PSYCHOLOGY

Local weather and climate concern

Americans are more likely to believe in global warming when it's hot outside. A study now provides insights on why this reasoning process is not easily changed.

Patrick J. Egan and Megan Mullin

A growing body of research shows that the beliefs and concerns many Americans have about catastrophic climate change are susceptible to variations in the weather itself. These are disconcerting findings for anyone desiring an informed public discussion about global warming. Writing in *Nature Climate Change*, Lisa Zaval and colleagues[1] report a series of Web-based experimental studies that help explain the responsiveness of climate change attitudes to weather patterns. Their findings show that the complexity of the climate change problem combined with the salience of our experiences of local weather produce — yes — a 'perfect storm' in which individuals' attitudes about global warming are unduly influenced by the weather outside their windows.

The evidence for the effect of weather on public opinion regarding climate change is now overwhelming. Belief in climate change and concern about its consequences is more likely among those who perceive the weather to be warmer[2–4] and among those who, according to weather data, have actually experienced unusually hot weather prior to being interviewed[5–9].

Whatever the explanation for these findings may be, it is not because Americans lack information. Since James Hansen's ground-breaking testimony on human activity and planetary warming before the US Senate in 1988, the public has experienced a quarter-century of sustained attention to the climate change problem by experts and elites, including, by our count, no fewer than 180 congressional hearings, 744 news stories on broadcast TV networks and 940 articles in the *New York Times* in addition to approval by the House of Representatives of major legislation to address the problem in 2009.

So, do individuals forget this kind of information when responding to survey questions about global warming? Zaval and co-authors reject this explanation. In one of their experiments, participants were randomly assigned to read a short passage about how weather variability is a poor indicator of climate change. The association between these subjects' perceptions of local temperatures and their attitudes about global warming was, nevertheless, just as strong when compared with those in a control group. Another experiment ruled out the explanation that the weather's effect comes down to the wording of the questions. Perceptions of local temperature play the same strong role in affecting attitudes, regardless of whether the problem is called 'global warming' or 'climate change'.

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Figure 1 | Unusually cold weather throws water on belief in climate change, but warm weather heats it up.

Our experience of weather seems to short-circuit the pathways through which we reach good judgments. Previous research found that merely placing individuals in a warm room makes them more likely to report their belief in global warming[10]. Zaval and colleagues show that an even simpler prime is to parse sentences with heat-related words like 'boils', 'sunburn' and 'roasted'. This leads experimental subjects to be more likely to report that they believe in global warming and are concerned about its effects.

This process is known as attribute substitution, and is an aspect of human fallibility in decision making that can apply to our thinking about difficult public policy issues[11]. Instead of engaging in a careful assessment of the complex attributes of the issue at hand, we substitute similar ones that come more easily to mind. We then proceed to render our judgment based on our evaluation of these substituted attributes. The vulnerability of our reasoning about global warming to attribute substitution stems from three intersecting factors: climate change is hard to understand, local weather is highly salient and it has attributes that seem to be relevant to the question of global warming's existence.

If attribute substitution is at work, the perceptions of temperature that should have the most influence on climate change judgments are those that are immediately accessible, which should also influence the recall of other temperature events. Zaval and colleagues find support for both these implications: priming attention to temperature amplifies its effect only for the current day's weather, not for the preceding day, and perceptions of warmth for the current day increase the belief that recent weather has been unusually warm.

What do these findings imply for the public's understanding of climate change? To be sure, they will disappoint those who wish that the long-standing public debate on climate change were actually closing the

gap between the scientific consensus and the public's divided beliefs.

But as troubling as the 'local warming' effect may be, it is not unusual: individuals regularly make assessments about society-wide conditions (like unemployment or crime) from their own experiences (of, say, losing a job or being mugged on the street). Considering that one of the chief effects of global warming is to raise the prevalence of unusually hot days, drawing conclusions about the existence of global warming from local weather is not entirely irrational. Zaval and colleagues show us that such reasoning stems from placing undue weight on this highly salient information compared with other information — like scientific research — that is much more relevant. The challenge facing scientists and climate change communicators is to raise the awareness of this latter information so that Americans might be encouraged to focus on large-scale patterns rather than the weather outside. ❐

Patrick J. Egan is in the Department of Politics, New York University, 19 W. 4th Street, New York, New York 10012, USA. Megan Mullin is in the Department of Political Science, Temple University, 1115 Polett Walk, 4th Floor Gladfelter Hall, Philadelphia 19122, USA.
e-mail: patrick.egan@nyu.edu; mmullin@temple.edu

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ATMOSPHERIC SCIENCE

A boost in big El Niño

Computer models and theory do not offer a consensus on how El Niño will change under global warming. Despite this disagreement, a study indicates a robust increase in the frequency of extreme El Niño episodes.

Nathaniel C. Johnson

About once every four years, on average, one of the most powerful and far-reaching climate phenomena, known as El Niño, extends its influence to most continents and oceans of the world. This phenomenon, which originates in the tropics and is characterized by unusually warm and wet conditions in the equatorial eastern Pacific Ocean, triggers large-scale weather patterns that disrupt remote regions through floods, droughts, heat waves and cold spells. During extreme El Niño episodes, as occurred in 1982/83 and 1997/98, the worldwide societal, economic and environmental impacts have been particularly costly, with damages totalling in the tens of billions of US dollars and thousands of lives lost[1]. Although the physical mechanisms and effects of El Niño in today's climate are relatively well understood, there is considerable uncertainty regarding how the El Niño phenomenon will respond to global warming[2]. Even in the face of this uncertainty, in this issue of *Nature Climate Change* Cai and colleagues[3] identify and report on a robust change in climate models — extreme El Niño episodes will increase in frequency under global warming.

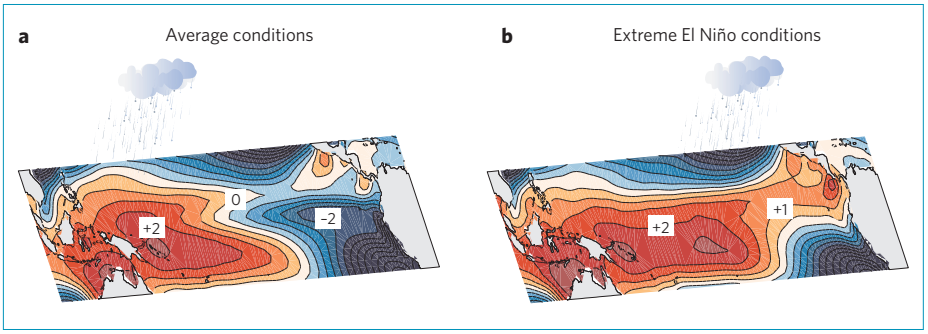

Figure 1 | Illustration of extreme El Niño conditions. **a**, Average sea surface conditions during austral summer (December–February). The filled contours represent the sea surface temperatures (°C) relative to the long-term, area-averaged (20° S–20° N) tropical mean (that is, a value of zero is the long-term tropical mean, ~27 °C in the current climate). Warm (cold) colours represent sea surface temperatures above (below) the tropical mean. Most of the tropical deep convection and heavy rainfall occur in the western equatorial Pacific Ocean. **b**, Sea surface conditions during extreme El Niño episodes. The eastern equatorial Pacific warms dramatically, the sea surface temperature gradient nearly vanishes, and most of the deep convection shifts to the central and eastern equatorial eastern Pacific.

Usually, during austral summer, which is the peak season of El Niño, conditions in the equatorial eastern Pacific Ocean region are very dry and relatively cool and most tropical ocean rainfall is confined to the warmer western Indo-Pacific region (Fig. 1a). During typical El Niño episodes, the eastern Pacific Ocean warms considerably and tropical rainfall shifts towards the equatorial central Pacific, but the equatorial eastern Pacific stays dry because the atmosphere remains stable. However, more dramatic eastern Pacific warming during extreme El Niño episodes disrupts the eastern Pacific sea surface temperature gradients, breaks the stability barrier and triggers enormous increases in deep showers and thunderstorms (Fig. 1b). This atmospheric convection, manifesting as heavy rainfall, is the primary driver of El Niño-related extreme weather in remote regions. Cai and colleagues focus on the