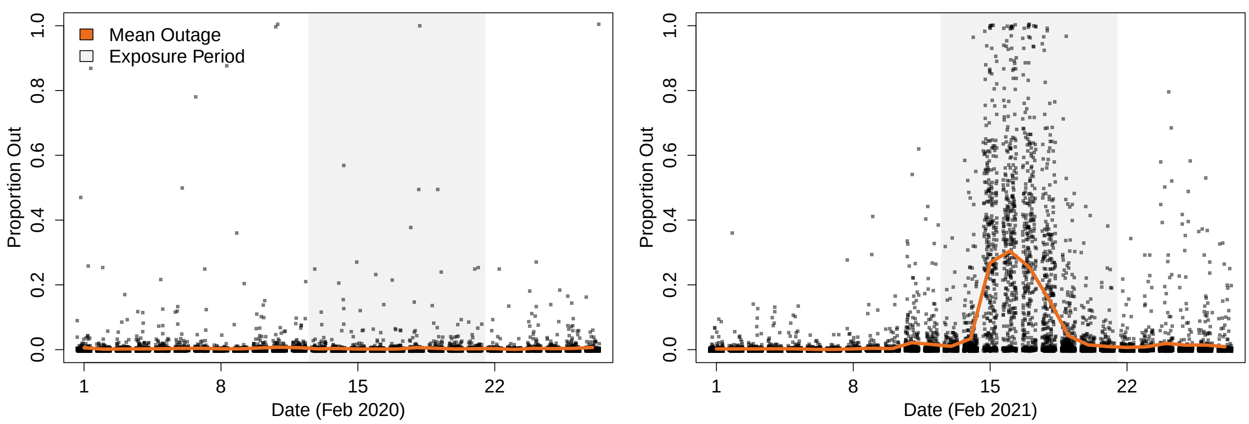

Figure 2: Proportion of households experiencing power outage by tracked administrative unit (i.e. counties or cities) in Texas during February 2020 (left) and during the winter storm in February 2021 (right).

For this study, we measured geographic exposure to the winter storms, which is an externally validated measure of exposure, as the extent to which individuals experienced power outages during mid-late February 2021. We estimated this using data from PowerOutage.US, a data aggregation company that tracks outage reports from utility companies in the U.S. In Texas, this comprised raw data from 62 utility providers tracking the accounts of 13.4 million customers. We aggregated the outage to the lowest administrative region permitted by the data (i.e. city or county) as the proportion of customers exposed to outage during the specified time period. Then, using respondents' self-reported ZIP codes, we matched them to the average power outage of an administrative region during the February 13–21 period. (Methods section 4.4 details our approach.) Figure 2 shows that Texas residents experienced unusually high levels of outages when the storms hit in February 2021 compared to February 2020.

With this treatment variable and outcomes from our surveys, we used a generalized difference-in-differences design to estimate the impact of geographic exposure to extreme weather events on individuals' climate attitudes. As before, we consider how this effect varies by partisanship by including an interaction term between the treatment variable and partisanship. (Methods section 4.5 contains detailed information about our difference-in-differences approach.)

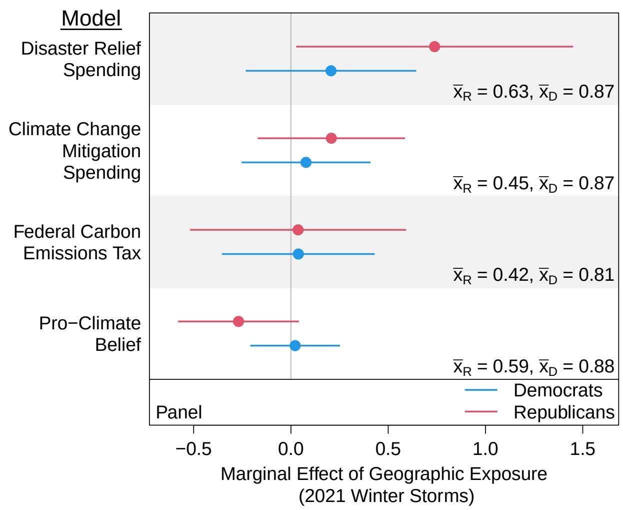

Figure 3: Treatment effects of geographic exposure to the 2021 power outages on climate attitudes (point estimates and 95% CIs), using a panel design for survey respondents who participated in both Wave 1 and Wave 2 surveys.

Figure 3 shows the treatment effects of geographic exposure to power outage during the 9-day period when Texas was hit by the winter storms (February 13–21, 2021). We find that, on the balance, the effect of geographic exposure to power outages on climate attitudes is much weaker than the effect we found for perceived personal experience to the winter storms. Among Republicans, for whom perceived personal experience strongly predicts greater support for all tested climate mitigation and disaster resilience policies, geographic exposure to power outages only affects preferences toward disaster relief spending.

Additional evidence (Supplementary Information S3) suggests that our null findings are attributable to the low precision in the operationalized measure of exposure to power outage – in line with prior work showing that individuals only accurately perceive very localized extreme weather [1] – and would otherwise be stronger if exposure could be measured with greater precision at the individual level. Specifically, our ZIP-associated regions are large and there is likely to be non-negligible variation in power outages within a region, presenting a type of measurement error that should bias the estimated effect toward zero.

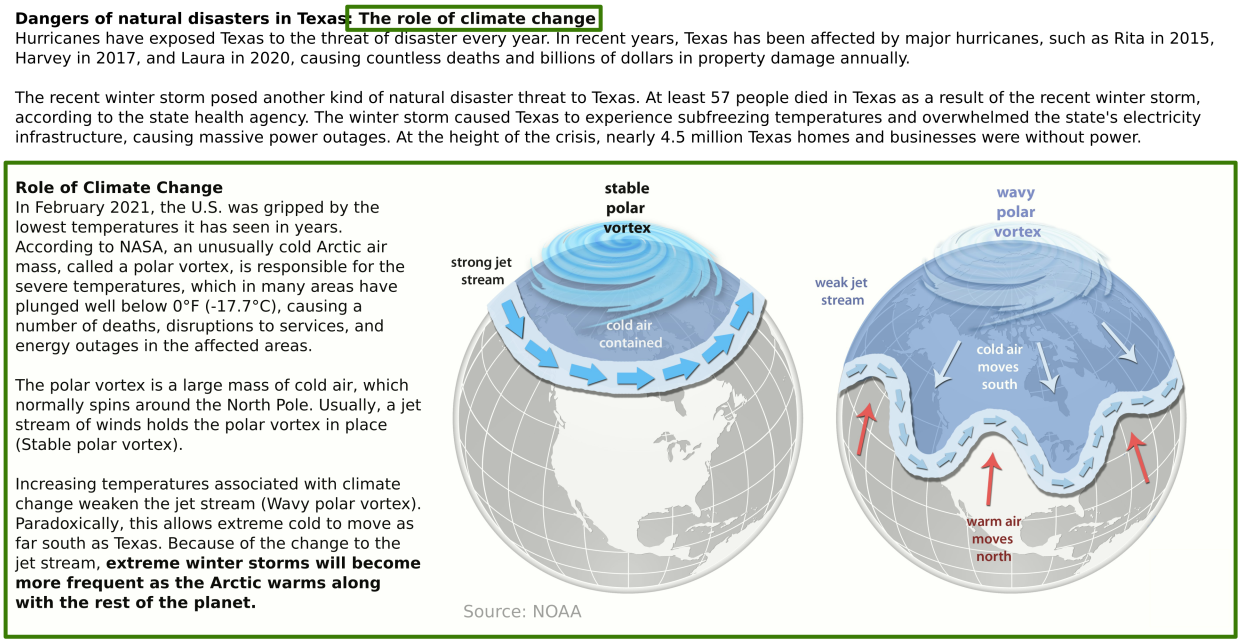

Figure 4: Experimental stimuli from the scientific information study. Parts highlighted in green are shown to the treatment group only, while unhighlighted parts are shown to treatment and control groups. (Diagram obtained from the National Oceanic and Atmospheric Administration [20].)

2.2 Scientific Information Experiment with Attribution of Winter Storms to Climate Change

To examine whether scientific information that attribute extreme weather and its costs to climate change reduces the partisan divide on climate attitudes, we embedded an experiment in Wave 2 of our survey that emphasized the link between the winter storms' extreme southward extension and climate change. (Supplementary Information S5 contains our preregistration plan.) Specifically, Wave 2 respondents were randomly assigned with equal probability into treatment and control conditions, where the former were exposed to the highlighted portions of Figure 4 that explain the link between raising temperatures in the arctic and extreme winter storms in Texas. To standardize respondent familiarity with the winter storms, the baseline (unhighlighted) portions outlining the outcome of recent extreme weather events in Texas were shown in both conditions.

We fit linear models where the effect of the treatment variable (i.e. scientific attribution of extreme weather to climate change) on support for pro-climate attitudes varies by respondent partisanship. Figure 5 shows that the scientific information treatment has no discernible effect on pro-climate attitudes. Across all models, the difference between the treatment and control conditions is statistically indistinguishable from zero. To further test whether uptake of scientific information depends on existing personal experiences, we fit additional models that

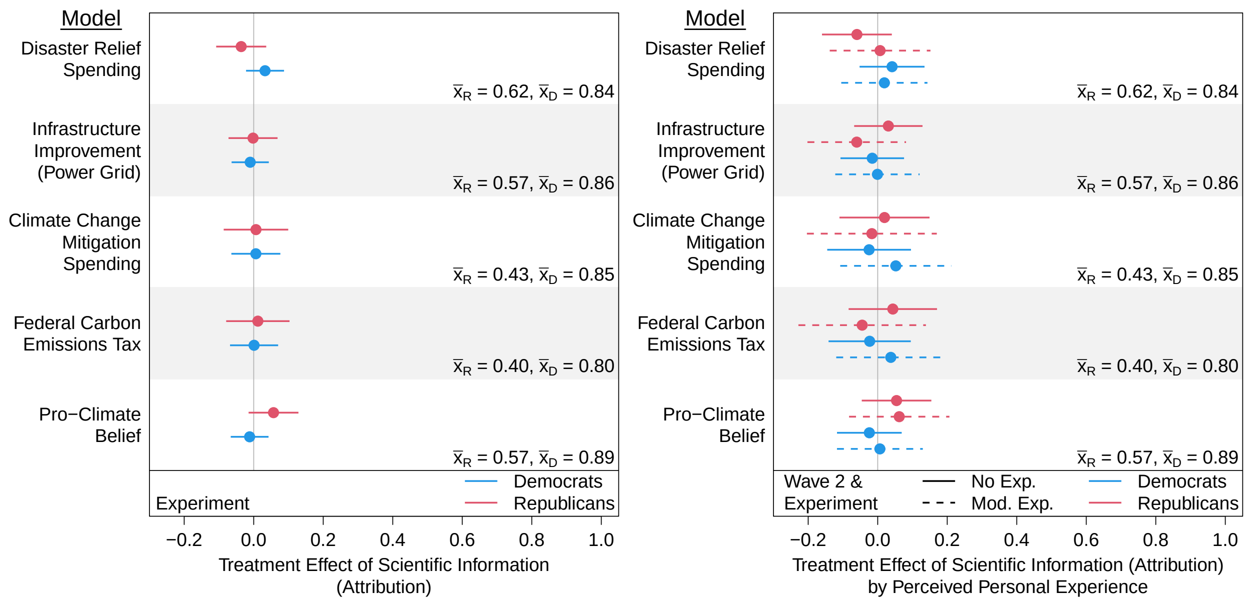

Figure 5: Treatment effect of scientific information attributing extreme weather to climate change (point estimates and 95% CIs), for Wave 2 survey respondents (left), and the same effects moderated by respondents' perceived personal experiences (right). $\bar{x}_R$ and $\bar{x}_D$ refer to, respectively, the sample mean of the outcome variable for the Republican and Democrat groups.

let the treatment effect of scientific information vary with the respondent's perceived personal experience with the 2021 winter storms. As we show in Figure 5, the scientific information treatment still has no effect when subsetting by respondents' personal experiences. Based on likelihood ratio tests, the expanded model (i.e. interaction between scientific treatment and perceived personal experience) and reduced model (i.e. without interaction term) are statistically indistinguishable from each other for all outcome variables.

3 Discussion

There is an ever-growing amount of experiential stimuli and informational stimuli that prompts individuals to link the costs of extreme weather to climate change. Using a two-wave survey of Texas residents, we examined the effects of personal experiences with extreme weather and scientific information attributing these events to climate change, two kinds of stimuli that has been discussed extensively in the literature but never directly compared. Leveraging Texans' experiences with Hurricane Harvey in 2017 and the North American winter storms in 2021, we conducted the first study to examine these two stimuli simultaneously for the same sample of individuals. Across a set of survey, quasi-experimental, and experimental results, we show that personal experiences shape people's belief in anthropogenic climate change and support for pro-climate policies but scientific information on attribution does not.

Measuring personal experience in two ways, we found that self-reported perceived personal experience with hardships was substantially and consistently associated with pro-climate attitudes in various forms, and externally-validated geographic exposure to power outages during the 2021 winter storm exhibited weaker, but causally-identified, effects. Due to what are likely ceiling effects for Democrats, the effect of personal experiences differed by partisan groups, which led to an overall closing of the partisan gap. However, when considering outcomes not subject to the ceiling effect, the positive effect of personal experiences held for Democrats as well.

As we discussed, a notable shortcoming in the literature is that the experiential stimuli and informational stimuli have yet to be directly compared to each other. Our research design allows us to not just compare these two stimuli but also model any potential interaction between them. Here, compared to the consistently positive effects for personal experience among Republicans, we find that scientific information attributing the 2021 Texas winter storms to climate change had no discernible effect on climate attitudes for either partisan group, even when accounting for individuals' existing personal experiences. Specifically, with our outcome variables and both independent variables rescaled to the unit interval, the effect of perceived personal experience for Republicans, averaged across all main outcomes, was 0.16 for Hurricane Harvey and 0.41 for the 2021 winter storms, and statistically significant for all outcomes but one. On the other hand, the effect of the treatment of scientific information was statistically indistinguishable from zero for all outcomes regardless of whether we included existing personal experiences as a moderator.

Overall, our study adds to the nascent body of research indicating that under the right conditions, personal experience with extreme weather or disasters can bridge the partisan gap on climate attitudes [5, 30]. Our findings suggest a number of future research pathways. We identified a context in which Republicans update their beliefs about climate change and climate policy preferences in response to personally-experienced climate threats. However, questions remain as to whether these effects are strong enough to translate to policy-relevant behavior such as voting, and whether the relative strength between experiential and informational stimuli will hold under different contexts. Relatedly, while we found scientific information to be ineffectual, we focused specifically on scientific attribution regarding unfamiliar extreme weather events. Further work should look to systematically compare different types of scientific attribution and other science-based informational stimuli more broadly.

4 Methods

4.1 Texas as a case study

Texas is an ideal political and environmental context to study change to partisan beliefs about climate change. Politically, though solidly 'Red' at the state level, Texas exhibits substantial political and demographic diversity in its major metropolitan areas. Climate change impacts also vary considerably by region in Texas. While Houston is at constant risk of hurricane exposure, the other metro areas are far enough from the coast that they are not directly threatened. In addition to the threat of hurricanes, Texas now faces more winter storm variation because of changes to the polar vortex. Subzero temperatures, once rare along the Gulf Coast region, are becoming more prevalent.

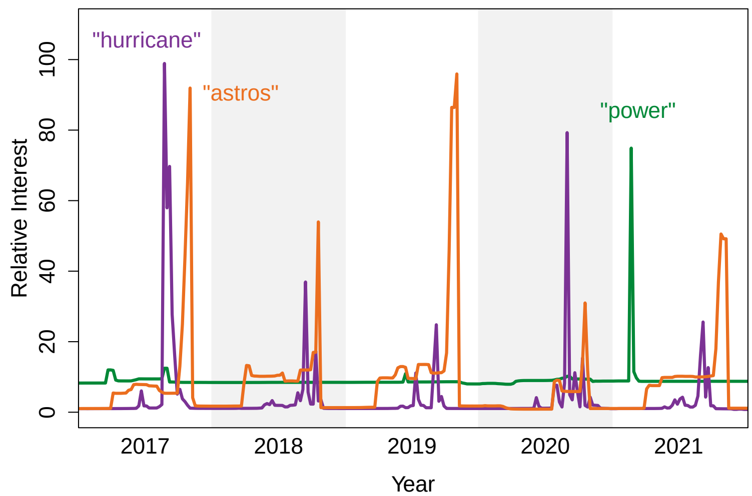

Figure 6: Comparison of relative web search interest from Texas (de-noised Google Trends) for terms associated with Hurricane Harvey, the 2021 North American winter storms, and the Houston Astros.

Further, as we show with Google Trends data (Figure 6), Texas residents have been highly aware of extreme weather events and their consequences, which adds further value to Texas as a case for our examination of how perceived experiences matter to pro-climate attitudes. These trends explicitly capture the relative search interest on given topics within Texas. Our approach is consistent with prior studies that used Google Trends to measure drought awareness in California [17] and global interests in human rights [6]. Major extreme whether events in Texas, such as Hurricane Harvey and the 2021 winter storms, have triggered peaks in disaster awareness. Comparing the relative degree of search interest for specific climate event terms to another popular search term (i.e., 'astros' for Houston Astros, a highly competitive Major League baseball team, which won Baseball's Major League World Series in November 2017 and played in the World Series in 2019), we see the peaks of awareness in Hurricane

Harvey, captured by 'hurricane', can be found in August–October 2017, and the peaks of awareness for the winter storms, captured with searches for 'power' for power outages, are found in February 2021.

4.2 Survey administration

We conducted a two-wave survey of Texas residents with a stated partisan affiliation. The first wave took place three years after Hurricane Harvey. It was was conducted between October 18, 2020 and November 5, 2020, through three survey platforms, Lucid, Prolific, and CloudResearch.[1] Using prescreening data from each platform, we recruited Democrats and Republicans who resided in Texas. We originally planned to recruit all participants using Lucid, but recruitment was slow due to the constrained nature of our target population. To avoid a large shift in the information environment due to election results reporting on November 6, we expanded our recruitment to Prolific and CloudResearch. For these subsequent samples, we implemented additional quality checks.

The second wave took place a few months after North American winter storms Uri and Viola in 2021. It was conducted between July 7, 2021 and October 14, 2021. For this sample, we recruited respondents from the first wave from Prolific and CloudResearch, but not Lucid because it does not support recruitment of past participants.

Table 2: Survey recruitment details by wave.

Field dates	Platform	n_D	n_R	Remuneration
Wave 1				
Oct. 18 – Oct. 23, 2020	Prolific	96	72	\$2
Oct. 24 – Nov. 5, 2020	Lucid	424	380	up to \$4
Oct. 29 – Nov. 5, 2020	Prolific	172	81	\$2
Oct. 30 – Nov. 5, 2020	CloudResearch	87	63	\$2
Wave 2				
Jul. 7 – Aug. 30, 2021	Prolific	116	62	\$2
Aug. 31 – Oct. 14, 2021	Prolific	42	25	\$4
Sep. 24 – Oct. 14, 2021	CloudResearch	36	24	\$2

n_D and n_R respectively indicate sample size of Democrats and Republicans.

In both Waves 1 and 2, at the beginning of the study, participants were given a consent form that described the study instrument (answering questions on demographics and disaster experiences, reading a news article about disasters), ensured that their responses will be kept

[1]Prior to the launch, we conducted a pilot on Lucid with 132 respondents (74 Democrats and 59 Republicans) who are not included in the final data set due to mismatches with our sampling criteria and other data quality concerns (i.e. speeders or spammers). Based on the pilot, we implemented more quality controls for the full launch.

anonymous, and that the study involved minimal risks. After the study, participants were debriefed with the purpose of the study (better understand how citizens are affected by disasters and evaluate political issues) and were provided with the contact information of the study team. The Wave 1 survey took approximately 12 minutes to complete and the Wave 2 survey took approximately 8 minutes to complete.

In the first wave, a total of 1375 eligible respondents (779 Democrats and 596 Republicans) were included in the analysis. In the second wave, the sample consisted of 305 respondents (194 Democrats and 111 Republicans) who participated in the first wave. The 305 Wave 2 respondents equate to a 53.4% retention of the subset of Wave 1 respondents we recruited for our Wave 2 survey.

These numbers exclude respondents who did not satisfy our sampling criteria (i.e. adults residing in Texas and identifying as a Democrat or Republican). In the Prolific and CloudResearch samples, we also removed respondents who indicated they had already participated in our survey through other platforms. A full breakdown of the participant pool by survey platform and partisanship is in Table 2, and Table 3 contains the distribution of basic sociodemographic variables for our Wave 1 and Wave 2 surveys.

Table 3: Distribution of demographic variables (%).

		Wave 1	Wave 2
Age	18-24	16.1	15.4
	25-34	27.1	29.5
	35-44	27.5	25.9
	45-54	14.0	13.4
	55-64	9.7	10.8
	65-	5.5	4.9
Gender	Female	57.5	56.1
	Male	41.8	43.6
	Other	0.7	0.3
Education	No college degree	43.8	43.0
	College degree	56.2	57.0
Partisan Identity	Democrat	56.7	63.6
	Republican	43.3	36.4
Observations		1375	305

4.2.1 Wave 2 attrition

We recruited 571 Wave 1 respondents for our Wave 2 survey. Of these, we recaptured 305 respondents for a 53.4% retention rate. To check if there are discernible differences between the retained ($n = 305$) and attritioned ($n = 266$) groups, we tested the bivariate relationships between attrition and a number of important Wave 1 variables. Our results are presented in Figure 7. The retained and attritioned group are balanced on sociodemographic characteristics, climate attitudes, and disaster exposure, with the exception of age, where older individuals were less likely to be attritioned.

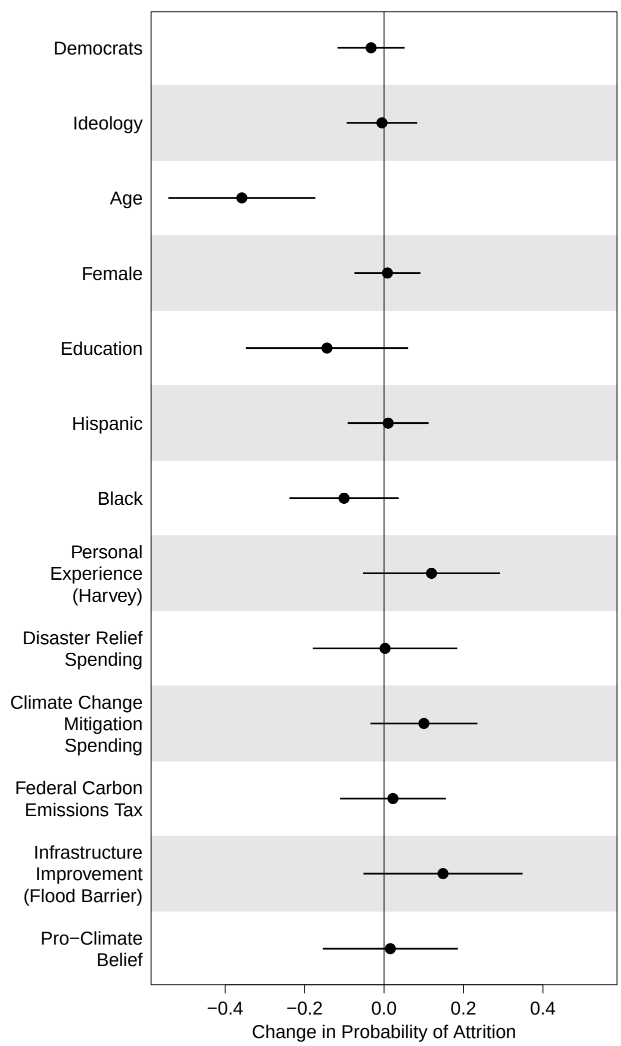

Figure 7: Bivariate relationships between attrition and important Wave 1 variables (point estimates and 95% CIs).

4.3 Measuring Perceived Personal Experience using Self-Reported Survey Items

In both waves of our survey, we asked respondents to recall the extent to which they were affected by disasters. From the first wave, 38.4% of respondents reported being affected by Hurricane Harvey. Those who responded in the positive were asked three follow up questions about the nature and severity of their experiences, in terms of finance, health, and property, which we report in Figure 8. We estimate perceived experience with Hurricane Harvey by combining the first stage question and the additive score of the follow up questions. Specifically, individuals who reported not having been affected in the first stage are treated as having experienced zero damage, and the rest received the additive score from the three follow up questions. In the second wave, we estimate experience with the winter storms as the sum of binary responses to a set of disaster experience items, adopted from Harville, Jacobs and Boynton-Jarrett [12], shown in Table 4. Both quantities were rescaled to the unit interval using min-max scaling to obtain our measures of perceived personal experience.

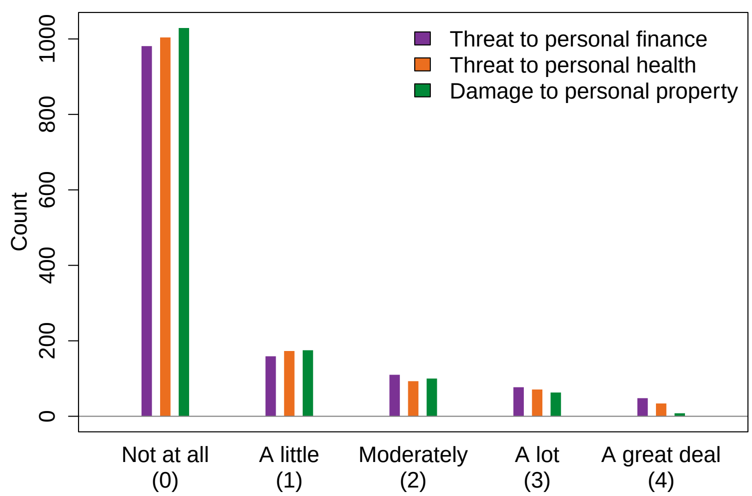

Figure 8: Personal threat and damage experienced during Hurricane Harvey in 2017.

Figure 9 shows the distribution of the self-reported exposure for both waves by partisanship, which illustrate that while our results differed by respondent's partisanship, it is not due to differences in their self-reported experiences.

4.4 Measuring Geographic Exposure using Power Outage Data

To measure personal experience with the winter storms, we estimated the extent to which individuals were exposed to power outages during mid-late February using data from PowerOutage.US, a data aggregation company that tracks outage reports from utility companies

Table 4: Disaster experiences during the North American winter storms in 2021.

Statement	% yes
Did you lose power in your house during the winter storm?	70.5
Did you ever feel like your life was in danger during the winter storm or in the aftermath?	28.9
Did the water pipes in your house break during the winter storm?	23.6
Were you forced to travel by walking during the winter storm?	15.7
Did the winter storm damage any of your vehicles (e.g., car, truck, or boat)?	11.1
Did any family members not living with you suffer injury or illness because of the winter storm?	9.2
Do you know of any other people, whose pets that died because of the winter storm?	8.5
Did the winter storm cause you to have an illness or injury?	7.5
Did the winter storm cause some other members of your household to have an illness or injury?	7.9
Did you lose anything of sentimental value (e.g., photographs, keepsakes) during the winter storm?	4.9
Did anyone else you know die because of the winter storm?	3.6
Did you have any pets die because of the winter storm?	1.6
Did anyone personally close to you die because of the winter storm?	1.0

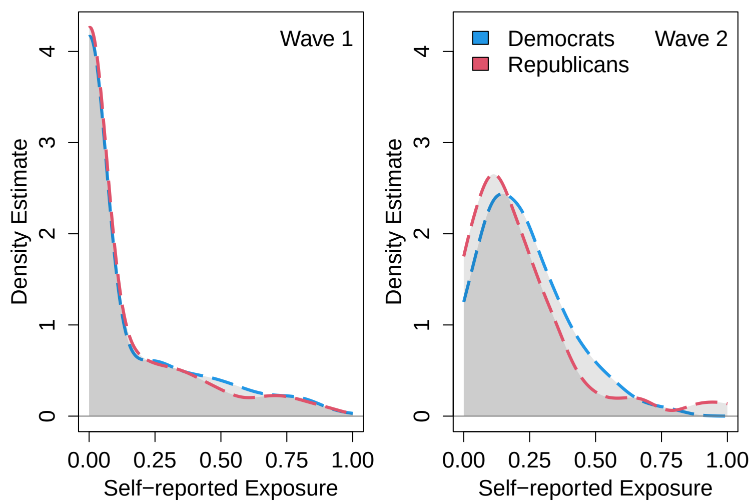

Figure 9: Distribution of perceived personal experience with Hurricane Harvey (Wave 1) and the 2021 North American winter storms (Wave 2) in Texas, rescaled to the unit interval.

in the U.S. Specifically, we have outage data aggregated to the city level or county level based on raw data from 62 utility providers in Texas tracking the accounts of 13.4 million customers. We aggregated the raw data (counts of outages and non-outages by geographical area) to the city level or county level depending on data availability. Specifically, counties exceeding a certain proportion of tracked-but-not-geolocated households are aggregated to the county level whereas counties with city-level data exceeding the information threshold were kept at the more precise city level. We refer to this hybrid-level geographical unit as the ZIP-associated region.[2] Then, using respondents' self-reported ZIP codes, we matched them to the average power outage in their ZIP-associated region during the February 13–21 period which we take as our measure of geographic exposure treatment.

[2]See Supplementary Information S2 for evidence that our main findings (Figure 3), which was based on a 25% threshold, are robust to thresholds ranging from 5–45%.

4.5 Difference-in-differences Analysis

Using our geographic exposure treatment variable and outcomes from our surveys, we used a generalized difference-in-differences design to estimate the impact of geographic exposure to extreme weather events on individuals' climate beliefs and policy preferences. We fit the following linear regression model:

$$Y_{izt} = \alpha_i + \tau_t + \gamma(outage_z \times storm_t) + \delta(democrat_i \times outage_z \times storm_t) + \epsilon_{izt}, \quad (1)$$

where Y_{izt} is the belief or attitude of individual i at time t, and z indicates the ZIP-associated region individuals reside in. $outage_z \times storm_t$ is the treatment of the 2021 winter storms. We are interested in the difference between Republicans and Democrats, so we further interacted the treatment with partisanship (i.e. the *democrat* indicator). γ and $\gamma' \equiv \gamma + \delta$ therefore capture, respectively, the treatment effects for Republicans and Democrats. We additionally included in our model individual and time fixed effects (α_i and τ_t). Because the treatment was assigned to the geographical unit, we conducted the analysis using standard errors that were clustered at the level of the administrative unit.

4.6 Analysis and results reproduction

All analysis for our study were conducted in `R v4.2.2` [23]. Estimation for the difference-in-differences models were done with the `fixest v0.11.1` package [3]. All marginal effect calculations were done with the `marginaleffects v0.9.0` package [2]. All reproduction code will be made publicly available under the MIT license at `https://github.com/tedhchen/floodStorm`.

5 References

[1] Akerlof, Karen, Edward W Maibach, Dennis Fitzgerald, Andrew Y Cedeno and Amanda Neuman. 2013. "Do people "personally experience" global warming, and if so how, and does it matter?" *Global environmental change* 23(1):81–91.

[2] Arel-Bundock, Vincent. 2023. *marginaleffects: Predictions, Comparisons, Slopes, Marginal Means, and Hypothesis Tests*. R package version 0.9.0.

[3] Bergé, Laurent. 2018. "Efficient estimation of maximum likelihood models with multiple fixed-effects: the R package FENmlm." *CREA Discussion Papers* 13.

[4] Chapman, Daniel A and Brian Lickel. 2016. "Climate change and disasters: How framing affects justifications for giving or withholding aid to disaster victims." *Social psychological and personality science* 7(1):13–20.

[5] Constantino, Sara M, Alicia D Cooperman, Robert O Keohane and Elke U Weber. 2022. "Personal hardship narrows the partisan gap in COVID-19 and climate change responses." *Proceedings of the National Academy of Sciences* 119(46):e2120653119.

[6] Dancy, Geoff and Christopher J. Fariss. 2023. "The Search for Human Rights: A Global Analysis Using Google Data." *American Political Science Review* .

[7] Davenport, Frances V, Marshall Burke and Noah S Diffenbaugh. 2021. "Contribution of historical precipitation change to US flood damages." *Proceedings of the National Academy of Sciences* 118(4):e2017524118.

[8] Dixon, Graham, Olivia Bullock and Dinah Adams. 2019. "Unintended Effects of Emphasizing the Role of Climate Change in Recent Natural Disasters." *Environmental Communication* 13(2):135–143.

[9] Dunlap, Riley E, Aaron M McCright and Jerrod H Yarosh. 2016. "The political divide on climate change: Partisan polarization widens in the US." *Environment: Science and Policy for Sustainable Development* 58(5):4–23.

[10] Gillis, Ash, Nathaniel Geiger, Kaitlin Raimi, Julia Lee Cunningham and Melanie A Sarge. 2023. "Climate change–induced immigration to the united states has mixed influences on public support for climate change and migrants." *Climatic Change* 176(5):48.

[11] Hart, P Sol and Erik C Nisbet. 2012. "Boomerang effects in science communication: How motivated reasoning and identity cues amplify opinion polarization about climate mitigation policies." *Communication research* 39(6):701–723.

[12] Harville, Emily W., Marni Jacobs and Renée Boynton-Jarrett. 2015. "When Is Exposure to a Natural Disaster Traumatic? Comparison of a Trauma Questionnaire and Disaster Exposure Inventory." *PLOS ONE* 10(4):e0123632.

[13] Hazlett, Chad and Matto Mildenberger. 2020. "Wildfire exposure increases pro-environment voting within democratic but not republican areas." *American Political Science Review* 114(4):1359–1365.

[14] Howe, Peter D. 2021. "Extreme weather experience and climate change opinion." *Current Opinion in Behavioral Sciences* 42:127–131.

[15] Howe, Peter D, Jennifer R Marlon, Matto Mildenberger and Brittany S Shield. 2019. "How will climate change shape climate opinion?" *Environmental Research Letters* 14(11):113001.

[16] IPCC. 2022. *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, UK and New York, NY, USA: Cambridge University Press.
URL: *https://report.ipcc.ch/ar6/wg2/IPCC_AR6_WGII_FullReport.pdf*

[17] Kam, Jonghun, Kimberly Stowers and Sungyoon Kim. 2019. "Monitoring of Drought Awareness from Google Trends: A Case Study of the 2011–17 California Drought." *Weather, Climate, and Society* 11(2):419–429.

[18] Lacroix, Karine, Robert Gifford and Jonathan Rush. 2020. "Climate change beliefs shape the interpretation of forest fire events." *Climatic Change* 159:103–120.

[19] Leiserowitz, A., E. Maibach, S. Rosenthal, J. Kotcher, E. Goddard, M. Ballew, J. Marlon, M. Verner, S. Lee, J. Carman, T. Myers, M. Goldberg and N. Badullovich. 2023. *Climate Change in the American Mind: Politics & Policy, Spring 2023*. Yale Program on Climate Change Communication.

[20] National Oceanic and Atmospheric Administration. 2019. *The Science Behind the Polar Vortex*.
URL: *https://twitter.com/NWSWPC/status/1090287763512049665*

[21] Ogunbode, Charles A, Rouven Doran and Gisela Böhm. 2020. "Individual and local flooding experiences are differentially associated with subjective attribution and climate change concern." *Climatic Change* 162:2243–2255.

[22] Parks, Sean A and John T Abatzoglou. 2020. "Warmer and drier fire seasons contribute to increases in area burned at high severity in western US forests from 1985 to 2017." *Geophysical Research Letters* 47(22):e2020GL089858.

[23] R Core Team. 2022. *R: A Language and Environment for Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing.

[24] Reser, Joseph P and Graham L Bradley. 2020. "The nature, significance, and influence of perceived personal experience of climate change." *Wiley Interdisciplinary Reviews: Climate Change* 11(5):e668.

[25] Rode, Jacob B, Amy L Dent, Caitlin N Benedict, Daniel B Brosnahan, Ramona L Martinez and Peter H Ditto. 2021. "Influencing climate change attitudes in the United States: A systematic review and meta-analysis." *Journal of Environmental Psychology* 76:101623.

[26] Sisco, Matthew Ryan. 2021. "The effects of weather experiences on climate change attitudes and behaviors." *Current Opinion in Environmental Sustainability* 52:111–117.

[27] Thaker, Jagadish and Christopher Cook. 2021. "Experience or attribution? Exploring the relationship between personal experience, political affiliation, and subjective attributions with mitigation behavioural intentions and COVID-19 recovery policy support." *Journal of environmental psychology* 77:101685.

[28] Trenberth, Kevin E, John T Fasullo and Theodore G Shepherd. 2015. "Attribution of climate extreme events." *Nature Climate Change* 5(8):725.

[29] Wong-Parodi, Gabrielle and Dana Rose Garfin. 2022. "Hurricane adaptation behaviors in Texas and Florida: exploring the roles of negative personal experience and subjective attribution to climate change." *Environmental Research Letters* 17(3):034033.

[30] Zanocco, Chad, Hilary Boudet, Roberta Nilson and June Flora. 2019. "Personal harm and support for climate change mitigation policies: Evidence from 10 US communities impacted by extreme weather." *Global Environmental Change* 59:101984.

[31] Zhou, Jack. 2016. "Boomerangs versus javelins: how polarization constrains communication on climate change." *Environmental Politics* 25(5):788–811.