Blowin' in the Wind: Short-Term Weather and Belief in Anthropogenic Climate Change

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ABSTRACT

A series of polls provides new tests for how weather influences public beliefs about climate change. Statewide data from 5000 random-sample telephone interviews conducted on 99 days over 2.5 yr (2010–12) are merged with temperature and precipitation indicators derived from U.S. Historical Climatology Network (USHCN) station records. The surveys carry a question designed around scientific consensus statements that climate change is happening now, caused mainly by human activities. Alternatively, respondents can state that climate change is not happening, or that it is happening but mainly for natural reasons. Belief that humans are changing the climate is predicted by temperature anomalies on the interview day and the previous day, controlling for season, survey, and individual characteristics. Temperature effects concentrate among one subgroup, however: individuals who identify themselves as independent, rather than aligned with a political party. Interviewed on unseasonably warm days, independents tend to agree with the scientific consensus regarding anthropogenic climate change. On unseasonably cool days, they tend not to agree. Although temperature effects are sharpest for just a 2-day window, positive effects are seen for longer windows as well. As future climate change shifts the distribution of anomalies and extremes, this will first affect beliefs among unaligned voters.

1. Introduction

While the evidence-based scientific consensus that humans are changing Earth's climate has strengthened in recent years, acceptance of this idea among the U.S. public has not followed suit. Instead, there have been fluctuations without clear trend in overall levels of acceptance. The surface calm masks deepening partisan division (McCright and Dunlap 2011). Survey analysis finds that political outlook dominates other characteristics in predicting individual beliefs about climate. Even education and science literacy have divergent effects, depending on politics (Hamilton 2008, 2011b, 2012; Hamilton et al. 2012; Kahan et al. 2011a,b; McCright 2011; McCright and Dunlap 2011). Among self-identified Democrats or liberals, higher education and science literacy are associated with greater concern regarding anthropogenic climate change. Among Republicans or conservatives, education and science literacy have weak or even negative effects. Among unaligned respondents, both climate change beliefs and the effects of education or science literacy fall between these partisan extremes.

Scientists, political figures, journalists, and bloggers offer the public competing interpretations of observed changes such as the decline of Arctic sea ice (Notz and Marotzke 2012), global temperature and sea level rise (Rahmstorf et al. 2012), and the frequency and severity of climate extremes such as droughts and heat waves (Trenberth and Fasullo 2012). These interpretations, including true and false facts, often are differentially accepted by people according to their preexisting beliefs—a process called *biased assimilation* (Lord et al. 1979; Munro and Ditto 1997; Corner et al. 2012; Hamilton 2012). Personal recollections of climate or weather events could be filtered in a similar fashion, and interpreted differently in accord with more general beliefs (Goebbert et al. 2012). Trivial personal experiences such as ambient temperature, thirst, and visual cues can affect responses to climate questions as well (Joireman et al.

2010; Lewandowski et al. 2012; Li et al. 2011; Risen and Critcher 2011), further evidence that scientific and political arguments are not the only forces affecting public beliefs.

Recently, survey researchers have tested whether objectively measured climate or weather influence climate beliefs. Analyzing data from diverse rural areas, Hamilton and Keim (2009) found that perceived local impacts of climate change were highest in snow-country regions with winter warming trends. Shao (2012) found associations between decadal temperature trends and public concern about global warming. Akerlof et al. (2013) report associations between personal experience (to some degree objectively confirmed) and perceptions of global warming risks. Goebbert et al. (2012) examined relationships between self-reports of temperature, drought, or flood experience and corresponding objective long-term indicators. Controlling for ideology and worldview, their temperature-comparison indicator had little effect on perceived temperature experience. Objective flood and drought-comparison indicators, however, exhibit stronger effects on perceptions. Egan and Mullin (2012) tested for effects of temperature anomalies on nationally representative surveys. They found a significant effect of daily temperature on expressed beliefs about the evidence for global warming (not necessarily anthropogenic). This effect appears short lived for normal temperature variations, being strongest when just a 2-day window before the interview is considered. Exceptional heat waves have longer-lasting effects. Political identity and education moderate the temperature effects.

In the analysis that follows, we test for weather effects on agreement with the scientific-consensus view of climate change. We find impacts from temperature generally consistent with earlier studies, but they place into sharp focus the question of *whose* beliefs change with the weather.

2. The Granite State Poll

Four times each year, the Granite State Poll conducts telephone interviews with random samples of about 500 New Hampshire (NH) residents. This poll achieves prominence during New Hampshire's presidential primaries and other elections. It employs standard, well-validated techniques for obtaining representative samples of the state's adult population. Probability weights permit minor adjustments for design and sampling bias—the latter, from comparison with census data. Typical Granite State Poll questions cover political and opinion topics; several climate questions were added to the mix beginning in April 2010 (Hamilton 2010). By July 2012, climate questions had been carried on 10 survey cycles,

involving more than 5000 interviews on 99 separate dates. A national Carsey Institute survey in 2011 [National Community and Environment in Rural America (NCERA)] asked the same climate questions and obtained results similar to those from New Hampshire (Hamilton 2011a, 2012). The quarterly New Hampshire data, however, provide a high-quality and uniquely resolved time series.

Table 1 describes variables in our analysis. For comparison, we show both statewide and national results on the climate questions. One response to the personal belief question, "Climate change is happening now, caused mainly by human activities," corresponds to the main point of statements and reports on climate change from leading science organizations (Oreskes 2004), national academies of science (G8+5 2009; NRC 2010), reviews of research results (Solomon et al. 2007; Richardson et al. 2009), and surveys of scientists (Doran and Zimmerman 2009). Similar statements containing the same elements as our survey question have been made by many science organizations (e.g., AMS 2012). No leading science organization takes a position of disagreement that human activities are now changing the Earth's climate. Telephone interviewers rotated the order in which responses were read to avoid possible bias. Fifty-three percent of New Hampshire respondents, and 52% nationwide, chose the now/human response to this question.

Background characteristics in Table 1 are the chief predictors identified by previous research (McCright and Dunlap 2011; Hamilton 2012). Our respondents could describe their politics on a seven-point scale from 1 = "strong Democrat" to 7 = "strong Republican," with 4 = "independent" being the middle category (about 2%, set aside here, chose "other" or declined to answer). In keeping with the common poll finding that people who say they are "independent but leaning" toward one party behave as partisans in practice, we grouped the 1–3 categories as Democrats and the 5–7 categories as Republicans; only the neutral 4 category is counted here as independents (about 900 people or 18% of the estimation sample).

On 10 surveys from April 2010 to July 2012, the now/human response to our belief question fluctuated from 49% to 57%, without trend. Some fluctuations no doubt reflect sampling variation. Some could reflect unmeasured factors such as current events. If we adjust for respondent characteristics, for season, and for survey-to-survey fluctuations caused by unmeasured factors, are there detectable weather effects in these data?

3. New Hampshire weather data

Our focus on one relatively small state simplifies the integration of survey with weather data. Daily

TABLE 1. Variable definitions with summaries. NH survey summaries are probability-weighted means or percentages based on non-missing values (*n* = 4897). Weighted percentages from a U.S. nationwide survey conducted in August 2011 (*n* = 2006) are given for comparison on the two climate questions (NCERA; see Hamilton 2012).

Climate questions

Understand—Next, I would like to ask you some questions about the issue of global warming or climate change. How much do you feel you understand about this issue . . . would you say a great deal, a moderate amount, only a little, or nothing at all? (Coding reversed for analysis, so higher values denote greater understanding.)

    A great deal (NH 25; U.S. 22)
    A moderate amount (NH 53; U.S. 50)
    Only a little (NH 18; U.S. 23)
    Nothing at all/NA (NH 4; U.S. 5)

Belief—Which of the following three statements do you personally believe? (Order rotated at random.)

    Climate change is happening now, caused mainly by human activities (NH 53; U.S. 52)
    Climate change is happening now, but caused mainly by natural forces (NH 36; U.S. 39)
    Climate change is NOT happening now (NH 5; U.S. 5)
    Don't know/NA (NH 5; U.S. 4)

Respondent background characteristics

Age—What is your current age? (mean 55 yr, std dev 16, range 18–96)

Gender—Male (49) or female (51)

Education—What is the highest grade of education you completed and got credit for?

    High school or less (21)
    Technical school or some college (22)
    College graduate (34)
    Postgraduate work (23)

Party—GENERALLY SPEAKING, do you usually think of yourself as a Republican, a Democrat, an Independent or what?

    Democrat (42)
    Independent (18)
    Republican (40)

Weather indicators

Temp—New Hampshire USHCN stations mean daily temperature anomaly relative to 1981–2010 normals. For 1 Jan 2010–23 Jul 2012, 1-day mean 1.35°C, std dev 4.06°C, range 12.26°–16°C.

Temp2—New Hampshire USHCN stations mean temperature anomaly on interview and 1 previous day. For the 99 interview days, 2-day mean 1.32°C, std dev 3.60°C, range 5.62°–11.96°C.

temperature and precipitation observations representing the weather across New Hampshire were obtained from the U.S. Historical Climatology Network (USHCN, http://cdiac.ornl.gov/epubs/ndp/ushcn/ushcn.html). The USHCN archive contains quality controlled records from a select group of high-quality, long-term weather stations that are adjusted for systematic biases (Menne et al. 2009). New Hampshire has five geographically dispersed USHCN stations that represent daily weather characteristics at relevant scales for temperature and regional circulation (Legates and Willmott 1990; Vinnikov et al. 2011).

Although all weather variables were considered, daily precipitation is difficult to quantify on a statewide basis because of the influences of terrain and season on the distribution of liquid and frozen precipitation. In New Hampshire, precipitation varies greatly in amount and type over short distances within the same regional weather pattern due to factors such as elevation and proximity to the coast. This leads to large differences among daily precipitation totals across the five USHCN stations. Daily snowfall amount and the depth of snow

on the ground are only relevant for surveys conducted during the snow season. Whether for measurement or for substantive reasons, the precipitation indicators we extracted (based on total precipitation or alternatively, occurrence of 1-inch events) show no relation to climate beliefs.

Spatial patterns in minimum and maximum temperature are more consistent at regional scales than any measure of precipitation (Vinnikov et al. 2011). Although absolute temperatures from individual New Hampshire stations differ, daily departures due to regional weather patterns strongly correlate between stations. One principal component captures 84% of the variance over our study period. Following Keim et al. (2003) we use the statewide mean of USHCN temperature anomalies as our regional index.

Table 1 describes two of the weather variables we extracted from station records and integrated with the dated survey data. Temp2 is average temperature anomaly for the interview and one day prior. This 2-day window gives the best overall fit in predicting climate beliefs, although we also tested many other windows.
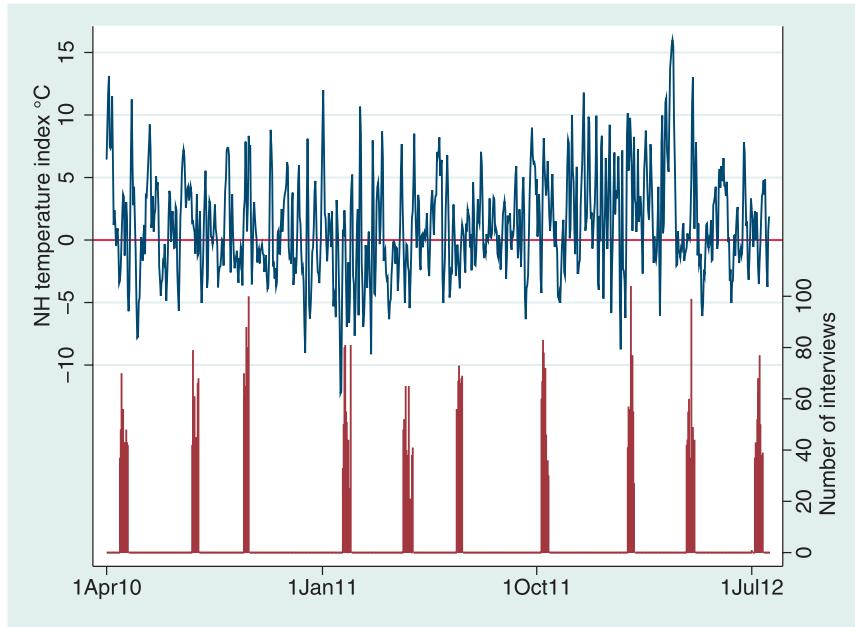
FIG. 1. Timelines of NH daily temperature index (mean deviation from 1981 to 2010 station normals) and the Granite State Poll: about 5000 telephone interviews in 10 surveys, spread over 99 separate days from April 2010 to July 2012.

Fig. 1 visualizes our time series. The upper curve tracks statewide temperature anomaly. The lower spike plot counts interviews on each date, across 10 surveys and more than 5000 interviews on 99 separate days.

4. Climate beliefs and temperature

Does short-term weather influence acceptance of the central point found in climate change statements by scientists? Table 2 shows results from three logit regression models. The dependent variable for each is a (0,1) indicator of whether people believe that climate change is happening now, caused mainly by human activities. Previous studies establish that age, gender, education, self-assessed understanding, and political orientation predict a wide range of climate-related beliefs. These are included as possible predictors in all three models. Odds ratios describe the multiplicative effects of a one-unit increase in each predictor on the odds of expressing a now/human belief. All background variables show statistically significant effects, in directions expected from previous research. Odds of a now/human response decrease with respondent age, are higher for women than men, increase with education and with self-assessed understanding, and are lower among Republicans than among independents and Democrats.

Model 1 is the base version, with season, two-day temperature anomaly, and the main effects of each background variable as predictors. Season exhibits no net effects. Unseasonably warm or cool temperatures on the interview day and the previous day, however, significantly shift the odds of believing that humans are changing the climate ($p = 0.023$).

Model 2 adds two complications. First, it incorporates party–education interaction terms in keeping with earlier studies. We find significant effects ($p < 0.0005$) in the expected direction: education raises the odds of agreeing with the scientific consensus among Democrats, does so more weakly among independents, and not at all among Republicans. Second, model 2 incorporates analogous party–temperature interaction terms. For independents only, the interaction proves highly significant ($p < 0.0005$)—indicating that temperature has a substantial effect for independents but not for people aligned with either party. Other models, not shown, tested for similar interactions between temperature and other background variables: age, gender, education, and understanding. Unlike party–temperature, these interactions proved weak and not significant. For parsimony and better precision, we omit them from the models of Table 2.

Model 3, a mixed-effects version of model 2, allows random intercepts to capture possible survey-to-survey variation that is not explained by variables in the model. Survey-to-survey variation could reflect unmeasured events such as political or economic developments,

TABLE 2. Individual characteristics, season, and temperature anomaly as predictors of belief that climate change is happening now, caused mainly by human activities. Model 1, weighted logit regression without interactions; model 2, weighted logit regression with interactions; model 3, mixed-effects logit regression with interactions and random intercepts for each of the 10 surveys (Fig. 1). Estimation sample $n = 4897$.

	Model 1		Model 2		Model 3	
	Odds ratio	p	Odds ratio	p	Odds ratio	p
Age	**0.983**	**0.000**	**0.982**	**0.000**	**0.982**	**0.000**
Gender	**1.434**	**0.000**	**1.425**	**0.000**	**1.422**	**0.000**
Education	**1.213**	**0.000**	**1.589**	**0.000**	**1.606**	**0.000**
Understand	**1.270**	**0.013**	**1.237**	**0.024**	**1.253**	**0.006**
Party						
Democrat	(Base category)		(Base category)		(Base category)	
Independent	**0.305**	**0.000**	0.692	0.136	0.740	0.177
Republican	**0.105**	**0.000**	**0.335**	**0.000**	**0.391**	**0.000**
Party–education						
Democrat	—		(Base category)		(Base category)	
Independent	—		**0.681**	**0.000**	**0.684**	**0.000**
Republican	—		**0.630**	**0.000**	**0.619**	**0.000**
Season						
Winter	(Base category)		(Base category)		(Base category)	
Spring	0.927	0.486	0.908	0.382	0.927	0.453
Summer	1.015	0.895	0.996	0.970	1.013	0.902
Fall	1.016	0.891	1.008	0.944	0.987	0.903
Temp2	**1.026**	**0.023**	0.998	0.887	1.000	0.976
Party–temp2						
Democrat	—		(Base category)		(Base category)	
Independent	—		**1.090**	**0.001**	**1.080**	**0.002**
Republican	—		1.015	0.528	1.002	0.941
Constant	3.781	0.000	2.133	0.001	1.969	0.001
					Std dev (SE)	p
Random intercept, 10 surveys	—		—		0.029 (0.090)	0.433

Boldface denotes individual odds ratio significant at $\alpha = 0.05$ or better. Wald test of interaction effects $p = 0.000$. Hosmer–Lemeshow goodness-of-fit test, observed responses vs predicted from model 2: $p = 0.722$ (model fits well). Model 2 correct classification rate 71%. Model 3 achieves no significant improvement by including random intercepts (likelihood ratio test $p = 0.433$).

scientific reports, or news coverage about weather in distant places. The mixed-effects model 3 offers no improvement over a simple logit model ($p = 0.433$), however. The standard deviation of random intercepts (0.029) is only a fraction of its own standard error (0.090), indicating that there is little survey-to-survey variation in responses beyond that accounted for by the predictors. Based on this null finding, we focus our interpretation on the more parsimonious but substantively similar model 2.

5. Interpreting the interaction effects

Temperature effects among independents, strongest over a 2-day window, remain statistically significant for 1–4-day, and for 30–210-day windows. They are positive, if not significant, for all windows. Our finding that a 2-day window shows the strongest effect presents an unexpectedly detailed agreement with Egan and Mullin's (2012) independent analysis.

The party–temperature interaction is visualized as an adjusted marginal plot in Fig. 2. Temperature anomaly over the past two days has little effect on the beliefs expressed by Democrats (high) or Republicans (low). The beliefs of independents, on the other hand, change with the weather. Adjusted probabilities of believing that climate change is happening now, caused mainly by human activities, shift from below 40% to above 70% over the $-6°$ to $+12°C$ range of temperature anomalies experienced on our interview days. The probabilities and 95% confidence bands graphed in Fig. 2 are calculated from model 2, adjusting for other predictors in that model.

In a related finding, Egan and Mullin (2012) report that political identity moderates the effects of temperature on responses to the question, "From what you've read and heard, is there solid evidence that the average temperature on earth has been getting warmer over the past few decades, or not?" They also find that Democrat and Republican responses are least affected by temperature. In their study, however, individuals who said they were "leaning" toward one party or the other show stronger temperature effects than either
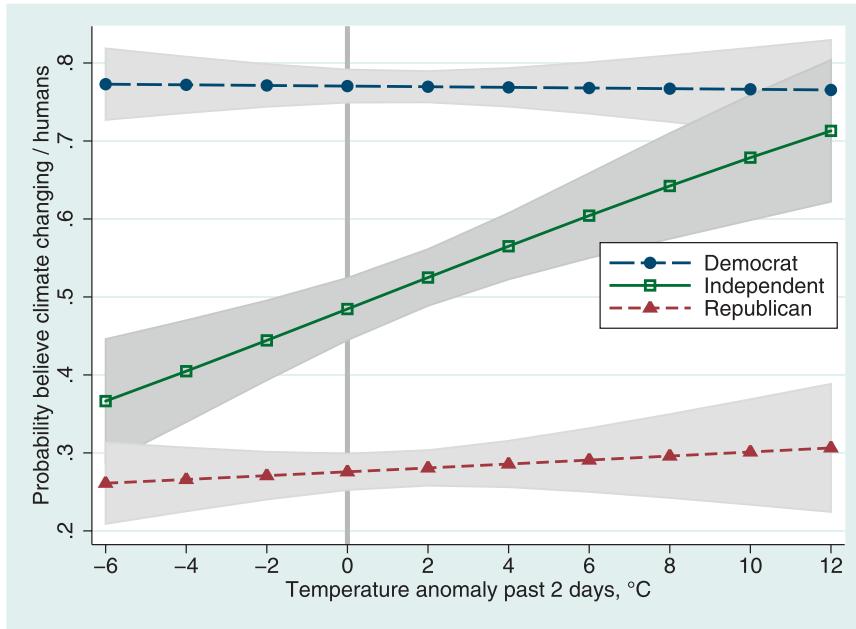
FIG. 2. Predicted probability of "climate change is happening now, caused mainly by human activities" response as a function of temperature anomaly and political party, adjusted for other variables in model 2.

partisans or independents. Egan and Mullin also report a temperature–education interaction that is weak or absent in our data. These contrasts might partly reflect different dependent variables, which in our case specify human causation. Attribution, more than the reality of warming, is now the main point of public contention.

The party–education interaction effect is graphed in Fig. 3. Consistent with previous studies, we see a strong positive effect of education among Democrats, a weaker positive effect among independents, and a near-zero effect among Republicans. This result is no longer surprising but widely enough replicated to
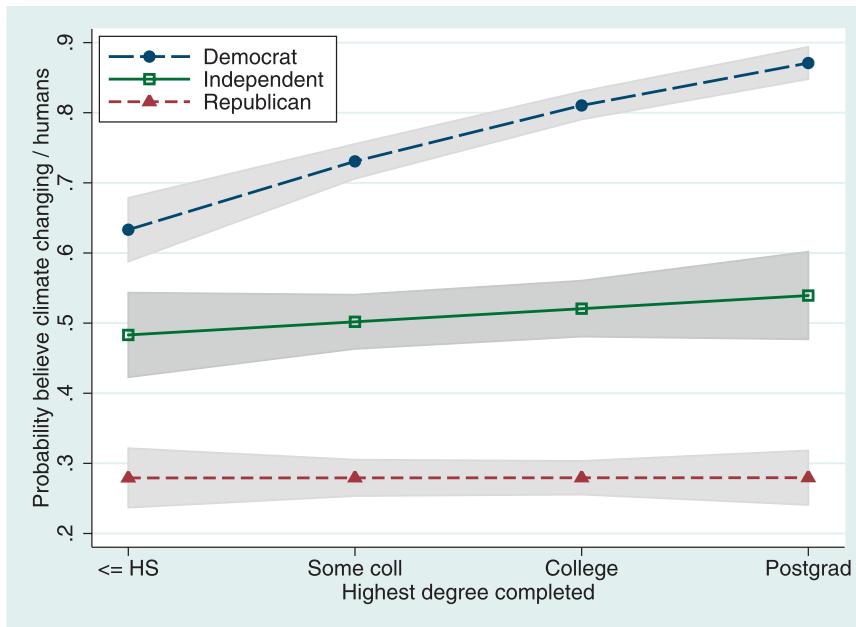

FIG. 3. As in Fig. 2, but as a function of education and political party.

merit inclusion with most analyses of climate change views.

6. Discussion

Distinctive features of our analysis include the following:

- Statewide data from 5000 random-sample telephone interviews conducted on 99 days over 2.5 yr (2010–12) are merged with temperature and precipitation indicators derived from USHCN station records.
- The dependent variable reflects agreement with scientific consensus statements that climate change is happening now, caused mainly by human activities.
- Individual-level independent variables are age, gender, education, political identity, and self-assessed understanding.
- Logit regression models include seasonal indicators, the political party–education interaction noted by other studies, and a party–temperature interaction.
- Random intercepts in mixed-effects logit models test for variation between surveys that is not explained by temperature, season, or individual respondent characteristics.
- Robustness of conclusions is supported by tests of alternative temperature windows, precipitation indicators, interaction effects, and model specifications.

We find that over 10 surveys, Republicans and Democrats remain far apart and firm in their beliefs about climate change. Independents average in between these extremes, but their beliefs appear weakly held—literally blowing in the wind. Interviewed on unseasonably warm days, independents tend to with the scientific consensus on anthropogenic climate change. On unseasonably cool days, they tend not to. These findings establish a climate science counterpart to poll-based and popular depictions of unaligned voters as a low-information group, who indecisively choose candidates for last-minute or superficial reasons (Galupo 2013; Kazin 2013).

Although the political classification of independents may vary from state to state, our self-identified New Hampshire independents generally resemble their counterparts on a nationwide survey that asked the same questions (Hamilton 2012). Independents comprise 18% of our New Hampshire estimation sample, compared with 17% nationally. They are similar with respect to education: 48% (NH) compared with 49% (U.S.) college graduates. The New Hampshire independent sample is slightly older (53 yr vs 46 yr) and more balanced with respect to gender (53% vs 57% male), but these differences fall within sampling uncertainty. Together with the similar NH and U.S. climate beliefs noted earlier, the comparisons suggest that our New Hampshire respondents are not wildly untypical.

Answering another recent national survey, many undecided voters said that they "need more information" on the issue and could "easily change their mind" (Yale Project on Climate Change Communication 2012). Such responses, like the volatility seen in our analysis, should encourage efforts at science communication to reach less partisan and committed segments of the population. Although undecided voters might be open to new information, however, they also fit a less sanguine image of people waiting for a change in the weather—that is, for personal experiences that feel consistent with "global warming."

Hansen et al. (2012) note that in a warming climate the distribution of temperature anomalies will shift upward, with positive anomalies and heat events becoming more frequent. If so, we could expect the average views of independents to shift toward the scientific consensus, becoming more like the average views of Democrats. Although temperature effects in our data are sharpest for just a 2-day window, we see positive and often significant effects for longer windows as well, suggesting at least some degree of persistence from mundane weather experience. Experience with extreme events probably has longer-term impacts (Egan and Mullin 2012; Goebbert et al. 2012). Personal weather experience may thus represent a persuasive, although globally unfortunate, path toward greater concern about climate change.

REFERENCES

Akerlof, K., E. W. Maibach, D. Fitzgerald, A. Y. Cedeno, and A. Neuman, 2013: Do people "personally experience" global warming, and if so how, and does it matter? *Global Environ. Change,* **23,** 81–91, doi:10.1016/j.gloenvcha.2012.07.006.

AMS, cited 2012: Climate change: An information statement of the American Meteorological Society. [Available online at http://www.ametsoc.org/policy/2012climatechange.html.]

Corner, A., L. Whitmarsh, and D. Xenias, 2012: Uncertainty, scepticism and attitudes towards climate change: Biased assimilation and attitude polarisation. *Climatic Change,* **114,** 463–478.

Doran, P. T., and M. K. Zimmerman, 2009: Examining the scientific consensus on climate change. *Eos, Trans. Amer. Geophys. Union,* **90,** 22–23, doi:10.1029/2009EO030002.

Egan, P. J., and M. Mullin, 2012: Turning personal experience into political attitudes: The effect of local weather on Americans' perceptions about global warming. *J. Polit.,* **74,** 796–809.

G8+5, 2009: G8+5 National Academies' joint statement: Climate change and the transformation of energy technologies to a low carbon future. National Academies of Brazil, Canada, China, France, Germany, India, Italy, Japan, Mexico, Russia, South Africa, United Kingdom, and United States, 2 pp. [Available online at http://www.nationalacademies.org/includes/G8+5energy-climate09.pdf.]

Galupo, S., cited 2013: Swing voters swing because they're uninformed. [Available online at http://www.usnews.com/opinion/blogs/scott-galupo/2011/03/15/swing-voters-swing-because-theyre-uninformed.]

Goebbert, K., H. C. Jenkins-Smith, K. Klockow, M. C. Nowlin, and C. Silva, 2012: Weather, climate, and worldviews: The sources and consequences of public perceptions of changes in local weather patterns. *Wea. Climate Soc.,* **4,** 132–144.

Hamilton, L. C., 2008: Who cares about polar regions? Results from a survey of U.S. public opinion. *Arct. Antarct. Alp. Res.,* **40,** 671–678.

——, 2010: Do scientists agree about climate change? Public perceptions from a New Hampshire survey. *New England Issue Brief,* No. 22, Carsey Institute, University of New Hampshire, Durham, NH, 1–7.

——, 2011a: Do you believe the climate is changing? Answers from new survey research. *New England Issue Brief,* No. 40, Carsey Institute, University of New Hampshire, Dunham, NH, 1–7.

——, 2011b: Education, politics and opinions about climate change: Evidence for interaction effects. *Climatic Change,* **104,** 231–242.

——, 2012: Did the Arctic ice recover? Demographics of true and false climate facts. *Wea. Climate Soc.,* **4,** 236–249.

——, and B. D. Keim, 2009: Regional variation in perceptions about climate change. *Int. J. Climatol.,* **29,** 2348–2352.

——, M. J. Cutler, and A. Schaefer, 2012: Public knowledge and concern about polar-region warming. *Polar Geogr.,* **35,** 155–168.

Hansen, J., M. Sato, and R. Ruedy, 2012: Perceptions of climate change. *Proc. Natl. Acad. Sci. USA,* **109,** E2415–E2423, doi:10.1073/pnas.1205276109.

Joireman, J., H. B. Truelove, and B. Duell, 2010: Effect of outdoor temperature, heat primes and anchoring on belief in global warming. *J. Environ. Psychol.,* **30,** 358–367.

Kahan, D. M., H. Jenkins-Smith, and D. Braman, 2011a: Cultural cognition of scientific consensus. *J. Risk Res.,* **14,** 147–174.

——, M. Wittlin, E. Peters, P. Slovic, L. L. Ouellette, D. Braman, and G. N. Mandel, 2011b: The tragedy of the risk-perception commons: Culture conflict, rationality conflict, and climate change. Temple University Legal Studies Research Paper 2011-26, 31 pp. [Available online at http://ssrn.com/abstract=1871503.]

Kazin, M., cited 2013: The trouble with independents: What if these voters are just a clueless horde? [Available online at http://www.newrepublic.com/article/not-even-past/87379/republican-democrats-independents-dewey-lippmann.]

Keim, B. D., A. M. Wilson, C. P. Wake, and T. G. Huntington, 2003: Are there spurious temperature trends in the United States Climate Division database? *Geophys. Res. Lett.,* **30,** 1404, doi:10.1029/2002GL016295.

Legates, D. R., and C. J. Willmott, 1990: Mean seasonal and spatial variability in global surface air temperature. *Theor. Appl. Climatol.,* **41,** 11–21.

Lewandowski, G. W., Jr., N. J. Ciarocco, and E. L. Gately, 2012: The effect of embodied temperature on perceptions of global warming. *Curr. Psychol.,* **31,** 318–324.

Li, Y., E. J. Johnson, and L. Zaval, 2011: Local warming: Daily temperature change influences belief in global warming. *Psychol. Sci.,* **22** (4), 454–459.

Lord, C. G., L. Ross, and M. R. Lepper, 1979: Biased assimilation and attitude polarization: The effects of prior theories on subsequently considered evidence. *J. Pers. Soc. Psychol.,* **37,** 2098–2109.

McCright, A. M., 2011: Political orientation moderates Americans' beliefs and concern about climate change. *Climatic Change,* **104,** 243–253, doi:10.1007/s10584-010-9946-y.

——, and R. E. Dunlap, 2011: The politicization of climate change: Political polarization in the American public's views of global warming. *Sociol. Quart.,* **52,** 155–194.

Menne, M. J., C. N. Williams Jr., and R. S. Vose, 2009: The U.S. Historical Climatology Network monthly temperature data, version 2. *Bull. Amer. Meteor. Soc.,* **90,** 993–1007.

Munro, G. D., and P. H. Ditto, 1997: Biased assimilation, attitude polarization, and affect in reactions to stereotype-relevant scientific information. *Pers. Soc. Psychol. Bull.,* **23,** 636–653.

Notz, D., and J. Marotzke, 2012: Observations reveal external driver for Arctic sea-ice retreat. *Geophys. Res. Lett.,* **39,** L08502, doi:10.1029/2012GL051094.

NRC, 2010: *Advancing the Science of Climate Change.* National Academies Press, 528 pp.

Oreskes, N., 2004: Beyond the Ivory Tower: The scientific consensus on climate change. *Science,* **306,** 1686, doi:10.1126/science.1103618.

Rahmstorf, S., G. Foster, and A. Cazenave, 2012: Comparing climate projections to observations up to 2011. *Environ. Res. Lett.,* **7,** 044035, doi:10.1088/1748-9326/7/4/044035.

Richardson, K., Coauthors, Eds., 2009: Synthesis report: Climate change; global risks, challenges and decisions. University of Copenhagen, 39 pp.

Risen, J. L., and C. R. Critcher, 2011: Visceral fit: While in a visceral state, associated states of the world seem more likely. *J. Pers. Soc. Psychol.,* **100,** 777–793.

Shao, W., 2012: Understanding public perceptions of global warming. Ph.D. dissertation, Louisiana State University, 156 pp.

Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K. Averyt, M. M. B. Tignor, and H. L. Miller Jr., Eds., 2007: *Climate Change 2007: The Physical Science Basis.* Cambridge University Press, 996 pp.

Trenberth, K. E., and J. T. Fasullo, 2012: Climate extremes and climate change: The Russian heat wave and other climate extremes of 2010. *J. Geophys. Res.,* **117,** D17103, doi:10.1029/2012JD018020.

Vinnikov, K. Y., Y. Yu, M. D. Goldberg, M. Chen, and D. Tarlpey, 2011: Scales of temporal and spatial variability of midlatitude land surface temperature. *J. Geophys. Res.,* **116,** D02105, doi:10.1029/2010JD014868.

Yale Project on Climate Change Communication, 2012: Climate change in the American mind: The potential impact of global warming on the 2012 presidential election. Yale University and George Mason University, 11 pp. [Available online at http://environment.yale.edu/climate/publications/global-warming-2012-election/.]